

HALOL NAGARPALIKA

**TALUKA: - HALOL
DIST: - PANCHMAHAL**

VOLUME –

TECHNICAL SPECIFICATIONS – ELECTRO-MECHANICAL

Bid Documents for

**CHIEF OFFICER
HALOL NAGARPALIKA
HALOL**

HALOL Dist PANCHMAHAL

VOLUME

SR.NO.	PARTICULAR	Page No.
1	INFORMATION OF THE TENDER	3
2	EXTENT OF WORK	5
3	TECHNICAL SECTION	6

CONTRACTORS TO READ CAREFULLY

- 1.0 Guarantee: All the materials / equipment shall be governed by guarantee of 12 months from the date of taking over of installation against any manufacturing defects, design & workmanship. Also, any malfunctioning of equipment / system due to faulty installation / design manufacturing process etc. shall be rectified free of cost by Contractor.
- 2.0 Tenderers are requested to furnish the information required in TECHNICAL DATA SHEET without fail. In case of not furnishing the details, tenders will be out rightly rejected.
- 3.0 Delivery of pumps within **45 days from the date of successful inspection** shall be confirmed by the Original Manufacturers.
- 4.0 The quantities indicated in the minimum BOQ are tentative to appraise the bidder about magnitude of the work & likely to vary during execution and the contractor shall have no objection to such minor or major changes or deletion or addition of the item. The sizing indicated in the minimum BOQ is binding to contractor and size smaller/ lower than this shall not be permitted. However, in case higher/ larger size is required as per Conceptual Design Report, it shall be provided at no extra cost. Quantities given for electro-mechanical items are indicative but minimum required to be supplied. However, bidder shall execute the items as per requirement in field. Payment shall be made on the unit rate determined for particular item on the basis of ratio of estimated cost put to tender and rate approved for award of contract. This being turnkey tender, any item specifically not mentioned in the BOQ but required for approval of the competent authority is deemed to be covered in the project.
- 5.0 Contractor has to maintain minimum pump efficiency as offered by them at the time of tendering for all works under this project throughout their contractual period. Contractor has to produce certificate along with results for efficiency every six month from ERDA Baroda. If efficiency is found less, then penalty will be levied & it will be binding to the contractor. Expenditure for measuring the efficiency, if any shall have to be borne by the contractor; no extra claim will be given.
- 6.0 Contractor has to provide make of pump, motor, valves, panel etc. from NAGARPALIKA approved make prior to submit the document for approved of drawings amongst approved vendor list and Quality Assurance Procedure etc. make will be finalized by competent authority. Quantity of items in schedule can be deleted as per site requirement/ at the time of execution. Contractor has no right to claim for deletion of items.

Extent of Work

Extent of work

The scope includes Supply, Installation & testing at manufacturer's works, delivery to site, Unloading & Storage at site, Installation testing at site, commissioning final painting at site, under at Water Head works.

1.MECHANICAL WORKS:

- (a) Supply, Installation, Testing and Commissioning of Vertical Turbine /Horizontal Split Casing Centrifugal / Mono-set / Submersible Pump sets as per details attached with Base plate, foundation Bolts, Flexible couplings, priming arrangements etc. with suitable capacity of electric motor.
- (b) C.I. Butterfly/ Sluice valves on Suction/ Delivery / Header Line
- (c) Dual Plate Check Valve /Non-return Valve on Delivery / Header Line
- (d) Pump house piping system for suction, delivery and common header line consisting of M.S. pipes, specials, flanges, etc., inclusive of connection of common header line with rising main outside the pump house with nut bolts, gaskets, joining material etc., as per requirement.
- (e) Pressure Gauge at outlet of each pump and on header line.
- (f) Electro-magnetic flow meter
- (g) Expansion bellows (as per relevant IS)

2. ELECTRICAL WORKS:

- (A) Suitable capacity L.T. motor control center designed to accommodate suitable Nos. of motor starter feeders according to motor H.P. with suitable starting incoming MCCB, capacitor banks, overload, earth protection relays metering instruments, indicating lamps etc. complete as per outline single line diagram (SLD) provided
- (B) Suitable size L.T. Power and control cable as per requirement with required accessories such as lugs, glands etc.
- (C) Earthing and lightning protection.
- (D) Miscellaneous items necessary to complete the installation in all respect and as described in specification
- (E) L.T. & HT cables and end termination
- (F) Liaising work, with local electricity authority.
- (G) Operation and maintenance including comprehensive maintenance of pumping station, mechanical and electrical equipment for 60 Months.
- (H) Transformer of required capacity at Head Work with necessary accessories.
- (I) 11 kV two pole MS structure fabricated from rolled structure
- (J) A draw out type Vacuum Circuit Breaker of required capacity for transformer ratings above 500KVA
- (K) Provision for remote starting of individual motors in the Inlet works by operating the starters in MCC located in the Pumping Station through push buttons located in HV switchgear room with Local / Remote Control switch.
- (L) Miscellaneous items necessary to complete the installation in all respect and as described in Schedule B and Specification.

3. CIVIL WORK:

- (A) Equipment foundation for pump sets, M.C.C. Panels, Transformers, and other electrical and mechanical equipment as per specification.
- (B) Thrust Blocks, Support for pipe and valves, valve chamber & other structural works. Puddle pipe and related civil works.

Technical Section

1.0 Vertical Turbine Pump

1.0 GENERAL TECHNICAL SPECIFICATIONS OF SUBMERSIBLE PUMPS SETS.

The pump set should be of steady constructed to lactate manual loading an unloading requirements. It should be repairable in workshop with minimum cost and should have last wearing parts of replaceable. Feature and easy re- windability of electric motors and of economy in repairs are over riding consideration after meeting the basic Hydraulic. Electrical and Mechanical performance needs. Pumps should generally confirm to IS: 8034 and motors should confirm to IS:9283 revised upto date.

The duty point of the set should be located at the optimum efficiency point of the pump rating curves and there should not be steep fail in efficiency in the range of+ l 0% and -25% in head variation. The verification of the pump sets performance will be as per relevant latest IS at rated voltage. the pump with lesser number of stages will be preferred.

The minimum overall (Pump and motor combined efficiency without any minus tolerance minimum motor Horse power rating, cable size starting system and delivery pipe size shall be as per Annexure - I attached.

The E.E.,C.P.Dn.3,G'nagar reserves the right to ask the tendering firm to give test check of the product at tender consideration stage itself.

PUMP: -

The pump should confirm to IS: 8034. Bowl's should be free from Blow Holes, stage inclusive and other detrimental defects. Bowls should be provided with renewable wearing rings except in radial flow pump set.

Bowls provided with wearing rings should be suitable or lubricated by water and shall be of superior quality. The aliment of wearing rings with interact fir or locking compounds is to be done. Casing should be hydraulically tested up to 1.5 times shut off pressure.

IMPELLER: -

Impeller should be of closed type, ensuring required performance and free of cavitations.

The materials of impeller will be as per Annexure -II.

SHAFT:-

The pump shaft will be guided by bush bearings provided in bowl wherever required. Below the impeller shaft assembly. Shaft proc Suction casing with strainer should be of minimum thickness for SS-0.5 mm or Brass 1 .0 mm.

BEARING SLEEVE:-

The material for the will be as per Annexure -II.

NON-RETURN VALVE:-

Non return valve will be provided with the pump discharge casing. NRV design shall be for instant closing of the NRV. NO back pressure should develop which may adversely affected the pump set. It should have k-factor within the limits of IS: 10805 NRV losses shall not be higher than 0.8 meter at rated flow. A separate test for K-factor is not required. However, the internal lest report of NRV is to be reviewed.

MOTOR:-

The motor shall conform to IS.9283. It should be designed for 400 + 10% and -15% volts, 3 phase 50 cycles. It should be totally enclosed squirrel cage induction type water cooled and water cooled, and water fabricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearings should be of well type water lubricated and provided with metal filing thrust pads, designed to take all lower load at most unfavorable running conditions.

The ball used in the thrust Assembly should be as per Annexure -II. Upper and lower bearing housings and thrust bearing housing should preferably be fixed separate replaceable bolts/studs and (not threaded connections) to line stator to facilitate easy dismantling. The inspection agency will open the motor base and check the thrust bearing and fitting pad type. If the fiber thrust bearing is provided, then it shall be marked with indelible ink.

Full proof sealing arrangement by sand guard shall be provided in the Motor inlet body to prevent tube well water impurities like sand, silt from entering the motor bearing stator and rotor should be impregnated with a superior varnish Class-B thermal insulation properties by vacuum pressure or epoxy paints on stator when cold rolled stamping used and rotor shall be painted with polyurethane paint & backed for at least 1/2 hour under controlled temperature condition and not by manual or gravity flow to remove air pocket so that these are thoroughly filled up by varnish. The motor rotor should be preferably lead shot blasted. Subsequently, rotor body should be baked repeatedly under controlled conditions to ensure long life of paint and hard finish to the surface to avoid corrosion before powder coating. The rotor shall be as per Annexure -II and provided with sleeves having materials as per Annexure -II in the bearing portion. The winding should be accessible. To facilitate checking and locating any faults without discharging all the coils and also to enable replacement of any defective coils. It should be possible to rewind the stator with readymade prelisted coils in order to save time during the repair. Kelvin bridge / digital resistance meter shall be treated preferably for measurement of hot and cold resistance of winding for evaluated temperature rise. Any deviation above should be indicated clearly. Full proof arrangement should be made for stopping the rotating of shifting of stampings

inside the stator body due to operation of pump sets. Earth leakage current should not be more than 50 milliamperes at rated voltage.

The quoted H.P. of motor should meet both the following conditions:

1. The minimum power margin over and above the duty point shall be 1.5%. The offered motor should not have output rating less than that mentioned in the Annexure -. (under the column Ml O.HP) in any case. The motor rating shall be equal to or higher than that mentioned in the Annexure -I. According to offered overall efficiency. However the motor shall not get overloaded during the specified 1 load range to the 2.5% over duty point head as per IS.
2. The motor should not get overloaded in the range of + 10% & (-) 25% of the specified pump head. The meaning of overload will be as per IS:8034. The HP rating of motor shall be selected from the following rating 3,4,5,6,7,8,10,12.5, 15, 17.5, 20, 22.5, 25, 27.5, 30, 35, 40, 50, 55, 60, 65, 70, 75, 80, 85, 90, 100, 110, 125, 135, 150, 160. The motor shall have the name plate giving the following information's.
 - a) name of the manufacturer
 - b) Motor make/model
 - c) Mfg's no and frame reference and sr.no.

- d) Frequency Hz
- e) Numbers of phase
- f) Rated output in KW/HP and current in Amperes
- g) Rated voltage
- h) Winding connection
- i) Rated RPM
- j) year of manufacture

Note: starting method : Up to to 7.5 HP, D.O.L. starter, 8 to 20 HP star delta and 21 H.P. & above Auto transformer starter type. Venders to submit cross sectional drawing of pump motor and non return valve with clear indication of material specification for the major components covered under specification.

Cable: Motor shall be provided with three core flat PVC water proof and flat flexible copper cable of 5 Rmt. length and suitable size. The cross sectional areas should be sufficient so as not to cause voltage drop of more than 2.5% of nominal voltage i.e. 10 volts at 400 volts throughout the length of the cable size of the flat cable will be as per attached Annexure - I.

Please confirm following by striking either Yes / No as actually applicable to offer made.

1.	Pump as per IS: 8034 with latest amendment.	YES / NO
2.	Bowl individually tested to hydraulic test pressure 1.5 times of shut off pressure.	YES / NO
3.	All rotating parts should be individually balanced on machine for minimum 700 RPM (and vibrations of the assembly during the testing shall not exceed to 80 micron peak to peak)	YES / NO
4.	Impeller closed type	YES / NO
5.	Bowl materials as per Annexure -II	YES / NO
6.	Impeller material as per Annexure -II	YES / NO
7.	Pump shaft material as per Annexure -II	YES / NO
8.	Suction casing materials as per Annexure -II	YES / NO
9.	Bearing sleeve materials as per Annexure -II	YES / NO
10.	coupling material as per Annexure -II	YES / NO
11.	casing wearing materials as per Annexure -II	YES / NO
12.	Discharge casing/ last stage bowl as per Annexure -I	YES / NO
13.	Stud & Nylon nut of alloy steel.	YES / NO
14.	Motor as per IS:9283 of with latest amendment.	YES / NO
15.	Wet type	YES / NO
16.	Tilling type thrust pads	YES / NO
17.	Ball of fitting bearing	YES / NO
18.	Brass/Carbon steel drain plug provided	YES / NO

19.	Compensating device provided	YES / NO
20.	Stator varnished by Vacuum pressure method or Epoxy painted (if cold rolled stamping used.)	YES / NO
21.	Rotor varnished by Poly Vacuum pressure method or urethane paint duly properly backed.	YES / NO
22.	Rotor painted and baked under consoled conditions or powder coated	YES / NO
23.	Winding easily as tumble	YES / NO
24.	Winding subjected to 1.8 KV after 24 hours	YES / NO
25.	Matching grooves for stopping stamping from rotation and shifting.	YES / NO
26.	The rotating component shall be dynamically balance on machine for minimum 700 RPM	YES / NO
27.	Stamping treated chemically to recover unwanted substance and impurities and the material shall be as per Annexure -II.	YES / NO
28.	Rotor lead /sand/ steel shot blasted.	YES / NO
29.	Thrust plate lapping is done on machine and the limit is 0.3 micron.	YES / NO
30.	The maximum outside diameter of pump & motor with cable and glands shall be 280 mm, 190/192 mm and 140/142 mm respectively for 300 mm, 200 mm and 150 mm tube well where as the minimum outside diameter of pump & motor shall be suitable to the respective dia. of the tube well so that the same can be easily lowered into or removed form the relevant tube wells. This mean that pump & motor of 142 dia shall be offered for 150 mm ia tube well only and not for 200/300 mm dia tube well. Similarly pump & motor of 190/192 mm dia. shall be offered for 200 mm dia. Tube well only and not for 300 mm dia. tube well and pump & motor of 280 mm dia. shall be offer for 300 mm dia. tube well only. Also dia of pump & motor shall be the same in any case mentioned above. In no case mismatching will be entertained. IN case of such mismatching the offer shall liable for rejection.	YES / NO
31.	Entrance velocity of water in the pump should not be more than 3.6 mt/sec.	YES / NO
32.	Sand guard provided as per Annexure -II.	YES / NO
33.	SS/Brass sanction screen provided.	YES / NO
34.	Stud and Nylon nuts of alloy steel.	YES / NO
35.	Stator end ring shall be of bronze metal or M.S.	YES / NO
36.	Stator is rewind able with readymade presorted coils in each type of motor offered.	YES / NO
37.	Cable conforming to IS:694.	YES / NO

Note: The material component should be as per relevant IS and with latest revision except that shown in Annexure-11. If any details are missing or further clarifications required the same should be

got clarity during pre-bid conference or otherwise the decision as may be taken their after shall be binding to all.

Marking: The methods of marking all the pumps to be delivered under scope of contract shall ensure that all the information will remain legible even after transportation, storage in open space etc. In general, the legible and marking upon the good shall indicate the following.

Any other important dealer that the manufacture deemed fit to be inscribed.

ANNEXURE-I

Performa for electrical details to be filled din for individual items:

Sr. No.	Pump Details	Suitable for Borewell
1.	Capacity in LPM	
2.	Head in motor	
3.	Type of pump	
4.	Maximum outside diameter of pump set including cable thickness in mm	
5.	No. of stage	
6.	Maximum bowl dia. in mm	
7.	pump efficiency at duty point %	
8.	NRV size in mm	
9.	Pump input at duty point (KW)	
10.	Minimum submergence required in mtr.	
11.	Specific speed	
12.	Head indicated in Schedule -G are in meters and are inclusive of head losses from all causes including NRV head losses.	
13.	Characteristic curves should over complete rate of operation i.e. minimum operation head to shut off head.	
14.	MOTOR DETAILS:	
15.	Motor rating (HP/KW)	
16.	Synchronous motor sped (RPM)	
17.	Efficiently of motor at full load	
18.	Efficiently of motor at duty point	
19.	Power factor at full load	
20.	Power factor at duty point	
21.	Method of starting (Star Delta/A.T.S/D.O.L.)	
22.	a) Current at duty point	
23.	b) Current at duty point	

24.	c) RPM at full load	
25.	d) RPM at duty point	
26.	e) Starting current as percentage of full load current.	
27.	f) Starting torque at percentage of full load torque	
28.	g) Method at starting	
29.	Motor input at duty point	
30.	Reserve power of motor (Minimum 15% more than duty point condition)	
31.	Maximum dia. of motor in mm	
32.	CABLE:-	
33.	Size of cable	
34.	Make of cable	
35.	Maximum current carrying capacity of cable.	
36.	OVERAL EFFICIENTY OF UNIT: -	
37.	Please confirm materials as per specification otherwise state the variation.	
38.	Performance curves of pump and motors are required as	
39.	(i) Discharge V/s Head.	
40.	(ii) Discharge V/s Power input KW	
41.	(iii) Discharge V/s Overall efficiency of pump set	
42.	(iv) Submersible motor characteristic curves as under:	
43.	a) load V /s power factor	
44.	b) load V /s RPM	
45.	c) load V /s efficiency	
46.	d) load V /s current	
47.	Cross section drawing for both pump and motor showing clearance at bearings wearing run out and material specification for major component's	

TESTING: -

Pumps shall have to be tested as per IS 8034/1 l 346 and motor will be tested as per IS:9283 at manufactures work with NRV fitted.

1. Wherever the IS specified it shall be as per latest revision.
2. Winding wires shall have to be utilized as per latest IS: 8034 and 9283.
3. Pumps will be lasted with NRV fitted.
4. Suppliers have to give internal tests report.
5. The firm has to maintain and produce proper records such as calibration of instruments etc. for variation by inspecting agency.
6. The leakage current of submersible pump set shall not exceed 50 mile ampere at rated voltage.

ANNEXTURE - II

Sr. No.	Particulars	Material
1.	Material at stator casing	M.S. carbon steel seamless pipe SS welded pipe or M.S. sheet welded pipe
2.	Stamping	Silicon steel cold Rolled M-45 or M-47 / or S-23 or Hot rolled B-630 SAIL material preferred I sample of GKW preferred.
3.	Thrust Bearing Housing thrust	a) Bearing Housing FG 200-260 plate
		b) Thrust plate GM with fiber plate (Ferro Asbestos) or SS with carbon plate
	Segments (if provided)	c) Segments: Bronze or Chrome steel
	Ball Retainer (if provided)	d) Ball Retainer - Bronze OH steel
	Steel ball	e) Steel ball - SS chrome steel AISI- 410
4.	Bearing Bush	LIB3 of LTB4 of IS:318- 1981
5.	Motor shaft with rotating sleeve	Motor shaft carbon steel Grade C- 45 or technically suitable superior quality grade IS-1570 (part-II) I 979 with rotating sleeve AISI 41 0/SS- 431 of shaft of AISI-410.
6.	Pressure sustaining components	C.I. Grade FG 200/260 of IS:210 / 1978
7.	Impeller	AB2 or SS CR 12 or 13 of IS; 1570 (part-V) 1978 or Gun metal (85/5/5/5) LT8-2. IS 318/1981. Glossy Glass filled Polyphenylene oxide as per IS 8024-2002
8.	Neck ring/ Casing wear ring (if provided)	LTB 3 or LTB 4 of IS: 318/1981
9.	Bowl	C.I. Grade FG 200/260 of IS:210 /1978
10.	Shaft pump	IS: 1570 (Part-V) or 12 Cr. 13 or AISI 41 0/420.
11.	Suction casing / Discharge casing. / Last stage Bowl	C.I. Grade FG 20/260 of IS:210/1978.
12.	Strainer	SS 0.5 mm (Mini Thickness) or Brass 1.0 mm (mini. Thickness)
13.	Sand Guard	Bronze or Nitrite Rubber NB-70
14.	Coupling sleeve	Chrome steel AISI-410
15.	Bearing sleeve	AISI 410

1.A SUBMERGED CENTRIFUGAL PUMPSETS

1. The pump set shall be of compact mono block solid shaft, motor above the pump. The pump casing shall be of volute casing type with the impeller mounted directly onto the extended motor shaft (without any couplings).
2. The pumps should be suitable for Vertical or Horizontal / Permanent or Portable Installation.

3. Installation

- 3.1. The pump shall be installed directly on the floor of intake structure constructed in the river/ reservoir. In case of pumps to be installed in a sump, it shall be installed horizontally in a suction pit in submerged condition, so it is likely to suck lot of silt, clay, pebbles, & vegetation. Hence it should be reliable & robust.

3.2. Installation arrangement

- 3.2.1. At present it is proposed to install the pumps in River / CWS in portable, horizontally / vertically submerged / unsubmerged condition. However in future the same pumps are to be installed permanently into the sump in vertical submerged condition.

3.2.2. Horizontal Wet (submerged) installation.

- 3.2.3. The pump shall be offered with fully portable & robust MS portable base frame with anti vibration shock pads.

3.2.4. Vertical Wet (submerged) installation (Auto Coupling System)

- 3.2.5. The pump set should be coupled to the rising main by an automatic coupling system.(For permanent wet pit installation). The automatic coupling system should have a pedestal (Which is bolted on to sump bottom by pre-grouted foundation bolts. (SS 304).

- 3.2.6. The automatic coupling system design should be such that a unibuilt bend is integrally cast with the pedestal. This design obviates the need of bolting on a separate duck foot bends to pedestal. Separately bolted CI IS DF bends are not allowed as they are not conducive to replace flange gaskets(between the CI IS DF bend and the pedestal).

- 3.2.7. To prevent swiveling of the pump set (while lowering into & pulling out of sump); larger pumps(with discharge size $\geq 125\text{mm}$); the pumpsets auto coupling bracket should be guided by two guide pipe / wires.

- 3.2.8. To "fish out" a vertical submerged pumpset from the wet well (even if a chain has not been attached to the lifting hook prior to the pumpset being lowered) the pump should have a self centering lifting hook. Its design should be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet sump

- 3.2.9. the scope of supply shall include the following installation auxiliaries:

- For Permanent Vertical Installation: Auto Coupling System with SS Foundation Bolts, 10m Alloy Steel Chain & 6m Guide Rail Pipe / Wire (Dual Running) of SS 304
- For Permanent / Temporary Horizontal Installation: MS Fabricated Portable Base Frame with Anti Vibration Shock Absorbing Pads

4. Pump End Design

4.1. Speed

- 4.1.1. To achieve best efficiency, reasonable cost & yet long life, the speed of the pump set should be such that the Specific Speed (N_s) of the pumps (*calculated for Single Stage, Single Suction Impeller pumps assuming duty point as the best efficiency point*); should not exceed :

- **58** for up to DN 100,
- **70** for pumps up to DN 200,
- **87** for pumps up to DN 300,
- **106** for pumps up to DN 400,
- **116** for pumps up to DN 500 &
- **125** for larger pumps.

$$\text{Where } N_s = \frac{\text{rpm} \times \sqrt{Q \text{ m}^3/\text{s}}}{(H \text{ m})^{0.75}}$$

- 4.1.2. In addition to 4.1.1; motors > 113 kW &/or with Pump's duty point flow rate > 100lps shall not be allowed in more than 1450rpm &
- 4.1.3. In addition to 4.1.1 & 4.1.2; while; Pump's duty point flow rate > 500lps shall not be allowed in more than 1000rpm
- 4.1.4. The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.
- 4.1.5. The head capacity curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be at least 120% of the specified duty point head.
- 4.1.6. The Impeller shall be of high efficiency Multi Channel Enclosed type (except for Specific Speeds ≥ 4500 USCS where Semi Open Impellers shall be allowable).

4.2. Suction Strainer

- 4.2.1. The pump is fitted directly with a Suction Bell mouth to which is compulsorily fitted a heavy-duty strainer (*to avoid pick up of gravel, pebbles, vegetation, etc.*)
- 4.2.2. sizing of the strainer should be as per the larger of the two:
- a. at the duty point flow, the Suction Velocity (at Strainer Holes), should never exceed 3.0m/s &
 - b. at the duty point flow, the total cumulative suction area of all the Strainer holes should always be ≥ 2.0 times greater than the Impeller's Suction Eye Area.
- 4.2.3. However Large & Slow Speed pumps (with outlet size $\geq 300\text{mm}$ & Solid Handling Ability $\geq 100\text{mm}$ & of Speeds $\leq 1000\text{rpm}$) may be offered without Suction Strainer only
- 4.2.4. The pump's solid handling size & maximum hole size of suction strainer should be as per below mentioned chart.

Table 1: Design of Impeller & Strainer		
Pump Delivery Size	Min Thickness of Suction Strainer	Max. Permissible Hole Size of Suction Strainer
DN 25, DN 32 & DN 40	2mm	Not more than 4mm
DN50 & DN65		Not more than 6mm
DN80		Not more than 8mm
DN100		Not more than 10mm
DN125	3mm	Not more than 12mm
DN150		Not more than 14mm
DN 200	5mm	Not more than 21mm
DN 250		Not more than 30mm
DN 300 & DN 350		Not more than 40mm
DN 400 & above	7mm	Not more than 50mm

4.2.5. The pump set shall be suitable for starting with delivery valve open as well as closed at any operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

4.2.6. Complete Performance Curve, Data Sheets, GA drawings showing Installation Sizes shall be submitted along with the Technical Bid.

5. (Submerged) Induction Motor End Design

Refer the section on Motor Specifications for more details.

5.1. The motor shall be of Squirrel Cage, Induction type, Air Filled yet capable of Water Immersion upto 20mwc for S1 duty - Motors with Oil or Water filled windings shall not be allowed.

5.2. The motor shall berated for $415 \pm 10\%$ V, 3 phase 50 Hz $\pm 5\%$ c/s A.C.

5.3. Its winding should be of Class “H” insulation *(withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temp rise of winding hotspot should not exceed that of class “B”.

5.4. The motor shall bewound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13. PVC / Poly propylene - poly ethylene insulation for winding wires will not be allowed.

5.5. The motor Insulation shall be Vacuum Varnish Impregnated and oven baked to ensure a moisture impervious and mechanically robust insulation. Dip or Pour type Air Dry Varnishing will not be allowed.

5.6. The Motor Rating should be higher of the two criteria :

5.6.1. 10% over Maximum pump shaft input at any point of the curve &/or

5.6.2. 20% over pump shaft input @ duty point

5.7. The **Motor’s Rotor** shall be of Dual Cage Copper Bar Brazed type to assure :

5.7.1. Long Corrosion free Service life (in presence of high moisture inevitable in submerged motors Aluminum corrodes much faster than Copper),

5.7.2. Ease of Onsite Repairing &

5.7.3. beneficial Fly Wheel type Inertial effect (as compared to aluminum rotor, copper rotor is heavy) which reduces detrimental effects of water hammer

5.7.4. Better Motor Efficiency & Cooler Operating Temperature.

5.7.5. Motors rated $\leq 113\text{kW}$ maybe supplied with Aluminum Die Cast Rotors but Dual Cage Copper Bar shall be preferred.

5.8. Motor Cooling:

5.8.1. To restrict the Dead Water Level (*in case of Vertical Installation*) in the Sump to 1m, Medium & Large sized pumps ($\geq 55\text{kW}$) should have a Cooling Jacket - i.e. motor cooling is accomplished by circulation of pumped water between the motor casing & the jacket shell.

5.8.2. In case the pumps are to be installed horizontally, the motor can be cooled just by water immersion i.e. no jacketing is required.

5.8.3. This jacket shell is fed by cold water from the pump casing & discharges its heated water back into the sump (*in case of Wet Installation*) or Pump casing (*in case of Dry Installation*) by integrally cast ducts. There should not be any pipes, hoses, etc for this circulation.

5.9 Alternatively Close Circuit Cooling technology (using Glycol, etc) may be also be offered.

Motor Protection

5.9.1. Thermal Overload Protectors (*Bi Metallic Over Load Relays*) should be embedded in each phase of the stator winding to detect overheating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (*above B temperature class*).

5.9.2. To detect primary Mechanical Seal's Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (*& not in the Motor casing or elsewhere*) - this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

5.9.3. Micro-processor based comprehensive motor protection relays shall be provided for motors above 150kW rating.

6. Cables

Refer the section on Cable Specifications for more details.

6.1. A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables.

6.2. The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length, minimum 10 m to be terminated in an IP 67 junction box (*in the scope of electrical contractor*) outside adjacent to the wet well & above the HFL. They shall be sized in accordance with the electricity utility regulations and BS 7671.

6.3. It should have Power as well as Control Cables of Dual Sheathed EPDS / PVC Armored type with Copper Core of required size. However the Cross Section of the cable be shall ample enough to ensure a Voltage Drop of not more than 2% at actual running conditions.

6.4. Submersible pump motors that come with their own cables shall be provided with a suitably rated junction box for terminating cables from the MCC on one side and the motor OEM supply cables on other side.

7. Shaft & Bearings

7.1. The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L_{10} life

of 75,000 hours in accordance with BS 5512

- 7.2. The bearings should be Permanently Greased with Premium Quality, High Temperature, Long Life Grease thereby obviating the need of re-lubrication for upto **L₁₀ life** of the bearings.
- 7.3. Oil Lubricated bearings shall not be allowed.
- 7.4. In case the motor is to be driven via a VFD, atleast one of the bearings (*DE or NDE*) should be Current Insulated to prevent “electric fluting damage” caused by Harmonics.

8. Stuffing Box / Oil Chamber

- 8.1. The pressurized entry of water into the motor (*from the pump's volute casing*) should be prevented by Two separate mechanical seals in mounted in a Tandem mode within an oil chamber.
- 8.2. The Primary (*Inboard*) seal should be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles. The Secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide - i.e. Thermally Unstable materials like Alumina/ Aluminum Oxide shall not be allowed.

9. Testing

The pumpsets shall be tested in accordance of ISO 9906 or IS 9137 or IS 5120 (*Tolerance Class 2*); with or without VFD

In case the pump sets are tube used with VFD at site, the testing has to be offered compulsorily with VFD.

2.0 INDUCTION MOTORS

1.0 SCOPE:

This specification covers the design, manufacture, inspection, testing at works, delivery to site, installation, commissioning of flange / foot mounted, three phase, squirrel cage, induction motors with all accessories for mentioned Pump.

2.0 CODES AND STANDARDS:

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the IEC 60034-1/2004 or latest applicable standards.

3.0 PERFORMANCE AND CHARACTERISTICS:

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions as specified in Data Sheet.

- a) Variation of supply voltage from rated motor voltage $\pm 10 \%$
- b) Variation in supply frequency from rated frequency $\pm 5 \%$
- c) Combined voltage and frequency variation $\pm 10 \%$

Motors starter shall be as indicated in Single Line Diagram of Electrical section.

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage.

Motors shall be designed to withstand 120 % of rated speed for two minutes without any mechanical damage, in either direction of rotation.

The motor shall be so designed that it shall have maximum efficiency on load varying from its 70% to 100% full load. Dropping efficiency from 100% full load to 60% of full load will not be acceptable. The motors shall be IE3 or better efficiency.

The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment.

Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard.

4.0 INSULATION:

Any joints in the motor insulation such as at coil connections or between slot and end winding sections shall have strength equivalent to that of the slot sections of the coil.

The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard. Overhang of winding shall be coated with Epoxy paint.

5.0 TEMPERATURE RISE:

The temperature rises shall not exceed the values given in Table-1.

TABLE - 1

Temperature Measurement by	Insulation Class	Maximum temperature Rise for all types of enclosures.
Thermometer Method	E	65° c.
	B	70° c.
Winding Resistance Method	E	75° c.
	B	80° c.
	F	100° c.
	H	125° c.

These temperature rises are acceptable for an ambient temperature of 45° c.

For motors specified for outdoor installation account shall be taken of heating due to direct exposure to solar radiation.

6.0 CONSTRUCTIONAL FEATURES:

The motors construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repairs.

Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

The rotor bars shall not be insulated in the slot portion between the iron core laminations and the bars. Unless otherwise approved, motors shall be designed to permit convenient access for drilling vertically through motor feet or mounting flange for installation of Purchaser's dowel pins after motors are mounted with the driven equipment.

7.0 BEARINGS:

Greased ball / roller / thrust bearings shall be of reputed make subject to the Purchaser's approval. The life expectancy of the bearings shall be stated.

The bearings shall be so constructed that the loss of lubricating fluid is kept to a minimum and greasing shall be possible without any dismantling operation

The bearings shall prevent dirt and water from getting into the motor. Bearing lubricant shall not find access to motor windings.

The bearings shall permit running of the motor in either direction of rotation.

If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level sight gauge shall be provided to show precise oil level required for stand-still and running conditions.

Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain the required oil supply or keep bearing temperature within design limits.

Lubricants shall be selected for prolonged storage and normal use of the motors in tropical climate and shall contain corrosion and oxidation inhibitors. Grease shall have suitable bleeding characteristics to minimize setting.

8.0 TERMINAL BOX:

Terminal box shall be of weather proof construction designed for indoor service, to eliminate entry of dust and water, gaskets of approved make shall be provided at cover joints and between box and motor frame.

Terminal box shall be suitable for single compression cable jointing kit. The terminal box shall be suitable for top and bottom entry of cables.

Unless otherwise approved, the terminal box shall be capable of being turned through 360 degree in steps of 90 degree.

The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances.

Suitable cable jointing kit shall be supplied by the motor vendor to match Purchaser's cable.

9.0 PAINT AND FINISH:

Motor external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of zinc epoxy primer and two coats of Epoxy paints.

The motor fan shall also be painted to withstand corrosion.

10.0 HEATING DURING IDLE PERIODS:

Motors shall be provided with normal space heaters as per standard practice for motor rating more than 100 HP.

11.0 ACCESSORIES:

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the Purchaser's earthing conductors. These earthing points shall be in addition to earthing stud provided in the terminal box.

12.0 TESTS:

Motor shall be subjected to all the routine tests as per applicable standard in the presence of the Purchaser's representative. Copies of test certificates of type and routine tests, as specified in the distribution schedule, shall be furnished for the Purchaser's approval.

TESTS AND INSPECTION (APPLICABLE FOR ALL TYPES OF PUMP SET)

GUARANTEED PUMP SET PERFORMANCE PARAMETERS:

- At Factory & site Testing / Commissioning stage, the following minimum guaranteed parameters must be achieved for the pumps and motors offered for the contract shall be asunder:
- Duty point flow, head, minimum pump Efficiency, Overall efficiency of each pump-set.
- For each motor, the minimum efficiency, Power Factor, other tests as per electrical datasheet, BOQ.
- Net Positive Suction Head required at duty point & maximum discharge.
- Power Consumption at duty point and maximum flow.

Note: No negative tolerance on flow, head, efficiency etc. shall be allowed in above.

- During Factory & Site Testing / Commissioning, each pump and motor set shall be tested and efficiency shall be worked out up to two Decimal. The combined efficiency of each pump and motor set shall also be worked out. If the guaranteed efficiency of each pump & motor set found lesser than the specified in BOQ/Data Sheet, then the pump and/or motor set shall be liable for rejection. Therefore, the contractor shall rectify/ repair / replace the system/ part and retesting/ re-commissioning to be carried-out for the pump and/or motor set within a week period. Thereafter, In case, the guaranteed efficiency of each pump and motor set not meeting the above guaranteed efficiency, then the pump and/ or motor set shall be rejected. Any claims from the Contractor against this shall not beentertained.
- During O&M Period: Minimum guaranteed combined efficiency of each Pump and motor set during the O & M period of 5 years as belowtable:

Particulars	At the time of commissioning	At the end of 1 st year O&M	At the end of 2 nd year O&M	At the end of 3 rd year O&M	At the end of 4 th year O&M	At the end of 5 th year O&M
Efficiency of Pump (%)	As per the test bed (but not less than specified in tender) hs	hs1=hs	hs2=hs1	hs3=hs2-0.25	hs4=hs3-0.25	hs5=hs4-0.25

Note:

- (1) hs = Efficiency measured during factory & site testing / commissioning “or” minimum **guaranteed efficiency specified in BOQ whichever is higher**
 - (2) Extraclaimonenergysavingduetohigherefficiencythanmentioned inBOQwillnotbe given to the contractor
- If efficiency of pump not meet the above mentioned value then increase in energy bill (including18%GST) due to decrease in efficiency will be recovered from the bill of contractor as penalty. For this amount of penalty will be derived as below by calculating actual power required to drive the motor (BKW) as following.
- If Pump efficiency at the end of 1st year O & M will be hs1’ (which is less thanhs1)then,

Increase in BKW = $(Q \cdot H \cdot 100 / (367.2 \cdot hs1)) - (Q \cdot H \cdot 100 / (367.2 \cdot hs1'))$ (i.e Actual Power- Guaranteed Power, as shown in above table)

- Amount of penalty = Increase in energy bill = Increase in BKW * Energy rate per unit (Rate shall be derived from the energy bill = Total Current Month Energy Charges as per the bill/Total units consumed during month)

Where H = Total Design Head in meter as per the Contractor's design.

Q = Total Design Flow

DOCUMENTS TO BE SUBMITTED:

- P & ID of the pumping system
- Pump set Performance Curve (Flow vs Head, Flow vs Efficiency, Flow vs Power, Flow vs NPSHr, Minimum Submergence, GD^2 Value) along with Torque - Speed Curve of the pump set.
- System Resistance Curve Superimposed on Solo & Parallel operation curve of Pumpset.
- General Arrangement drawing of Pump motor set with Foundation details, static & dynamic load.
- Pump Motor Datasheet.
- Pump House layout/sectional details indicating type of pump & motor, valves, fittings, piping arrangement, sump bed level, minimum water level, maximum water level, pump discharge floor level, starter panel, associated cabling, crane/hoisting arrangement, maintenance bay.

EVALUATION

- It is clarified that no commercial implications of bids based on efficiencies shall be applicable i.e., all bids below the achievable efficiencies as per HIS (without negative tolerance) or specified shall be rejected while all bids meeting or exceeding the same are to be accepted at par.

3.0 BUTTER-FLY VALVE

Resilient seated butterfly valve shall be as per IS 13095/ BS 5155 or another international standard. Valve shall be suitable for mounting in any position.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve and valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Sr. No.	Component	MOC for PN 2.0 Rating	MOC for PN 1.0 / 1.6 Rating
1.	Body, Disc	Graded Cast Steel ASTM A216 Grade WCB	CI. IS 210 FG260
2.	Shaft /Thrust Pad	Stainless Steel AISI 410	
3.	Body ring (Retainer/ seat)	Stainless Steel 304; BS 970 Gr. 316 S 13	
4.	Bearing Bush	G.M. IS :318 LTB 2	
5.	Seat	EPDM rubber/ Nitrile rubber	
6.	Internal Fastenings	Stainless Steel AISI 304	
7.	External Bolting	Stainless Steel AISI 304	

INSPECTION AND TESTING AT MANUFACTURER'S PREMISES FOR DIFFERENT VALVES

1.1. Valve (manufactures test Certificate to be furnished.)

- 1.1.1. Testing there shall be no visible evidence of structural damage to any of the valve component.
- 1.1.2. Motorized valve shall be tested with their actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable to opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.
- 1.1.3. The following test shall be carried out for sluice valves: (manufactures test certificate to be furnished)
 - a) Seat leakage test at rated pressure
 - b) hydrostatic test at 1.5 times the rated pressure
 - c) Valve operation.
- 1.1.4. The following test shall be carried out for non- return valves: (manufactures test Certificate to be furnished)
 - a) Seat leakage test at rated pressure
 - b) Body hydrostatic test at 1.5 times rated pressure
 - c) Operation.

4.0 AIR VALVES

1.0 SCOPE OF CONTRACT:

The contract shall be covering manufacturing, supplying and delivering of;

Air valves single ball flanged /screw type

Air valve double ball flanged

Air isolated valves double ball flanged

Air cushion valve with C.I. body as per item of tender

2.0 GENERAL

The contractor shall be covering manufacturing, supplying and delivery of:

Air valve conforming to IS: 14846 or its latest revision (Specification for Air valves

With ISI certification

3.0 CLASSIFICATION

3.1 Air valve shall be of two types

(a) Single Air valve

(b) Double Air valve

3.1.1 Single air valve shall have single small or large orifice for releasing air during pipe filling and ventilating the pipe during emptying. Air valves up to 40 mm dia directly shall be screwed on the main.

3.1.2 Double air valve shall have two ball chambers, on outlet of large capacity shall be provided for admission and release of bulk volume of air during emptying and filling of the main, another of small outlet type for the escape of smaller quantities of air accumulating under pressure. They shall be of flanged type.

4.0 MATERIALS

4.1 CAST IRON

Cast Iron for bodies' pressure covers, splash covers, glands, caps, and joints support rings shall be best gray iron of selected grade, 20 of I-S-210-1978 specification for grey iron castings.

4.2 GUN METAL

Gunmetal shall be of mixture of 88% copper, 10% tin, 2% Zinc having excellent hard wearing qualities, Ball guides of small orifice units and outlet bushes of large orifice valves shall be of gunmetal.

4.3 FOREGED BROZNE

Nipples, spindles shall be machined from rolled, extruded or forged high tensile brass or aluminum bronze. The produce shall possess much greater strength than ordinary cast product.

4.4 MILD STEEL

Bolts, nuts, flanges etc. shall be of mild steel unless otherwise specified and shall confirm to I.S. 226-1975 specification for structural steel.

4.5 MATERIALS FOR BALLS

The balls shall be of rubber covered and vulcanite covered. The rubber shall have a smooth and hard surface. It shall be as per I.S. 638-1965 specification for rubber and insertion jointing.

4.6 FLANGE JOINTING MATERIALS

The jointing material used between the flanges of components part of the valve shall be compressed fiberboard or rubber of thickness between 1.5 mm to 3 mm. The rubber shall be as per I.S. 683:1965 specifications for rubber and Insertion jointing. The fiberboard shall be impregnated with chemically natural mineral oil and shall have a smooth and hard surface.

5.0 DIMENSION

Small orifice air valve having single rubber ball is available in the following sizes- 12mm, 20mm, and 25 mm.

Large orifices single air valves are available in following sizes- 40mm, 50mm, 80mm, 100mm, 150mm.

Double air valves are available in sizes- 50mm, 80mm, 100mm, 150mm, and 200mm.

Air valve up to 40mm size shall be of screwed type fitted with Nipples.

6.0 CHARACTERISTICS

- 6.1 Small orifice valves shall have rubber covered balls and nipples of forged bronze or special alloy in to brass plug.
- 6.2 Large orifice valve shall have vulcanite-covered ball closing on rubber sealing backed with leather and gunmetal outlet bushes. They shall be screwed or flanged. The flanged shall be faces and drilled to I.S.S.
- 6.3 For sewage mains, the air valves shall be actuated by mild steel floats bronze spindles and shall be fitted with synthetic rubber seals.
- 6.4 Air valves shall be sound in all respect and uniformly forged so as to have uniform bore. They shall be free from any defects such as unwanted projection, holes or roughness and shall have inner and outer surface perfectly smooth.
- 6.5 The following size of air valves shall be used for main of different sizes.

Size of air valves in mm	Suitable size of min. dia. in mm
12 mm	Up to 80 mm
20 mm	Up to 80 mm
25 mm	Up to 80 mm
40 mm	Up to 100 mm
50 mm	125 mm to 200 mm
80 mm	125 mm to 400 mm
100 mm	450 mm to 550 mm
125 mm	600 mm to 880 mm
150 mm	900 mm
200 mm	1000 mm to 1200 mm

7.0 COATING

- 7.1 Immediately after casting and before machining, all cast iron parts shall be thoroughly cleaned and before rusting commences shall be coated by dipping in a bath containing a composition having a tar base.
- 7.2 The coating shall be such that it shall not impose any test of small to water. The coating shall be smoothing glossy and sufficiently hard. It shall not chip when scratched lightly with the point of penknife.

8.0 INSPECTION AND TESTING

- 8.1 The engineer in charge or his authorized representative shall have free access to the works for inspection at any stage of manufacture and to reject any materials, which does not confirm to the specified requirements.
- 8.2 The manufacturer shall arrange to supply all labor and appliance for the tests if the testing is to be done at his works. Each valve shall be subjected to the hydraulic test and shall show no sign of leakage under these tests i.e. the balls shall function properly. The valve shall be tested to double the maximum working pressure.

9.0 MANUFACTURERS GUARANTEE

The manufacturers shall guarantee that if any defects chargeable to faulty workmanship, design or materials are found in the valves within a period of one year of dispatch shall replace any part that prove defective, free of charge at the place of dispatch.

The following information shall be cast on each valve body:

- (a) Manufacturer's name or trademark.
- (b) Size of valve

10.0 TENDER PRICE:

The tender price shall include all labor, material and machinery cost necessitated to be utilized for;

- a) Proper manufacturing of the valves.
- b) All tests required to be undertaken at manufacturer's premises.
- c) Transportation of the valves either by Rail and/or Road services with all the covers duly and appropriately insured.
- d) Delivery of specials with proper loading, unloading, stacking at as specified store as indicated by Engineer-in-charge.
- e) Further towards proper discharge of all contractual obligations. The storage of all specials to be manufactured, supplied and delivered under the scope of contracts shall be in general be made as described in Technical specification document. Cost of Required GI/CI air raises Flanged pipe (3.0 meter above GL) Foundation block and Column in CC M-150.

11.0 DELIVERY SCHEDULE:

The delivery schedule shall be governed by the Chief Officer of as specified.

12.0 MARKING

The methods of marking all the valves to be delivered under scope of contract shall ensure that all the information will remain legible even after transportation, storage in open space etc. In general the legible and indelible marking upon the valves shall indicate the followings:

- i) Manufactures brand name and/or trademark.
- ii) Purchasers mark as specified is inscribed.
- iii) Diameter and class of valves.
- iv) Any other important matter that the manufacturer or purchase or deems fit to be inscribed.

13.0 PACKING AND HANDLING:

- 13.1 The materials shall always be packed separately dispatched from manufacturer's works with adequate protective measures to prevent damages deterioration while in transport or stored at any place. The packing shall always be so neat and tidy that may withstand any robust and rough handling.
- 13.2 When the materials are transported at railway risk, special packing as per IRCA rules are absolutely necessary for which the extra cost, if any, shall be borne in total by supplier only.
- 13.3 The supplier shall use proper handling instruments/equipment's and shall follow to a suitable method of handling pipes as may be approved by Engineer, while unloading and stacking material in the stores.

14.0 MATERIALS AND WORKMANSHIP:

- 14.1 General requirements of materials and workmanship shall mean any material or article either raw or finished one is required to be used in the manufacturing process of tanks.
- 14.2 All the material shall be new and of high quality.
- 14.3 In case, if material is not specified by relevant ISS for manufacturing part or the whole as item, the supplier shall prepare specifications in concurrence with manufacturer and shall seek an approval of Engineer-in-charge prior to its use in the manufacturer.

15.0 TEST CERTIFICATE:

- 15.1 The supplier shall always provide manufacturer's test certificate in accordance with every batch/lot of goods so manufactured and supplied.
- 15.2 The supplier shall also produce in addition to manufacturer's test certificate as mentioned in Para 7.1 above, the inspection certificate issued by the authorized person/agency appointed by Chief Officer for the same purpose.

16.0 INSPECTION

- 16.1 This clause is applicable in general to all materials such as all types of valves, Pre-cast chambers, other specials and materials etc. which are to be supplied by the contractor.
- 16.2 Inspection of materials will be carried out at factory site by Inspecting agency to be fixed and authorized by as specified. The supplier on receipt of supply order from as specified shall intimate inspecting agency to carry out inspection as soon as material is ready.

- 16.3 The inspection call for Air valve should be given. Inspection will be carried out normally within one week time and on receipt of such intimation the inspecting agency will inspect the materials as per the specification and on satisfying itself, will mark the inspection marks on all pipes and issued inspection note to the supplier and concerned consignee.
- 16.4 For inspection purpose the manufacture has to go in for stenciling for identifying size and class for proper segregation. The stock of offered material shall be in a manageable batch with adequate space like spreading the pieces etc. to permit proper inspection and inspection authority to be present during stamping so as to ensure that only actually cleared material is stenciled. Manufacturer does not load material after sunset to avoid inadvertent dispatch of wrong material.
- 16.5 Inspection note issued by the inspection agency to supplier as well as consignee (Chief officer) materials with inspection mark will be dispatched to stores stipulated in supply order and on receipt at stores the verification will be carried out by concerned Engineer as regards quantity and quality. Here quality means physical soundness of materials as precaution against breakage during transit. The supplier has to submit the test certificate as well as detailed test results carried out by inspection authority to the consignee along with the dispatch documents of materials. The material shall be considered as received only on receipt given by the concerned Engineer after verifying and satisfying the above requirements.

17.0 INSTALLATION

- 17.1 The air valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- 17.2 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the air valve bore. It shall be even at both the inner and outer edges.
- 17.3 The flange faces thoroughly greased.
- 17.4 If flange faces are not free, the contractor shall use thin fibers of lead wool.
- 17.5 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.
- 17.6 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.
- 17.7 Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.
- 17.8 Extra excavation required for facility of lowering and fixing air valve shall not be paid for.

18.0 MODE OF MEASUREMENT AND PAYMENT

Measurement shall be paid on number basis as per relevant dia. of the item in schedule 'B' of the tender.

5.0 DUAL PLATE CHECK VALVE

1.0 SCOPE:

This specification covers the design requirements, features of construction, inspection, testing, painting, delivery, installation and commissioning of Dual Plate Check valves at site.

2.0 CODES AND STANDARDS:

The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the vendor of this responsibility. The valve shall be confirming to IS 5312 or other international standards.

3.0 DESIGN REQUIREMENTS FOR DUAL PLATE CHECK VALVE:

The Non return valves shall be of swing type single door design.

The valves shall be designed for minimum head loss.

The valves shall have flat faced flanged ends. The back side of the flanges shall be fully or spot faced.

By pass arrangement shall be provided for above 300 mm. valves

The valves shall have non slam characteristic. This is to be achieved by internal design. Dead weight arrangement is not acceptable.

4.0 PAINTING:

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.

Valves used in pipes carrying water, the inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or odour to the water.

5.0 TESTS AND INSPECTION:

Valves shall be tested as per the relevant Indian Standards. Specification IS - 5312 - 1969 PART 1 with latest revisions.

Valves shall be offered for visual inspection and dimensional checks.

The hydrostatic and water tightness testing shall be witnessed by the purchaser.

Valve shall be offered for inspection and following tests. (before painting) at Vendor's shop.

- Visual inspection with dimensional checks.
- Hydrostatic test

6.0 M.S. PIPES AND PIPE SPECIALS

1.0 SCOPE:

Providing, fabrication, testing, painting, supplying and installation of M.S. pipe of specified ID / OD and specified wall thickness conforming to Indian Standard 1239 / 3589 - 1981. This section covers pipe and specials up to battery limit (up to reducer to be provided at the bridge end for V.T. pumping station and 10 MTRS. from the pump house for SCF and submersible pumping station).

Pipes shall be erected on rollers / saddles as per the requirement. Thrust blocks shall be provided at bend and dead end.

2.0 QUALITY OF STEEL:

Pipes shall be fabricated from steel plates conforming to IS 2062.

2.1 MANUFACTURE OF THE PRODUCT:

Pipes shall be made from steel plates or strips by butt welding longitudinally or spirally. The weld shall be continuous. Prior to welding, edges of plates or strips may be prepared suitably where required by the process of manufacture.

Wherever agreed to between the manufacturer and the purchaser, a maximum of two circumferential welds shall require.

3.0 ORIGINAL CROSS - SECTIONAL AREA OF THE SPECIMEN:

3.1 OUTSIDE DIAMETERS (AS PER IS 1239):

The outside diameters of the finished pipes shall be as given below:

Nominal size (In mm)	Max. Outside Diameter (In mm)	Min. Outside Diameter (In mm)
50	60.80	59.70
80	89.50	88.00
100	115.00	113.10
150	166.50	163.90

3.2 OUTSIDE DIAMETERS (AS PER IS 3589/2001) :

The outside diameters of the finished pipes shall be as given below:

Nominal size (in mm)	Outside Diameter (in mm)
200	208
250	262
300	312
400	412
600	612
750	766
900	916
1000	1020
1400	1424

Pipes of outside diameter other than those covered in above clause shall be permissible as agreed to between the manufacturer and the purchaser.

3.3 TOLERANCE:

- a) Pipes Ends - If so specified by the purchaser, the tolerance on outside dia. for distance of 100 mm from the end of the pipe shall be as follows:

Up to and Including 250 mm	:	+ 1.6 mm
		- 0.50 mm
Over 250 mm	:	+ 2.4 mm
		- 0.8 mm

- b) Thickness - The tolerance on specified wall thickness shall be as follows Pipe
: $\pm 10\%$

- c) Straightness - Finished pipe shall not deviate from straightness by more than 0.2% of the total length.

Checking shall be carried out using a taut string or wire from end to end along the side of the pipe to measure the greatest deviation.

- d) Length - Straight pipe shall not vary from the specified overall length by +10 mm or minus up to 0 mm for length up to and including 6 mtr.

4.0 THICKNESS OF PIPES:

The pipe with medium duty shall have minimum specified wall thickness specified in following Table

MINIMUM SPECIFIED THICKNESS OF PIPES AS PER IS 1239	
Nominal Size (mm)	Minimum Specified Thickness of pipe mm.
50	3.6
80	4.0
100	4.5
150	4.8
MINIMUM SPECIFIED THICKNESS OF PIPES AS PER IS 3589	
Nominal Size (mm)	Minimum Specified Thickness of pipe mm.
Above 150 to 300	4
Above 300 to 500	6
Above 500 to 600	6
Above 600 to 850	8
Above 850 to 1200	10

5.0 HYDRAULIC PRESSURE TEST:

Each pipe shall be hydrostatically tested at the manufacturer's works before the pipe is coated, wrapped or lined at the manufacturer's work.

The Hydraulic test pressure shall be the pressure calculated from the following formula, except that the maximum test pressure shall not exceed 5 MPa.

$$P = \frac{2 \times S \times t}{D}$$

P = Test pressure.

S = A stress in MPa which shall be taken as 40% of the specified minimum tensile strength.

t = Specified thickness in mm and

D = Specified outside diameter in mm.

Test pressure shall be applied and maintained for sufficiently long time for proof and inspection.

6.0 SPECIFICATION FOR INSIDE / OUTSIDE COATING:

The coating of the pipes shall be smooth, dense and hard. The coating shall be free from excessive surface irregularities. Projection exceeding 3 mm. measured from the general surface shall be removed. For inside coating of epoxy paint, the inside surface of the pipe should be sand or shot blasted. The surface should be thoroughly rubbed down with rough sand paper or wire brush so that surface will be uniformly rough. Mixed paint should be used within 3 to 4 hours of mixing and fresh mixing is taken for every new application.

Zinc rich epoxy primer and asphaltic bitumen paint of approved quality shall be used for internal painting. No primer shall be applied without prior approval of the owner. The mix of zinc rich epoxy primer shall be prepared at works site not earlier than 15 min. before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer shall be applied by spray giving a film thickness of approximately 1 mil. No thinner shall be added to ready mix paints without previous approval of the owner and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer, the surface should be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer. When complete section is checked as above, first coat of Interpol or equivalent shall be applied, when one coat is applied, the date of application of this coat should be written on either end of section.

The painting shall be done by cross brushing, i.e. one coat shall be given vertically and another coat shall be given horizontally so as to get required thickness, a good looking surface and also to avoid sagging of paint. Every successive coat of paint shall be given only after 48 hrs. of painting the previous coat. Before applying the

next coat, the surface shall be properly cleaned by duster. Each coat of interol 49 W thick or equivalent shall give a film thickness of 3-4 mils.

7.0 LAYING OF PIPELINE:

The laying, jointing and testing of welded steel pipes conform to latest and relevant IS: 5822.

Pedestals shall be constructed before commencing the pipe laying work in any section.

The welded joints shall be tested as per IS 3600 of 1966.

8.0 M. S. SPECIALS:

Providing, testing and installing M.S. Specials suitable to M. S. pipes, valves and other fittings from steel plates at site of work tested to specified test pressure and including providing flanges required, painting inside zinc epoxy coating and outside anti corrosive red primer, coated with three coats of anti-corrosive water proof paint including freight, loading, unloading, carting, stacking as directed, and including all taxes, insurance etc. The sizes and types of specials shall be as per requirements taking into consideration in tender items like pumps, sluice valves, non-return valves, scour valves, expansion joints, dismantling joints etc.

9.0 FLANGES:

The flanges and their dimensions of drilling, whatever not specified, shall be in accordance with part- IV and VI of IS: 1538 (part-I to XXII) 1976 (specification for cast iron fittings for pressure pipes for water, gas and sewage) or its latest revision. The flanges shall be flat faced with off center bolt holes. Prior to manufacturing process, the contractor shall have to obtain approval of Engineer in charge for all sizes and types of flange drawings.

10.0 JOINTING MATERIAL:

Each valve shall be supplied with all necessary joint ring, nuts, bolts and washers for completing the joints on all the flanges of valve supplied under this contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing M.S. pipes. The cost of all jointing material supplied under the contract shall be included in rates. Joint rings shall be of flat section at least 3 mm thick. They shall be of rubber in accordance with IS 638-1965.

7.0 FULL BORE ELECTROMAGNETIC FLOW METER

1.0 MATERIAL AND MANUFACTURE

1.1 General:

Water meters and their parts in continuous contact with water shall be made of material resistant to corrosion and shall be non-toxic, where cast iron is used, it shall be protected suitably against corrosion.

1.2 Casting and body:

Casing:

The casing of the meter shall be made from cast iron confirming to Grade FG 200 of IS 210-1978

Body:

Body of the water meter shall be made of Grade Cuzn 40 of IS: 1261-1965. In case of enclosed type water meter, the liner shall be made of minimum 1.5 mm thick brass sheet confirming to IS:410-1977. The integral shape of the body shall ensure smooth flow of water and easy dismantling.

1.3 Connections:

The water meter shall be provided with flanges at both the ends. The flanges should be machined flat. The dimension and drilling of the flanges shall be in accordance with IS: 1538 (Part-IV)-1976 and IS: 1538 (Part-VI)-1976. For meters 50 mm size the dimension and drilling of the flanges and tolerances shall be in accordance with table-I of IS: 2373-1981.

1.4 Screws, Studs and Nuts:

Screws, Studs and Nuts shall be of Mild Steel i.e., corrosion resistant material.

1.5 Registration Box:

The registration box shall be made of the same material as specified for the body.

1.6 Cap:

The cap box shall be made of the same material as specified for the body. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial, shall be inserted from inside into the cap. The protective lid shall be secured by a robust hinge or other suitable methods of robust construction.

1.7 Strainer:

Strainer shall be made of the same material as meter casing. They shall be rigid, easy to remove and clean and shall be fitted on the inlet side of the water meter. The strainer shall have total area of holes not less than twice the area of the nominal inlet bore of the pipe to which the meter is connected. Where strainer is installed outside the meter, it shall be at such a distance that it does not affect the accurate functioning of the meters.

1.8 Runners (Impellers):

Runner of the meter shall be accurately balanced. It should be durable and should work with as low a friction resistance as possible. Impellers shall be one piece molded up to 150 mm dia. water meter.

1.9 Runner Chamber:

The Runner chamber shall be rigid and shall not change its form as a result of internal stresses or with use.

1.10 Gears:

Gears shall be so constructed as to fully and smoothly mesh with each other and shall be firmly fitted on their shaft. Gears coming in contact with water shall be of stainless-steel conforming to designation 07 Cr 18 Ni 9 of IS: 1570 (Part-V)-1972. In the helical type meter, the worm type gears shall be fitted on a shaft and the worm wheel shall be enclosed and protected against the incursion of solid particles.

1.11 Bearings:

Impeller bearing shall be suitably ground and polished. The shape of the impeller bearing shall be such as to prevent the penetration of particles of sand and to preclude the deposit of anything in solution or suspension in water and to facilitate the washing away of such deposits by water flow. The shaft of the gears shall revolve freely in their bearings.

1.12 Counting Mechanism:

The pointer shall be made of brass sheet conforming to IS: 410-1977. The indicating device shall be of the straight reading cyclometer type counter. The roller of the cyclometer counter shall be made of plastic especially suitable for the purpose and shall be such that it will not fade away under continued use.

The range of registration shall be as given in the Table-1 below.

Table-1
Range of registration of water meter
(Clause 2.3.1 and 2.5)

Nominal Size mm	Ranges of registration of water meters in liters	
	Minimum registration in division not to be more than	Maximum registration not to be less than
50	10	100000000
80	10	100000000
100	100	100000000
150	100	100000000
200	100	1000000000
250	100	1000000000
300	10	1000000000
350	100	1000000000
400	1000	10000000000
500	1000	10000000000

1.13 Dial:

The Dial shall be of vitreous enamel of suitable plastic, ensuring indestructible marking and good legibility. The unit of measurement namely “liters” or “Kiloliters” shall be marked on the dial as “liters” or “Kiloliters” in hold face, the min. cubic meters (m³) may also be used in place of kiloliters.

1.14 Sealing:

Sealing holes shall be provided and the meter shall be sealed in such a manner as render to inaccessible to the measuring unit including registration box and cap without breaking the seal. The sealing wire shall be rust proof such as turned copper.

1.15 Regulator:

Every meter shall be provided either an internal or an external regulator. The external regulator shall be accessible from outside to be operated by a suitable key without dismantling the meter and protected by a sealed cover. The internal regulating device shall not be accessible from outside.

1.16 Location of serial number:

Location of serial number of the meter shall be clearly indicated in any suitable place except the lid.

2.0 PERFORMACE REQUIREMET:

2.1 Temperature:

The meter shall be suitable for use up to 450°C.

2.2 Hydraulic Test:

Meters shall satisfactorily withstand a pressure of 1.6 MPa(16 kgf/cm²).

2.3 Capacity rating for water meter:

2.3.1 Nominal capacity or short period rating:

Vane-Wheel water meters shall be capable of giving discharge not less than as given in Table-2 without the head loss exceeding 10 Mts. within the meter. The helical meters shall be capable of giving discharge not less than as given in Table-2 without the head loss exceeding 3 mts. Within the meter.

Table-2
Nominal capacity ratings
(Clause 2.3.2 and 2.5)

Nominal Size mm	Capacity rating of water meters in liters per Hour	
	Vane-wheel type	Helical type
50	30000	50000
80	50000	125000
100	70000	200000
150	150000	500000
200	250000	800000
250	400000	1100000
300	500000	1500000
350	-	2000000
400	-	3000000
500	-	5000000

Table-3
Minimum starting flows
(Clause No.2.4)

Nominal Size mm	Minimum starting flows in liters per Hour	
	Vane-wheel type	Helical type
50	250	500
80	500	1000
100	700	1500
150	1000	3500
200	2400	5500
250	3200	9000
300	6400	14000
350	-	20000
400	-	25000
500	-	35000

2.3.2 Recommended capacities for intermediate flows:

Vane Wheel type water meters shall be capable of giving discharge not less than given in Table-3 without the head loss exceeding 3 mts. Within the meter, helical type water meters shall be capable of giving discharge not less than given in Table-3 without the head loss exceeding 1 mts. The head loss within the meter shall be measured in accordance with the method given in Appendix-B of IS: 2373-1981.

2.4 Minimum starting flow:

The minimum flow at which the meter starts registering shall be as give in Table-4.

2.5 Metering Accuracy:

The accuracy at lower limit of flow shall be calculated at 1/13 tk. of the nominal capacities of water meter given in Table-2 at the lower limit of flow, the metering accuracy shall be + 2 % for both types of water meters. The same accuracy shall be compiled with at least up to intermediate floes specified in Table-3.

Note: This accuracy is attainable when the meter is flowing full under pressure.

MARKING:

2.1 Each water meter shall be marked with the following information:

- manufacturer's make of trade-mark;
- Nominal size of the meter;
- Direction of flow of water on both sides of the meter;
- GUDC/NAGARPALIKA mark.

2.2 Each Water meter (With or without strainer)

3.0 TESTS:

3.1 Classification of Tests

Test shall be classified in to three grounds namely

Production routine test

Type test and

Acceptance test

3.1.1 Production routine tests:

These tests are carried out on each and every meter to check the requirements which are likely to vary during production (See 3.3)

3.1.2 Type Test:

These tests are carried out to provide conformity to the requirements of the relevant specifications. These are intended to check the general quality and design of a given type of meter (See 3.4). Once a meter has undergone type test any major or essential alternations, which the manufacturer intends to make shall be reported to the testing authority and further type test shall be carried out in accordance with the procedure laid down in this standard.

3.1.3 Acceptance Test:

Test carried out on samples selected from a lot for the purpose of acceptance the lot.

3.2 Samples for tests:

3.2.1 Type Tests:

Two meters in the case of 50 mm size and one meter in the case of 80 mm size and above shall be sent along with 4 copies of the manufacturer's detailed specification together with figures for the loss of head and accuracy curve to the recognized testing authority for the purpose of type test. The samples shall be picked up at random from stock or routine factory production.

3.2.2 Acceptance Test:

The number of samples shall be minimum one or 10 % of the ordered quantity.

3.3 Production routine test:

Production routine test shall consist of

- a) Hydraulic test (See 2.2) and
- b) Tests conducted to determine the following performance requirements:
 - 1. Recommended capacity for intermediate flow (See 2.3.2)
 - 2. Minimum starting flow (See 2.4) and
 - 3. Metering accuracy (See 2.5)

Note: However, for meters 200 mm and above, flow test may be conducted

3.4 Type test:

Besides all the production routine tests outlined in 4.3, the type test shall be comprised those given in 4.4.1 and 4.4.2.

3.4.1 Constructions:

The meter shall be dismantled completely to its component parts and checked for conformity with regards to dimension and tolerances with this standard; in the case of meters of 50 mm size only.

3.4.2 Flow Test:

The meter (both the meter in the case of 50 mm size) shall then be subjected to the flow test to measure the following:

- a) Loss of head at nominal capacity (See 2.3.1) and recommended capacity at intermediate flows (See 2.3.2).
- b) Minimum starting flows (See 2.1) and
- c) Metering accuracy (See 2.5)

Note -1: Before the meter is subjected to the flow test it shall be run and brought to normal condition by passing through them water at intermediate flow value for a period of 2 hours.

Note -2:

Type test certificate may be made available in lieu of flow test at manufacturer's premises. Results of the type test shall be reported in the form given in Appendix-C of IS: 2373-1981.

4.0 Installation diagram or installation instructions should invariably be supplied with each meter to facilitate proper installation of water meters.

5.0 Installation, Commissioning & maintenance of water meters:

The ordered meters shall be installed as per the instruction of the consignee and it shall be commissioned properly. The same has to be maintained by the agency. For this purpose, regular calibration shall be carried out as directed by Engineer-in-Charge. Spare kit of water meter shall be kept during maintenance period. There should not be a single day without working of water meter as this is required for measurement of flow. Any complaint received during maintenance period for non-attendance of complaint the firm will be black listed & action will be taken accordingly. For finding error in calibration, the water meter should be changed within a day and such error found on replication should be considered seriously and the action up to black listing may be done by competent authority.

6.0 Payment:

Payment shall be made as per terms and condition of the tender agreement.

8.1 EOT CRANE

The crane shall be electrically operated with all accessories including crane rails and fixtures and shall conform to IS: 15560 or relevant internationally approved standards. The crane is to be designed in accordance with IS: 807, IS: 3177 / 1965 code of practice for design manufacturing erection & testing of structural portion of the crane & IS: 3177 code of practice for design of over travelling crane. In the design of components adequate factor of safety as per relevant code is allowed. Impact, fatigue, wear, stress concentration factors etc. have to be considered whenever applicable. All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits etc. necessary for the safe and satisfactory operation of the crane shall be provided.

Steel:

Steel conforming to IS: 2062 or equivalent is to be used in the manufacturing of the main load bearings members.

Brakes:

Electromagnetic, hydraulic thrusters type brakes are to be provided in the hoisting, L.T. & C. T. Motion. The brakes shall be automatically released when the motor circuit is ON & shall be applied when the motor circuit is OFF. This feature has to work to ensure safety incase of power failure.

Bearings:

All moving parts of the crane are to be supported on anti-friction type ball / roller bearings of required size & reputed make.

Coupling:

Flexible / Universal / Geared couplings are to be provided between all gear boxes & motors.

Operation:

The crane is floor operated.

Pendent Push Button:

Push button station is to be suspended from the one end of bridge at suitable height from the floor level with stepped down voltage of 110 volts.

Power:

The crane is suitable for operation of 415 V \pm 6 %, 3 phase 50 cycles A C supply.

Crab:

The frame work shall be from all welded construction fabricated from rolled steel FRAME section and plates. The hoist & cross travel mechanism is to be mounted on this frame.

Hoist:

Hoist mechanism shall consist of motor brake, gear box, rope drum & bottom block.

Rope Drum:

The rope drum shall be made from mild steel fabricated construction having right & left hand spiral grooves properly machined to suit the hoisting ropes. The drum shall be such that there is not more than one layer when rope is fully wound, and length of the drum shall be such that each lead OD drum when hook is at its lowest position & one spare groove for each rope lead when the hook is at its highest position.

Wire Rope:

Wire rope shall be made from best quality & grade plough steel fiber core normally in 6x37 construction having Tensile strength of 160 / 175 Kg / sq mm. The wire rope shall have minimum factor of safety in accordance with IS 3177 depending on the class of the duty of the crane. Make of wire rope will be as per relevant IS & of reputed make.

Bottom Block:

The hook shall be of single plain shank type conforming to IS: 3815 and made of forged steel or equivalent supported on thrust bearings.

Rope Sheaves:

They are made from C.I. running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.

Limit Switches:

Two number shunts / Roller type reputed make is to be provided to prevent the over lowering and over hoisting

Cross Travel Machinery:

Cross travel machinery shall consist of suitably rated motor as per relevant IS and totally enclosed dust proof gear box, break etc.

Wheels:

The wheel of the trolley and the end carriages shall be made from forged steel & shall be double flanged straight thread type fitted with antifriction bearings

Bridge Girders:

The girders shall be plate welded box / ISMB type construction designed to sustain all stresses arising due to vertical and lateral forces.

Trolley Track:

Suitable square steel section tracks are to be provided for travel of the trolley. These shall be welded on the girders.

End Stoppers For Cross Travel Trolley:

Steel end stoppers are to be provided on either side of the bridge to limit the motion of the trolley.

Platform:

M S chequered plate / antiskid plate platform shall be provided for full length on one side of the bridge girder.

End Carriages:

End carriages shall be fabricated from rolled steel section / plates with adequate diaphragms and stiffeners to give a rigid construction. The girders with gusset plates are to be set on the end carriages and jointed with bolts in rimmed holes. Rubber buffers shall also be provided on either side of the end carriage.

Long Travel Mechanism:

The driving machinery for the long travel motion can be either single motor drive or twin motor drive depending on manufacturers' standards.

Paintings:

The structural parts of the crane shall be thoroughly cleaned and shall be applied with one coat of red oxide and followed by two coats of enamel paints before dispatch. Exposed machinery parts such as wheels, bright bars, etc. are also to be coated with rust protective paints.

8.2 H.O.T. Crane

1. SCOPE:

This specification covers design, material and construction Features manufacture, inspection, testing, installation and commissioning of Hand Operated Travelling crane with Mechanical chain pulley block at Pumping Station

2. CODES AND STANDARDS:

The design, material construction manufacture, inspection, testing and performance of Hand operated chain pulley block and trolley shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable relevant standards.

3. DESIGN REQUIREMENTS:

Crane bridge shall consist of single girder and wheeled trolley, steel used by vendor shall be tested quality steel conforming to IS. 226. Where plate used shall confirm to IS: 2062.

All material used shall be of recent manufacture, free from defects, mill scales.

laminations, pitting, rust, etc. All welds shall be free from defects like blowholes, lack of penetration, slag intrusion etc. The bridge shall be designed to carry the load specified in accordance with IS 807 Hand operated crane shall be complete with chain pulley block, chain drum, chain, hook, necessary gearing, sleeves, brakes for chain and travel motions, travel stops, and other accessories to meet the full requirements of the client.

The chain pulley block will be required to operate in the local climatic conditions. All the parts of

the chain pulley block and trolley shall be designed to withstand such atmospheric conditions without any deterioration.

The wheel diameter and rail size shall be suitable to take the wheel load.

4. FEATURES OF CONSTRUCTION:

The Chain pulley block shall have the following requirements:

a. GEARS

Gears shall be from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one-piece gear section

b. BEARINGS

All anti-friction bearings are to be of reputed make. Bearings shall have a minimum life expectancy of 8000 hours and may be ball, roller, or removable bronze- bushing type.

c. ROTATING SHAFTS

Shafts and axles shall have ample strength and rigidity and adequate bearing surfaces for their duties.

d. LUBRICATION:

A grease lubrication unit with hand operated grease pump shall be provided for anti- friction bearing.

e. WHEEL:

The long travel bridge wheels shall be rim toughened, heat-treated carbon or alloy steel wheel shall be single flanged. The wheels shall have antifriction bearings. The wheels shall be machined on their treads to match the runway rail section Axle and shaft shall be made of carbon steel and accurately machined and properly supported

f. HOOKS

Hooks shall be solid, forged, heat-treated alloy or carbon steel of rugged construction and provided with a standard depress type safety latch. They shall have swivels and operate on ball or roller thrust bearing with hardened races. Lock to prevent hooks from swivelling shall be furnished.

g. BRAKES:

Chain pulley block shall be equipped with mechanical type brakes having torque capable of holding 150 % of the full rated hook load.

5. TESTS AND TEST CERTIFICATES:

Overload tests at 150 % of the rated load shall be carried out and test certificates shall be furnished for hook, chain pulley block.

9.0 SPECIFICATION FOR OUTDOOR SWITCHYARD

1.1 GENERAL

The work consists of supply, erection, testing and commissioning of two pole / four pole M.S galvanized, H-frame structure, outdoor transformers, lightning arresters, isolators, dropout fuse, insulators and hardware, galvanized structure for supporting the equipment, ASCR conductors, outdoor cable termination, chain link fencing, pad lockable double gates and filling up sub-station area with rubble of 50 mm size to depth of 100 mm.

The substation consisting of transformer yards with L.A's., isolators, transformers, fence gate, 2 pole/4 pole structure shall be properly earthed as per IE Rules 1956.

The equipment shall conform to the latest applicable standards. All standards and code of practices referred to shall be the latest edition including all official amendments and revisions.

1.2 CONDUCTORS

The overhead line and jumpers shall be made by ACSR (Aluminum Conductor Steel Reinforced) conductor and shall conform to IS 398.

Aluminum strands of ASCR conductor shall be hard drawn from 99.5% pure electrolytic aluminum rods with 60% IACS conductivity. The Supplier shall specify the guaranteed minimum and average value of conductivity.

Chemical composition of the material shall comply with the requirements of relevant standards.

The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections, which may be cause for increasing corona losses when the conductor is used on extra high voltage lines.

No joints shall occur in aluminum wires closer together than 15 meters. No joints shall be permitted in steel wires.

The steel wire strands of ACSR conductor and steel conductor shall be hot dip galvanized. Zinc coating shall be evenly and uniformly coated complying with relevant Standards IS 2629/2633.

1.3 ISOLATOR AND EARTHING SWITCH

The isolators shall conform to IS : 9921 and IEC 600129.

The isolator with earthing switch shall be complete with all parts that are necessary for efficient operation. Such parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.

The isolator design shall be such that it is free from visible corona discharge in both closed and open positions at the visible discharge test voltages as per applicable standards.

The isolator and earthing switch shall be provided with high current carrying contacts on the hinge and jaw ends. All contact surfaces shall be silver faced copper.

Earthing switch shall form an integral part of each pole of the isolator. Two independent earthing pads each with flexible copper braids and suitable connectors for copper flat earth conductor lead shall be provided at the hinge end of the switch.

Isolators and earthing switches shall be provided with padlocking facility to lock them in fully open or fully closed positions. Rust proof padlocks shall be supplied with the isolators.

Isolators and earthing switch shall be mechanically interlocked such that it will not be possible to close the earthing switch when the isolator is closed and vice-versa.

Insulators used in the assembly of isolators shall be of porcelain and of brown color. Insulator cap and base shall be of high-grade cast steel or malleable steel casting and they shall be machine faced and galvanized.

The operating mechanism for isolator and earthing switch shall be either manual or motorized as indicated in technical data sheet.

Operating mechanism shall provide a quick, simple and effective operation. One man shall be able to operate the isolator/earthing switch without undue effort.

The manual operating handles shall be mounted on the base of the supporting structure. Guide bearings shall be provided if necessary, at a height of 750 mm above grade level. All brackets, angles, guides, guide bearings or other members necessary for attaching the operating mechanism and operating handles to the supporting structure and foundations shall be supplied as an integral part of the isolator. Rust-proof pins and bearings of the bronze bushing, ball and roller type, shall be furnished. All bearings shall be weather protected by means of covers and grease retainers. Bearing pressures shall be kept low to ensure long life and ease of operation.

Isolators and their operating mechanism shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations, chocks or accidental touching or breaking of the connecting rods or the operating mechanism.

All the supporting structures for isolators, earthing switches shall be of Galvanized steel.

1.4 H.V DROP OUT FUSES

Fuse assembly shall be complete with fuse carrier, post insulator, jaw and hinge, live parts, terminals, channel base, all fixing bolts, nuts and washers. Fuse links of specified current rating shall be supplied for use with these fuse assemblies.

All materials used in the manufacture of drop out fuses shall be suitable for conditions specified and shall withstand variations of temperature and atmospheric conditions without deterioration or distortion of any kind in any part. All non-metallic parts of fuse carrier shall be tough, non-ignitable insulating materials.

Mounting of drop out fuses shall be such that its isolation/ removal replacement shall be easy. It shall have positive guides for this purpose.

Bird proof construction features shall be provided.

It shall be possible to adjust spring pressure of the top contact to ensure consistent performance

All current carrying parts shall be of copper alloy. The contacts shall be of gunmetal brass or phosphor bronze. The contact surface shall be silver plated to ensure low contact resistance.

Fuse links shall be such construction as to prevent danger from overheating, arcing and scattering of hot metal or powder or emission of flame, when operating in service.

When the fuse link ruptures or when the fuse carrier is pulled downwards, the carrier shall swing free to an inverted position. The carrier shall be brought to a cushioning stop to eliminate shock on the carrier and lower insulator unit.

The base channel and all ferrous parts shall be hot-dip galvanized conforming to IS 2629/2633.

HV drop out fuse base channel shall bear a name plate describing the major technical particulars. Fuse base, fuse link and fuse carrier shall bear the markings as per IS.

1.5 LIGHTNING ARRESTER

Lightening arrestor shall be of outdoor, metal oxide gapless type and shall conform to IEC 60099-4.

Lightening arrestors (LAs) shall be of the hermitically sealed type of self-supporting construction, suitable for mounting on steel structures.

Outer insulators shall be of porcelain having adequate mechanical strength and rigidity, for satisfactory operation under climatic conditions obtaining at site. Porcelain shall be finely glazed and shall be free from imperfections.

LAs shall incorporate anti-contamination feature to prevent arrester failure, consequent to uneven voltage gradient across the stack in the event of contamination of the arrester porcelain.

LAs shall be complete with insulating base having provision for bolting to flat surface of supporting structure.

LAs shall be complete with line and earth terminals. The terminal clamps/ connectors on the earth terminal of the arresters and the discharge counter incoming and outgoing terminals shall also be provided.

1.6 INSULATORS

The porcelain post insulators shall conform to IS 2544, IEC 60273, the insulators for overhead lines shall conform to IS 731, BS 60383, IEC 60305, 433 and the insulator fittings shall conform to IS : 2486, BS 3288

Porcelain used for the manufacture of insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown color, free from blisters, burns and other similar defects. The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed. Insulators shall have compression type glaze with a good luster and of uniform brown color.

Insulators shall be designed to avoid excessive concentration of electrical stresses in any section of electrical stresses in any section or across leakage surfaces. Design features which increase radio influence level shall be avoided.

All metal parts shall be made of good commercial grade malleable iron or open hearth or electric furnace steel, hot dip galvanized to relevant standards. Casting shall be free from blow holes, cracks and such other defects.

1.7 ACCESSORIES

An operating rod with provision at the top for switching and removing fuse carrier shall be provided. The rod shall be minimum 6.0 meter long unless otherwise stated.

Multi-bolt (bi-metallic) terminal clamps shall be provided at the top and bottom of fuse base contacts suitable for connection to the ACSR conductor.

Fuse kit shall be supplied, consisting of fuse-link assembly, refusing tool and any other item necessary to restore the fuse units to service after an operation.

H.V drop out fuse frame shall have two earthing terminals.

1.8 HARDWARE FITTINGS

All hardware shall be drop forged from high carbon steel.

All ferrous parts shall be hot dip galvanized conforming to IS 2629 & 2633.

All clevis fittings and shackles shall be furnished with a high strength high carbon steel galvanized bolt with nut and cutter key.

1.9 CLAMPS & CONNECTORS

The material for clamps and connectors shall be as indicated in technical data sheet.

The clamps shall be light in weight and easy to handle. Suspension clamp shall have ease of oscillation around horizontal axis and small moment of inertia enabling it to follow freely the movement of the conductor. The clamps shall have low effective power loss.

Connectors used for copper to ASCR conductor connections shall be aluminum alloy clamps with necessary cast in copper liners.

All casting shall be free from blow holes, surface blisters, cracks and cavities.

The Electrical power connectors shall conform to IS 5561, BS 159.

10.0 SPECIFICATIONS OF DOL, S/D and ATS MCC PANEL

Supply of fully automatic air break MCC Panel for operation on 415V, 3Ø, 50 Hz AC supply. The details of the equipment/accessories for the control panel shall be as per the given data sheet and rating chart. The control panel manufacturer must be Board approved vendor list and must also possess ISO: 9001 certificates with Design, Development, Manufacture and Supply criteria.

ENCLOSURE:

The MCC panel shall be dust and vermin proof, fabricated out of minimum 14 SWG sheet. It shall be wall mounting cum pedestal type/free standing type. All the items inside the control panel shall be mounted on minimum 16 SWG steel base plates. All the metal parts shall be thoroughly cleaned, digressed and made free from rust after the application of zinc cremateprimer. The MCC panel shall be powder coated. The color shade shall be as per shade 631 of IS 5. The degree of protection shall be IP 51. The MCC panel shall have channel/legs/angle iron stand of 300 MM height for easy termination of I/C and O/G cables. The I/C and all O/G cables shall have bottom entry only.

WIRING & TERMINALS:

Power and control wiring shall be done with PVC insulated copper conductors and shall be terminated with adequately sized compression type lugs for connections to the equipment terminals and terminal strips. Each wire shall be identified at both ends by ferrules. Not more than two wires to be terminated at one terminal and size of terminals shall be used keeping in view the components for which they are used, so that adequate surface contact can be achieved. I/C and O/G to be made at terminals only. The minimum distance between the cable gland plate and the termination shall be 300 MM. Control wiring shall be done with 1.5 sq mm only. Wires used shall be of ISO 9001 accredited company.

EARTHING:

2 Nos. of earthing terminals shall be provided for connecting the earth. All non-current carrying metallic parts of the equipment shall be earthed. A separate CU strip 19 X 3 MM shall be provided through-out the width of the panel.

MAIN INCOMING:

An MCB/MCCB/ACB shall be provided as the Main I/C. The switchgear selection shall be as per type 2 co-ordination. Suitable Castell Key interlocks shall be provided for “two incomers and one bus coupler” type of configurations.

Depending on the fault withstand ratings, upto 40A rating, MCBs with suitable tripping characteristics shall be used. Above 40A and upto 630A, MCCB shall be used. Above 630A, ACB shall be used. ACB shall be Manually operated, D/O type with U/V trip, S/C trip and O/L trip.

MCCB shall be TP+N with shunt trip.

Moreover, the following components shall be provided in the MAIN I/C feeder.

- (1) R.Y. B Phase indicating LED lamps.
- (2) 20A X 415V HRC control fuses with 6A HRC links.
- (3) Sq-96, Digital Voltmeter and Ammeter with selector switch.
- (4) Suitable range CTs for Ammeter.

SUB MAIN INCOMING:

A FSU/Isolator of AC-23 duty with door interlocking facility shall be provided as the Incoming of each feeder panels. The rating of FSU/Isolator and HRC fuses shall be as per the rating chart in IS : 13947 (Part 3) 1993.

CONTACTORS:

Contactors of AC-3 duty of 415V or with wide band coil of 320-480V shall be provided. The ampere rating shall be as per the rating chart and the data sheet.

TIMER:

An electronic timer for S/D change-over having 50 msec pause time delay shall be provided for S/D and ATS control panels only. In case of ATS control panels, a master timer (electronic) shall also be provided. This master timer shall operate within 15 seconds, if the S/D timer fails to operate within 10 seconds.

O/L RELAY:

O/L relay of suitable range shall be provided as specified below. The O/L relay shall have inbuilt SPP feature and must have manual reset facility. In case of DOL and ATS panels, relay range shall be decided by multiplying min. 1.3 times and max. 1.5 times the HP rating of the motor. In case of S/D panels, it shall be decided by multiplying 0.6 of min. 1.3 times and max. 1.5 times the HP rating of the motor.

INDICATING LAMPS:

22.5 dia, clustered LED type indicating lamps with inbuilt resistor shall be provided as specified in the data-sheet.

PUSHBUTTONS:

22.5 dia, Red, Green, Yellow and Black pushbuttons shall be provided for STOP, START, TIMER and O/L RESET respectively for ATS panels. Red, Green and Black pushbuttons shall be provided shall be provided for STOP, START and O/L RESET respectively for DOL and S/D panels.

SINGLE PHASING PREVENTOR:

S.P.P of negative phase sequence principle, voltage operated with U/V and O/V cut off at 320V and 480V respectively shall be provided.

EARTH LEAKAGE RELAY:

ELR having 0.5 seconds time lag to avoid nuisance tripping and with suitable dia C.B.C.T shall be provided of 0.5 to 2.5A range. E.L.R shall have a bypass toggle switch to bypass the same in case of emergency.

AMMETER:

Digital Ammeter of 96 sq mm size shall be provided. An Ammeter selector switch shall also be provided to read current in each phase.

CONTROL FUSES:

20A X 415V HRC control fuses along with 6A HRC fuse links shall be provided for the control circuit.

AUTO-TRANSFORMER:

Air cooled auto-transformer of 6 starts/hour having 60%, 70%, 80% tapings shall be provided. It shall be copper wound with 'E' class insulation. The winding shall withstand starting current for at least 15 seconds. It shall be vacuum impregnated for longer life. The % regulation shall not exceed 10%. It shall be in accordance as per the latest IS 13947 (Part 4/sec 1) of 1993 (for ATS panels only).

CAPACITOR FOR MOTORS:

A capacitor of 415V shall be provided as per the rating chart. Capacitor shall be MPP type, GEB tested (certificate required). HRC fuses shall be provided before capacitor. The rating of the HRC fuses shall be as per rating chart. An electronic Delay timer along with contactor as per rating chart shall be provided for automatic switching of capacitor. The capacitor shall switch on after one- minute the motor starts. A selector switch for AUTO-MANUAL selection shall also be provided. STOP-START pushbuttons shall be provided in case of manual operation. A LED indicating lamp shall be provided for 'ON' indication.

Alternatively, APFC relays with bulk power factor correction units shall be provided.

In all cases, suitable calculations shall be provided to ensure the rating of capacitors is appropriate for correcting the power factors.

CAPACITOR FOR POWER TRANSFORMER:

In order to take care of Inductive load of Power transformer, a MPP capacitor bank rated for 415V shall be provided along with HRC fuse protection as mentioned in the rating chart. The kVAR of capacitor shall be provided to ensure a power factor of 0.99.

BUSBARS:

TPN Busbars shall be of Aluminum, duly sleeved with heat shrinkable colored sleeves. The current density of the Al. busbars shall be 1 Sq mm = 1A. The size of the phase busbars shall not be less than the Ampere rating of the Main Incoming. The neutral bus bar shall be of 50% of the phase busbars. Bus bar supports shall be of SMC/DMC type.

LIGHTING FEEDER:

Nos. of 63A FSU/Isolator of AC-23 duty shall be provided along with HRC fuses in a separate compartment for domestic lighting.

THERMISTOR and MLC:

Thermostat and Moisture level controller (MLC) shall be supplied along with bypass toggle switch in case of Sewage control panels only. Relevant indicating lamps for each unit shall also be provided on the front door of the panel. The control panel shall be as per the enclosed rating chart, data sheet and makes specified only. The contractor shall have to submit 2 copies of GA drawing, Bill of Materials and Wiring diagram for the approval to the Executive Engineer, prior to manufacturing.

Following tests shall be carried out at manufacturer's works at his own cost and risk

- (01) Single phasing in each phase and 15% unbalance voltage tripping.
- (02) U/V and O/V cut off at 320V and 480V respectively.
- (03) Leakage current test.
- (04) H. V test at 2.5 KV for Power circuit & 1.5 KV for Control circuit.
- (05) H. V test between phases.
- (06) Temperature rise test on ATS as per IS 13947 (Part 4/Sec I)-1993.
- (07) Percentage regulation test not exceeding 10%.
- (08) Megger test.

RATING CHART FOR O/G FEEDERS

Sr. No.	HP Up to	SFU/ SWITCH		HRC FUSES		CONTACTORS FOR STAR, DELTA, MAIN CAP.		HRC FUSES FOR CAP.	CAP. KVAR
1	2	3	4	5	6	7	8	9	10
01	DOL 5.0	16A	16A	---	---	16A	16A	10A	2
02	DOL 7.5	25A	25A	---	---	25A	16A	16A	3
03	S/D 10.0	25A	25A	16A	16A	16A	16A	16A	4
04	S/D 15.0	32A	32A	25A	25A	25A	16A	16A	5
05	S/D 20.0	40A	40A	32A	32A	32A	16A	16A	6
06	ATS 25	63A	50A	16A	25A	70A	16A	20A	7
07	ATS 30	100A	63A	25A	32A	70A	25A	20A	8
08	ATS 35	100A	80A	32A	40A	70A	25A	25A	9
09	ATS 40	100A	80A	32A	40A	80A	25A	25A	10
10	ATS 45	100A	100A	32A	40A	95A	25A	32A	12
11	ATS 50	125A	100A	40A	70A	100A	32A	32A	13
12	ATS 55	125A	125A	40A	70A	125A	32A	40A	14
13	ATS 60	125A	125A	40A	70A	125A	32A	40A	15

Sr. No.	HP Up to	SFU/ SWITCH		HRC FUSES		CONTACTORS FOR STAR, DELTA, MAIN CAP.		HRC FUSES FOR CAP.	CAP. KVAR
1	2	3	4	5	6	7	8	9	10
14	ATS 70	200A	160A	40A	70A	170A	40A	63A	17
15	ATS 75	200A	160A	45A	100A	170A	40A	63A	18
16	ATS 80	200A	160A	50A	100A	200A	40A	63A	19
17	ATS 90	200A	160A	50A	100A	200A	40A	63A	21
18	ATS 100	200A	160A	50A	125A	200A	65A	80A	23
19	ATS 125	250A	225A	70A	140A	250A	65A	80A	27
20	ATS 150	300A	250A	110A	170A	300A	100A	100A	33
21	ATS 170	400A	350A	150A	200A	300A	125A	100A	37
22	ATS 200	400A	400A	170A	200A	400A	125A	125A	42
23	ATS 250	630A	500A	200A	300A	630A	150A	160A	50

Note: -The switchgear and contactors used inside the control panel shall be of one make only. Usage of different makes of switchgear and contactors is not at all permissible.

11.0 TECHNICAL SPECIFICATION FOR 11 / 0.433KV TRANSFORMERS, HIGH VOLTAGE / LOW VOLTAGE EQUIPMENT

SPECIFICATION FOR DISTRIBUTION TRANSFORMER OIL TYPE.

The bidder has to quote for the following types of distribution transformers. The transformer should be as follows:

Specification for 11/0.433kV OIL Type Distribution Transformer

1.0 General Information

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard, IEC standard and CBIP manuals except where modified and / or supplemented this specification.

The electrical installation shall meet the requirement of Indian Electricity Rules as amended up to date, relevant IS code of practice and Indian electricity act. In addition, other rules of regulations applicable to the work shall be followed.

The Transformer offered shall in general comply with the latest issues including amendments of the following Indian standards.

2.0 Code and Standards

The transformer shall comply with the latest edition of the following and other relevant Indian Standards / Manual:

IS 335;	Insulating oil
IS 1271:	Thermal evaluation and classification of electrical Insulation
IS 1180:	Specification of Transformers from 100kVA to 2.5MVA
IS 2026:	Power Transformers
IS 2099:	Bushing for alternative voltages above 1000V
IS 2705:	Current transformer
IS 3347:	Dimension for porcelain transformer bushings.
IS 3637:	Gas operated relays
IS 3639:	Fitting and accessories for power transformers
IS 4201:	Application guide for CTs
IS 6600:	Guide for loading of oil immersed transformer
IS 8478:	Application guide for ON load tap changers
IS 8468:	On load tap changers
IS 10028:	Code practice for selection, installation and Maintenance of transformer
IS 13947:	LV Switchgear and Control gear - Part - I General rules CBIP
Manual	on transformers
IS 2074:	Ready mixed paint, air drying red oxide, zinc chrome priming
IS 5:	Color of ready mix paint
IEC 76:	Power transformer

IEC 76.2 or IEC IEC-76-1 or IEC 726 or IS:2026 IEC-298, or IEC 466 IEC-947-1, IEC-439-1 IS:1180 IS:2026 IEC-550 (151):1978 IS:1885 IEC-60-1:1989 IS:2017 Part I IEC-68-2-62:1991:	Temperature limits (All Parts) High voltage Switch gear and Control gear Low voltage Switch gear and Control gear For distribution transformers SEV Chapter 151 Electro magnitude devices. High voltage test Technique Part-I. General definition and test requirements. Environmental testing - part 2, tests impact amendment1(1993)
IEC-71-2:1976 IS:3716 IEC:76-1:1993 IS:2026 (Part I) IEC 76-2:1993 IEC 76-5, 1976	Insulation co-ordination Part 2 Application guide Power transformer Part I general Power transformer Part 2 temperature rise. Power transformer Part 5 ability to withstand short circuit test
IEC:243-1,1988: IS:258-1 IEC: 354:1991: IS:6600 IEC: 551:1987: IS:13964 IS:2932:	Methods of tests for Electric strength of solid insulating Material Part - I tests and power frequencies. Loading guide for oil immersed power transformer. Determination of transformer and reactor sound level.
IS:3347:	Enamel synthetic, exterior a) under coating b) Finishing Dimension of porcelain transformer bushing for use in very heavily polluted atmosphere
Indian Electricity Rules: 1956 Indian Electricity Act: 1910 The Electricity Act: 2003	

Transformer shall also conform to the provisions of the latest revisions of the Indian Electricity rules and any other statutory regulations currently in force as per standards.

3.0 DESIGN CRITERIA

The transformers shall be installed in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

The transformers shall be capable of continuous operation of rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard and Indian Electricity Rules, 1956 / IEC with latest amendments in force.

The transformer shall conform to best engineering practice.

The transformers shall be capable of withstanding the short circuit stresses due to terminal fault between phase to phase and phase to ground on one winding with full voltage maintained on the other windings for a minimum period of three seconds.

The transformers shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.

The equipment offered shall be suitable for continuous satisfactory operation in the state of Gujarat.

4.0 SPECIFIC REQUIREMENT:

- 4.1 **Requirement:** 11000/433 Volt Oil immersed ONAN cooled double wound; core type suitable for outdoor duty.
- 4.2 **Voltage Ratio:** No load voltage 11000/433 volts within tolerance as stipulated in IS: 1180.
- 4.3 **Rating:** The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified. The rated KVA shall be the product of the rated voltage in kV, the corresponding rated current and the phase factor 1.73. When the transformer is operated with the rated primary voltage applied to the terminals of the primary winding, the apparent power (kVA) at the terminals of the secondary winding, when carrying the rated secondary current differs from rated kVA by an amount corresponding to the regulation of the transformer and is the product of the actual secondary voltage, the rated secondary current and phase factor 1.73.
- 4.4 **System:** 11000 volts A.C. supply, on H.V. side and 433 Volts on L.V. side with variations, as per statutory variation governed by relevant Indian Standard and Indian Electricity Rules, 1956 / IEC with latest amendments in force. The 11kV neutral and L.V. neutral is earthed solidly at each transformer substation. The transformers will be connected in a system consisting of both overhead and underground mains (both on HV and LV sides)
- 4.5 **Temperature Rise:** The maximum temperature rise at the specified maximum continuous output shall not exceed 40°C by thermometer in the hottest portion of the oil or 50°C measured by resistance of winding above ambient temperature.
- 4.6 **Type of Load:** The transformer shall be suitable for carrying load within temperature rise indicated in the Indian Standard specification IS: 6600 'Guide for loading of oil immersed Transformer'.
- 4.7 **Overloads:** The transformers shall be suitable for carrying overload within temperature rise indicated in IS: 6600 'Guide for Loading of oil immersed Transformer'.
- 4.8 **Connections:** H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11 of IS:1180.
- 4.9 **Tapping:** Each transformer shall be provided with Rotary type tap Switch so as to provide for a voltage adjustment on H.V. from +10% to -10% of rated voltage of 11000 volts in 4 equal steps (5 position) to obtain rated voltage of 433 volts on LV side.

4.10 Tank

The transformer tank and cover shall be fabricated from robust M.S. plate steel without pitting and shall have adequate thickness, with external cooling tubes or radiators. The tank and cover shall be of welded construction. All seams shall be welded and where practicable they shall be double welded. All edges shall be double welded. The tank wall shall be reinforced by stiffener to ensure rigidity, so that it can withstand without any deformation

(a) Mechanical shock during transportation

(b) oil filling by vacuum.

All removable covers shall be provided with weatherproof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any leakage of water into or oil from the tank.

The tank shall be subjected to a pressure test of **0.35 kg/cm²** with hot oil for **12 hours** when the transformer is complete with all fittings. During the test average oil temperature shall be maintained at 45°C above Ambient temperature throughout test period by circulating suitable current in HV winding and short circuiting L.V. winding. There shall be no leakage of oil during or after the test. Also, there shall be no deflection at all when the pressure is removed. The purchaser's representative may be present during these tests for which advance intimation shall be given and **test Certificate for this test shall be produced by the supplier in triplicate before dispatching the units.**

Air release plugs shall be provided on main tank top cover to cover entire area suitably.

- a) Inspection covers shall be provided to facilitate individual inspection, without lifting the tank cover, for the following:
- b) Connection of primary winding to cable box/disconnection chamber bushings.
- c) Connection of secondary winding to cable box/disconnection chamber bushings.
- d) Main tank center for core/winding inspection.

6.0 **Oil:** The necessary quantity of new transformer oil according to IS: 335 shall be supplied filled in the transformer tank & up to a height above the minimum filling mark of hermetically sealed tank. The Supplier shall furnish the relevant technical particulars and test certificates of the oil supplied. An additional 10% of the total quantity of oil required shall be supplied loose along with the transformer.

- 1. **Leakage of Oil:** Suitable approved type of material such as "Neoprene" which has an oil proof agent, as specified in IS: 1866 shall be provided at all joints to prevent leakage of oil during continued operation or during transportation.
- 2. **Drying-out:** The transformer winding shall be thoroughly dried out & kept immersed in oil to avoid any further drying out by the purchaser & to facilitate immediate commissioning of the transformer on receipt.
- 3. **Clamping of leads:** All leads from the coils to the terminals shall be suitably clamped to prevent snagging and fouling with other parts and the tank.
- 4. **Phase Marking:** Phase markings as per IS: 1180 punched on small non-corrosion metallic tags shall be permanently fixed for H.V. just below the cable box or on some suitable removable part of the tank and above L.V. Bushings. Phase markings tags shall be properly fixed with proper alignment.

6.1 Core and Coil

- 6.2 The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain-oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.
- 6.3 The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage.
- 6.4 Insulating material shall be of proven design. The insulating materials shall be class “A” or above specified as per IS: 1271. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum.
- 6.5 Transformers will be connected at the end of 11 kV and 0.433 kV overloaded feeders, in a lightning prevalent area.
- 6.6 The coil assembly shall be supported suitably between adjacent sections by insulating spaces & barriers. Brazing shall be arranged to ensure a free circulation of the coil & to reduce the hot spot of the winding.
- 6.7 All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used wherever practicable.
- 6.8 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding as per IS:2026.
- 6.9 The efficiency of the transformer shall be as indicated in the IS 1180.

7.0 List of Fittings: -

- a. Conservator with filling cap and drain plug.
- b. 2 Nos. of Lifting lugs on top tank lid for lifting the complete transformer.
- c. Silica Gel breather of Minimum 500 Gms.
- d. Drain valve with suitable protection to stop theft of oil.
- e. Shut Off valve between Conservator tank and main tank body.
- f. 4 Nos. of Jacking lug of suitable size
- g. Filter valve with Plug
- h. Rating & diagram plate of stainless steel.
- i. 4 Nos. of Earthing terminals on tank body.
- j. All terminals of HV & Lvsides should be properly marked.
- k. Off circuit tap changer bridge type for voltage variation on HV side preferably with 5 taps in steps of 2.5%.
- l. Explosion vent

- m. Air release plug on the top tank body for releasing the trapped air.
- n. Corrugated type radiators for cooling on all four sides.
- o. 3Nos. of HV bushings, Porcelain type.
- p. 4Nos. of LV bushings, Porcelain type.
- q. 4Nos. of MS Rollers
- r. 4 nos. of Anchor point for haulage.
- s. Thermometer pocket on top of the tank lid for dial type thermometer (OTI) with alarm & trip contact.
- t. Thermometer pocket for stem type thermometer.

8.0 TESTS for Oil Type Distribution Transformer

ROUTINE TESTS (As per IS 2026)

The following tests are to be carried out as per IS 2026, clause 13.2.

- i. Measurement of winding resistance
- ii. Measurement of voltage ratio & check the voltage vector relationship
- iii. Measurement of impedance voltage (principal tapping), short circuit impedance & load loss all shall be corrected to a temperature of 75 °C
- iv. Measurement of no-load loss and current
- v. Separate source withstand voltage
- vi. Induced over voltage withstand
- vii. Dielectric Test of Oil

TYPE TESTS (As per IS 2026)

- i. Measurement of winding resistance
- ii. Measurement of voltage ratio & check the voltage vector relationship
- iii. Measurement of impedance voltage (principal tapping), short circuit impedance & load loss all shall be corrected to a temperature of 75 °C
- iv. Measurement of no-load loss and current
- v. Separate source withstand voltage
- vi. Induced over voltage withstand
- vii. Dielectric Test of Oil

SPECIAL ACCEPTANCE TEST (As per IS 2026)

- i. Short Circuit test
- ii. Acoustic Noise Level Test
- iii. Oil Leakage Test by application of pressure.

MISCELLANEOUS

- All components' parts and auxiliary equipment such as bushings, tap changing gear, etc. shall be routine tested as per relevant Indian Standards.
- The manufacturer shall have the necessary laboratory grade instruments and equipment for carrying out all routine and type tests and get these calibrated at frequent intervals.

- The transformers (including tap change gear) shall be capable of withstanding without damage the thermal and mechanical effects of short circuits at the terminals of any winding or the periods as provided by latest IS:2026/Part1/1977. The manufacturer shall supply the calculation for short circuits in case required by purchaser.

C. SPECIFICATION FOR LT SYSTEM

LT compartment shall be suitable to house the equipment as per the indicative Single Line Diagrams. The bus bar ratings shall be same as the incoming circuit breaker ratings.

The design should comply for the following standards.

1. IEC-439-1, 1992 Low voltage Switch gear and Control gear assemblies Part-I, type tested and partially type tested assemblies.
2. IEC-947-1, 1998 Low voltage Switch gear and Control gear Part-I general rules.
3. IEC-1180-1, 1992 High voltage test techniques for low voltage equipment Part-I definition test and Procedure requirement
4. IEC-529, 1989 Degree of protection provided by enclosures (IP code)

EQUIPMENT SPECIFICATION

1. Air circuit breaker (ACB)

These shall be fixed type with manually operated mechanism. The short circuit mechanism and breaking capacity as shall be supported by test certificate. The test certificates should be from CPRI / any Govt. approved recognized test house / laboratory. The circuit breaker shall be fitted with CT operated thermal overload and short circuit releases devices for current rating 1250Amps.

- a) Overload releases should be settable from 50% to 100% of the rated current I_n .
- b) Ambient temperature compensated type and there should not be de-rating of ACB current carrying capacity at 40°C. The testing of ACB for the temperature rise shall be carried out by the manufacturer as per the prevailing, IS / IEC or any other international standards.
- c) ACB shall be provided with overload and short circuit release. Short circuit release should have settable value of 15kA to 25kA with a adjustable times having setting range of 40 - 460 m seconds, to have a proper co-ordination with short circuit release of outgoing MCCBs.
 - 1) 3 phase, 4 wire, neutral earthed having link arrangement.
 - 2) Rated current thermal current - As per indicative SLDs
 - 3) Service voltage - 415 volts
 - 4) No. of break / pole - one
 - 5) Frequency - 50 c / s

- 6) Rated insulation voltage - 1000 volts
- 7) Rated short circuit breaking capacity
Rated services S/C breaking capacity I_{cs} (rms) - 50kA
Rated ultimate S/C breaking capacity I_{cu} (rms) - 50kA
- 8) Break Time - less than 40ms
- 9) S/C making capacity 1cm (peak) - 125kA
- 10) Rated short time withstand current: I_{cw} 50kA for 1 sec.
- 11) Suitable for outdoor installation.
- 12) It shall conform to IS 13947 / pt.2 / 1993 with latest amendment, if any.
- 13) Performance category: Utilization category - B.
- 14) The status of open and close shall be clearly visible.
- 15) The trip indication separated for overload and individual phase wise trip indication for short circuit to be provided.
- 16) The ACB shall have the provision to lock the operating mechanism in off position.
- 17) The operating mechanism should be from front and the compartment should have the degree of protection IP - 54.
- 18) Separator shall be provided between all phases inside. ACB enclosed to prevent travel of arc during short circuit.
- 19) The CTs mounted for thermal overload release shall have secondary winding inaccessible including tripping mechanism of O/L and magnetic releases to avoid tampering CTs should also have provision of separators.
- 20) Two nos. earthing bolts for propose of earthing of ACB may also be provided & suitable for G.I stay wire of size 7 / 10 SWG.
- 21) The bus bar size shall be confirming to relevant IS and the neutral bus bar shall be of same wire of size as phase bus bar and should be suitable for connecting neutral.
- 22) The ACB shall be tested in accordance with the provision of IS 13947 - Part I or relevant IEC

2. Molded case circuit breaker (MCCB)

1. The rating for MCCB shall be as per indicative SLD having $I_{cu} = I_{cs}$ with TMD fixed type release.
2. MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing.
3. MCCBs shall have an ultimate short circuit capacity not less than the prospective short circuit current at the point of installation.
4. MCCBs shall have a service short circuit breaking capacity equal to the ultimate short-circuit capacity.
5. Each pole of MCCB shall be fitted with a bi-metallic thermal element for inverse time delay protection and a magnetic element for short circuit protection. Alternatively, they shall be fitted with a solid-state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism. Thermal element shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility. Thermal elements shall be ambient temperature compensated.
6. The MCCBs shall be provided with the following features.
 - 1.10 Common trip bar for simultaneous tripping of all poles

- 1.11 Shrouded terminals
- 1.12 Time for clearing short circuit current of 20 msec.
- 1.13 2 NO + 2 NC auxiliary contacts

3. Interconnecting bus bar

Bus bar shall be of high conductivity aluminum (E91E) supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in BIS. The main bus bars shall have uniform current ratings throughout their length as specified in data sheet / job specification. The current rating of the neutral shall be half that of the phase busbars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar, joints and supports.

The hot spot temperature of bus bars including joints at design ambient temperature shall not exceed 95°C for normal operating conditions.

The current rating of the bus bars shall be 1600A for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

Minimum clearance between live parts, between live parts / neutral to earth shall be 19mm. However, clearances between terminals at components shall be as per applicable individual standard for components.

Interconnections between the main bus bars and individual units shall be made using vertical / horizontal aluminum bus bars of adequate rating.

Auxiliary supply

3 phases with neutral, 440V AC supply shall be tapped from main bus bar after the ACB/MCCB for supply to lighting of the substation. Necessary protection in incomer and outgoing shall be provided.

i. Miniature Circuit Breaker (MCB)

- 1. MCB shall be hand operated, air break, quick make, quick break type.
- 2. Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.
- 3. Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the connected load. Where this is not specified, it shall be Type C.
- 4. The short circuit rating shall be not less than that of the system to which they are connected.

ii. Contactors

1. The power contactors used in the switchboard shall be of, air break, single throw, triple pole, electromagnetic type. Contactors shall be suitable for uninterrupted duty and rated for Class AC3 duty in accordance with the latest edition of IS 13947.
2. Operating coils of all contactors shall be suitable for operation on 240 V, single phase, 50 Hz supply.
3. Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.
4. Contactors shall not drop out at voltages down to 70 % of coil rated voltage.
5. All contactor shall all be provided with single phasing preventer (SPP).
6. Motor starters shall be complete with auxiliary relays, timers and necessary indications.

iii. Switch Disconnectors and Fuses

1. LV switch disconnectors shall be of the load break, fault make, group operated type. For use on 3-phase systems, the switches shall be of the triple pole type with a link for neutral wire. For use on single phase system and DC systems, the switches shall be of the two-pole type.
2. Switch disconnectors shall be of the heavy duty, quick make and quick break type. Their contacts shall be silver plated, and contact springs shall be of stainless steel. Their handles shall have provision for locking in both fully open and fully closed positions. Mechanical ON-OFF indication shall be provided.
3. Switch disconnectors for controlling motor circuits shall be of the load break, fault make type, and shall be capable of breaking locked rotor current of the associated motor.
4. Where combination units of switch disconnectors and fuses are used, the following interlocks shall be incorporated.
5. The fuses should not be accessible unless the switch disconnectors is in fully open condition.
6. It should not be possible to close the switch disconnectors when the fuse cover is open, but an authorised person may override the interlock and operate the switch disconnectors. After such an operation, the cover shall be prevented from closing if the switch disconnectors are left in the "ON" position.
7. All fuses shall be of the HRC cartridge type, mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated. Current vs. time characteristics of all types of fuses shall be furnished to the Engineer's Representative.
8. Fuses and links functionally associated with the same circuit shall be mounted side by side.
9. An adequate number of spare fuse cartridges of each rating shall be supplied and fitted in clips inside the panel.

iv. Instrument Transformers

1. Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block.
2. CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current.

3. CT core laminations shall be of high-grade silicon steel and CT shall be cast resin/tape wound type.
4. Identification labels giving type, ratio, output and serial numbers shall be provided.
5. Secondary winding of voltage transformer (VT) shall be rated for a three-phase line to line voltage of 110 V.
6. Protection for primary winding of VT shall be provided with current limiting fuses and secondary winding of VT shall be provided with HRC fuses/ MCB. Primary fuses shall be rated to interrupt short circuit current corresponding to the switchgear rating.
7. It shall be possible to replace the VT fuses easily without having to de-energise the main bus bar.

v. Control and Selector Switches

1. Control and selector switches shall be of the rotary type, having enclosed contacts, which are accessible by the removal of the cover. Control and selector switches for instruments shall be flush mounted on the front of the panels and desks.
2. All control switches shall be of the spring return to normal type and shall have momentary contacts. Selector switches shall be of the stay-put, maintained contact type.

vi. Indicating Instruments & Meters

1. Electrical indicating instruments shall be 96 mm square with 240° scale. Taut band type of instruments is preferred.
2. Instrument dials shall be white with black numbers and lettering.
3. Normal maximum meter reading shall be of the order of 60 % normal full scale deflection. Ammeters for motor feeders shall have suppressed scale to show current from full load up to six times the full load current.
4. Watt-hour meters shall be of the induction type and shall be provided with reverse running stops.
5. Instruments shall have an accuracy of Class 1.0.

RELAY CO-ORDINATION

Bidder shall ensure proper relay co-ordination between 11 kV switchgear & LT ACB & other downstream protection equipment. The bidder shall provide calculation in support of the same.

Routine Test

The tests shall be carried out in accordance with IEC 62271-202 include but not necessarily limited to the following:

- i. Dielectric test on the HV interconnection.
- ii. Test on auxiliary and control circuits.
- iii. Functional tests.
- iv. Verification of correct wiring.
- v. Test after assembly on site.

Type Test

The tests shall be carried out in accordance with IEC 62271-202 include but not necessarily limited to the following:

- i. Tests to verify the insulation level of the prefabricated substation.
- ii. Tests to prove the temperature rise of the main components contained in a prefabricated substation.
- iii. Tests to prove capability of the main and earthing circuits to be subjected to the rated peak and rated short-time withstand currents.
- iv. Functional tests to prove satisfactory operation of the assembly.
- v. Tests to verify the degree of protection.
- vi. Test's to verify the withstand of the enclosure of the prefabricated substation against mechanical stress.
- vii. Internal arc test.
- viii. EMC compatibility tests.

Type test certificate of PSS, if so desired by the customer, shall be furnished.

TEST WITNESS

All tests shall be performed in presence of owner's representatives, if so desired by the Owner. The Contractor shall give at least fifteen (10) days advance notice of the date when tests are to be carried out.

TEST CERTIFICATES

Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

The equipment shall be dispatched from works only after receipt of Owner's written approval of the test reports.

13.0 DRAWING APPROVAL

The bidder has to take the approval for the various components of the electrical system before start of manufacturing.

ConstructionThe MV switchboard panels shall be floor mounting, free standing, compartmentalized, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp and vermin proof. Enclosure shall have IP-52 or better degree of protection for indoor unit and IP-55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be additionally provided with canopy or weather shed for protection.

Overall height of Panel shall not exceed 2300mm (For VFD, Soft Starter panel height up to Max. 2500mm can be accepted) including 75mm ISMC base frame. However, in case of panel mounted on floor without cable trench shall be mounted at least 350mm above the floor level to provide adequate bending radius for in and out cables and the overall panel height shall not exceed 1750-1950mm.

VFD, Soft Starter cubical compartment shall be provided with Min. 750mm width and Mini. 700mm depth and 1800/mm Height.

Bus bars chamber compartment shall be provided with Min. 300mm or higher as required.

MFM and Ammeter both shall be provided for all starters rated 30kW and above.

MV switch boards housing shall be of CRCA mini. 2.0 mm thick. Gland plate shall be CRCA sheet min. 3.0 mm thick. Make of the Panel CRCA / MS / GI Plates and sheet shall be "Essar / Tata / Jindal / Sail / Zenith / Asian" only.

All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.

All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.

Suitable lifting hooks shall be provided on each panel or on each shipping section for ease of lifting of switchboard.

LT Panel shall be of fixed type, single/double front execution. LT Panel shall be single tier for all incomers and bus couplers and multi-tier for all outgoing feeders. Vacant space on incomer and bus coupler panel shall not be used for mounting the starter and switch gear modules.

All auxiliary devices for control, metering, protection, indication and measurement such as push-buttons, control and selector switches, indicating lamps, ammeters, voltmeters, kWh meters and protective relays shall be mounted on the front side of respective compartment, for easy operation without opening the door.

Cable alley should be provided as per requirement for all outgoing feeders.

Circuit Breakers for capacitors shall have a current rating of at least 160% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified / supported by manufacturer recommendation.

The switch board components, Bus bars etc. shall be designed to withstand the maximum designed short circuit level for minimum 1 sec.

MCCB for power feeders shall have built-in short circuit and thermal overload releases. The rated service short-circuit breaking capacity (Ics) of MCCBs shall be more than or equal to the specified fault level.

The outgoing Motor Feeders should comply with Type-2 Coordination as per IS: 13947.

Panel shall have main horizontal and riser bus bars air insulated, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers.

The MCC shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.

All control wiring except C.T. secondary wiring shall be carried out with minimum 1.5 sq.mm copper conductors. C.T. secondary wiring shall be carried out with 2.5 sq.mm copper conductor. Adequately rated anti-condensation heater with porcelain connectors shall be provided in each breaker panel and in cable alley to maintain inside temperature 5 deg C above outside ambient temperature. It shall be supplied from 240V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having variable setting of 30-70 deg C and manually operated switch fuse and link for phase and neutral respectively.

All starters shall be provided with Auto-Off-Manual and Local-Remote selector switches, to monitor and operate MCC or LCS, ICP / PLC.

All multifunction meters, VFD and soft starters, where provided shall have RS485 port to communicate with PLC/SCADA.

Open, Close and Stop Push Button shall be provided for electrical actuator operated delivery valve of each pump at associated starter panel. Also LED type illumination lamp for valves' status indication (OPEN position, CLOSE position, Fault, L/R status) shall be provided at associated starter for each actuator at delivery line of pump.

Bus Bar

Bus bars shall be of high conductivity, electrolytic copper / aluminum (E91-E) suitable for carrying the rated and short time current without overheating supported on insulators made of non-hygroscopic, non-flammable material to ensure free thermal expansion. With tracking index equal to or more than that defined in IS. Aluminum bus bars shall be sized for maximum 0.8 A/mm² current density only and Copper bus bars shall be sized for maximum 1.6 A/mm² current density only.

Bus bars for risers shall be rated to carry 125% of the rated current of all feeders connected to the risers.

The current rating of neutral shall be min. half that of phase bus bars.

Both horizontal and vertical TP and N, bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second.

Only zinc passivated or cadmium plated high tensile steel bolts, nuts and washers shall be used for all bus bars joints and supports.

The hot spot temperature of bus bars including joints at design temperature shall not exceed 95 deg C for normal operating conditions.

All bus bars shall be insulated with heat shrunk PVC sleeves of 1100V grade.

Auxiliary Bus bars

Auxiliary power bus bars of suitable rated size shall be provided for all Soft Starters, VFD and all Starters above 30kW rating. Cables / Wires shall not be acceptable.

Auxiliary bus bars of suitable size in Aluminum / Copper shall be provided for following application.

Exact number of bus bars shall depend on various controls, metering and auxiliary power distribution requirement.

Panel space heater supply and motor space heater supply.

Control supply for breaker tripping, closing and indication circuits.

Control supply for breaker spring charging motors, motor starter control and indication circuits.

AC potential supply for energy meters, voltage operated relays, etc.

Wiring and Terminal Blocks

All wiring shall be done with IS approved FRLS insulated copper conductors. The insulation grade for these wires shall be 650/1100V grade. The control wiring shall preferably be enclosed in plastic channels or neatly bunched together.

Control / CT circuit wiring shall be FRLS insulated, copper conductor of 2.5 sq.mm size.

Each wire shall be identified at both ends by PVC ferrules.

Inter panel wiring shall be done through PVC sleeves or rubber grommets.

A minimum of 2 nos. or 20%, whichever is higher, spare terminals shall be provided on each terminal block.

Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

Earthing

All vertical panels shall be connected to a GI/Alu earth bus bar running throughout the length of the switchboard. The minimum earth bus size shall be 50x6 sq.mm GI or equi. Aluminum for fault level of LT Panel.

All doors and movable parts shall be earthed using flexible copper connections to the fixed frame of the switch board. Provision shall be made to connect the Earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos., 10mm Dia whole shall be provided on the earth bus for termination of earth strip / wire.

Name Plate

Nameplates shall be provided as per standard.

Painting

The LT Panel shall be treated with seven tank process with cleaning of scale, grease rust and foreign adhering matter and chemical de-rusting, sand blasting, degreasing, pickling in acid bath and phosphate as per IS: 6005 and primed.

After cleaning, the surfaces shall be given 2 coats of epoxy primer.

After seven tank process and primer coating the external paint shall be powder coated with RAL-7035 or paint shade shall be 631 of IS-5 for indoor and outside of LT Panel.

Switchgear Modules

Minimum 1kVA control transformer shall be provided for each bus section for motor control circuit voltage and each transformer shall be sized for the entire switchboard, with manual changeover switch.

Air Circuit Breakers

Circuit breakers shall be air break, draw out type for feeders rated 630A above.

The ACB shall have 50kA (1 Sec.) S/C withstands rating and having ICW for 1 Sec. = ICS = ICU. The breaker shall be Electrical draw-out type and electrically operated motor spring charging type in open execution

All ACBs shall comply and tested as per IS - 13947 / IEC 60947-1 and IEC 60947-2 standards.
ACB for all Incoming, Bus coupler and PCC Feeder outgoing should be Four Pole Type.
ACB shall be with RS 485 Communication port on MODBUS

ACB Trip Release should have Minimum following

- Overload with time delay
- S/C with time delay and Inst. Trip Setting
- Earth Fault with Time Delay.
- Under/over Voltage for incomer
- Trip Indications
- Ammeter Display

ACB shall be fitted with following

- Heavy duty switches having not less than 4 NO + NC contacts
- Built in resin cast current transformer
- Auxiliary contacts
- Shunt and under voltage tripping device

The ACB shall be suitable for locking the breaker in various positions. Provision for door locking ACB shall be provided with the requisite end termination lugs/sockets. Terminal bars for connecting more than one terminal.

Switches/ Fuses

The switches or fuse switches shall be load break, heavy duty / motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch. Fuses shall be non- deteriorating HRC cartridge link type.

Rating of heavy duty switches or motor duty starter modules shall meet the requirement of AC23 duty as per IS: 13947.

Contactors

The contactors shall be air break type, equipped with three main contacts and minimum (2NO + 2NC) auxiliary contacts. The main contacts of a particular contactor for motor starter module shall have AC-3 rating.

Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1 Ph., AC supply and shall work satisfactorily between 65 to 110% of the rated value.

Bimetal Relay

All bimetal overload relays shall be of manually reset type with at least 1NO and 1NC contact with reset type push buttons, mounted on door such that it shall be possible to reset the O/L relay without opening the compartment door.

Moulded Case Circuit Breakers (MCCB)

All MCCBs shall be comply and tested as per IS - 2516 / IEC 60947-1 and IEC 60947-2 standards. MCCB shall be provided with short circuit delay and instantaneous protection, over load protection and Earth fault protection as inbuilt protection along with time delays. Position of the knob shall be clearly indicated ON, OFF and TRIP conditions as a minimum in front and 1 NO + 1 NC Aux. Contacts.

MCCB shall be rated 80A to 630A. All incomer, bus coupler and outgoing feeder above 200A shall be Microprocessor based.

All MCCB shall be of min. 50 kA (1 sec.) rated ultimate short circuit breaking circuit current rating as a min. or of higher short circuit current rating capacity as per fault level.

MCCB as part of motor starter module shall be current limiting type and type tested for Type-2 co-ordination as per IS: 13947 / IS/IEC: 60947.

Protective Relays

Relays shall be rectangular in shape, flush mounting type, having dust tight covers, removable from front, and shall be equipped with externally reset, positive action operations indicators. The relay shall have auxiliary units of either series connected or shunt connected type. All auxiliary relays shall be non-draw out type and protection relays shall be draw-out type with test facilities.

Test plug shall be supplied loose. All relays shall conform to the requirements of IS- 3231 or relevant IEC in general and IS - 3231 in specific.

Relays shall be provided with adequate number of potential free self-reset / hand reset output contacts as required. Provision shall be made for easy isolation of trip circuits of each relays for the purpose of testing and maintenance.

Motor Protection Relay (MPR)

Motor Protection Relay (MPR) shall be electronic type with having Overload, Earth fault; Phase currents out of balance, Over Voltage and under Voltage, Phase loss/reversal, No load running, Negative sequence and Single Phasing Preventer protection.

Ten channels Temperature scanner shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signals to temperature scanner shall be derived from motor Industrial Type Pt-100 resistance temperature detectors provided in the motor windings and bearing

1	Service and type	Motor winding and bearing temperature measurements - microprocessor based
2	Range	0 to 200o C
3	Alarm Contacts	Adjustable 4 Nos. (High temperature and very high temperature) for motor winding and bearing temperature high, very high and bearing temperature high and very high.
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor
6	No. of channels	10 Nos. (6 Nos. for Winding, 2 nos. Bearing, 2 Nos. Spare).
7	Accuracy	± 1o C
8	Communication	RS-485 for Instrumentation panel interface

12.0 CABLES

1.0 SCOPE:

This section shall cover supply and installation of cables.

2.0 STANDARDS:

The following standards and rules shall be applicable:

IS : 1554 PVC insulated electric cables (heavy duty).
IS : 3961 Recommended current ratings for cables.
IS : 8130 Aluminum conductors for insulated cables
Indian Electricity Act and Rules.

3.0 MEASUREMENTS:

The cables will be measured in meters. The unit rate shall include cutting the cable into required lengths, packing, loading, unloading, insurance, transportation, delivery to stores/site as per work order, stocking in stores, testing of cables at stores etc. of medium voltage cable.

4.0 GENERAL:

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

5.0 MATERIAL:

Medium voltage cable shall be PVC insulated. PVC sheathed, aluminum or copper conductor, armored and unarmored heavy duty, conforming to IS : 694 Part I & II, IS : 1554 Part I.

5.1 TYPE:

The cables shall be circular, multi core, annealed copper, PVC insulated and PVC sheathed, armored.

5.2 CONDUCTOR:

Uncoated, annealed copper / Aluminum of high conductivity, upto 4 mm.² size the conductor shall be solid and above 4 mm.² conductors shall be concentrically stranded as per IEC: 228.

5.3 INSULATION:

Polyvinyl chloride (PVC) or XLPE extruded insulation as per IEC 502.

5.4 CORE IDENTIFICATION:

Two cores	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green, Yellow for earthing

Black shall always be used for neutral.

5.5 ASSEMBLY:

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

5.6 ARMOUR:

Galvanized steel flat strip / round wires applied helically in single layers complete with covering the assembly of cores.

For cable size up to 25 Sq. mm.

Armor of 1.4 mm dia G.I. round wire

For cable size above 25 Sq. mm:

Armors of 4 mm wide 0.8 mm thick G.I. strip

5.7 SHEATH:

5.7.1 Polyvinyl chloride (PVC), 70 deg.C. Rated extruded as per IEC: 502.

5.7.2 Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables.

5.7.3 Outer sheath shall be of an extruded type layer of suitable synthetic material compatible with the specified ambient and operating temperature of cables and with FRLS compound. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The color of outer sheath shall be black.

5.8 RATING:

Upto and including 1100 Volts.

6.0 GENERAL:

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. Without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

7.0 TESTING:

7.1 FINISHED CABLE TESTS AT MANUFACTURER'S WORKS:

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of client's representative.

7.1.1 VOLTAGE TEST:

Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

7.1.2 CONDUCTOR RESISTANCE TEST:

The D.C. Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20° c. to check the compliance with the values specified in IS 8130 - 1976.

7.2 Prior to dispatching cables, and at the time of delivering the cables at stores, following tests shall be carried out :-

7.2.1 Insulation Resistance test between phases and phase to Neutral and phase to earth.

7.2.2 Continuity test of all the phases, neutral and earth continuity conductor.

7.2.3 Sheathing continuity test.

7.2.4 Earth resistance test of all the phases and neutral.

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Vendor shall provide necessary instruments, equipment's and labor for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the client and results shall be recorded in the prescribed forms.

8.0 CABLE MARKING:EMBOSSING ON OUTER SHEATH:

The outer sheath shall be legibly embossed with following legend:

ELECTRIC CABLE: 1100 V, SIZE: 3.5 C xs ----- mm ².

Manufacturer's Name & year of manufacturing.

9.0 SEALING, DRUMMING & PACKING:

After tests at the manufacturer's works, both ends of the cable shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 ± 10% meters on packed non-returnable drums of sufficiently sturdy construction.

Cables of length more than 250 meters shall also be supplied on non-returnable drums.

The spindle hole shall be 110 mm minimum diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

10.0 TRANSPORTATION & DELIVERY:

The cable shall be supplied in the actual length as per detailed purchase order.

The cable shall be dispatched at client's stores or at site as per detailed instructions given by client at later stage.

The cable shall be loaded from the main vendor's store and properly stacked as per instruction of client's local representative. All such labor and transportation charges shall be clearly mentioned in the offer. Cable shall be supplied in non-returnable drums as per IS 10418 standard. Cable identification details like Voltage, size, name, etc. shall be written on Drums also as per IS.

Cable Drums:

Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

The Bidder shall indicate in the offer, the maximum length for each size of cable, which can be supplied on one drum. The actual length supplied on each drum shall be within tolerance limit of $\pm 5\%$ without any tolerance on total ordered quantity of each size of cable. However before winding the cables on drums, Contractor shall obtain Employer's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.

Drawings and Data:

a) As a part of the Tender, bidder shall furnish the following:

General information

ii) Principal technical data

(Description of insulation, sheathing and screening: This should include data on resistance to attack by chemicals, fungus, termites, rodents, water and ultra violet radiation).

iii) Installation and termination instrumentation.

iv) Type / routine test certificates for all types of cables included in the Tender.

After award of contract it shall be the responsibility of contractor to work out a detailed layout for the complete plant cable system. The layout drawing shall be furnished for the approval of Purchaser's representative before commencement of installation including cable trays, cable racks, accessories, tray supports, conduits etc.

CABLE CARRIER SYSTEM:

1 General

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories.

2 Applicable Standards

Sr. No.	Description	Standards
1	Steel for general structural purposes	IS: 2062
2	Dimensions for hot rolled steel beam, column channel and angle Sections	IS: 808
3	Code of practice for use of metal arc welding for general construction in mild steel	IS:816
4	Hot deep galvanizing of iron & steel	IS: 2629
5	Methods of testing uniformity of coating of zinc coated articles	IS: 2633
6	Hot dip zinc coatings on structural steel and other allied products	IS: 4759

Cable Racks and Trays

Typical cable tray arrangement/trench arrangement / directly buried cable arrangement etc. are shown on drawing.

Cable racks / trays shall be fabricated from standard structural steel members as indicated in drawing.

All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.

Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.

Where embedded steel inserts in concrete floors / walls for welding the supports for cable racks / trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.

Cable shall be clamped to the cable trays at regular intervals.

Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

4 Galvanizing

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

Galvanizing shall be carried out only after drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

13.0 EARTHING

1.0 GENERAL

All the non-current carrying metal parts of the electrical installation and mechanical equipment's shall be earthed properly. The cables armored and sheath, electric panel boards, lighting fixtures, ceiling and exhaust fan and all other parts made of metal shall be bonded together and connected by means of specified earthing system. An earth continuity conductor shall be installed with all the feeders and circuits and shall be connected from the earth bar of the panel boards to the conduit system, earth stud of the switch box, lighting fixture, earth pin of the socket outlets and to any metallic wall plates used. All the enclosures of motors shall be also connected to the earthing system.

2.0 SCOPE OF WORK

The scope of work shall cover supply, laying, installation, connecting, testing and comm. of:

Earthing station with G.I / Copper plate of size as given in BOQ.

Earthing G.I / Copper strips from earthing station to equipotential bar.

Earthing G.I / Copper strips / wires from equipotential bar to power panels, DBs, motors etc.

Bonding of Non-current carrying parts, and metallic parts of the electrical installation.

3.0 STANDARDS

The following standards and rules shall be applicable:

- 1) IS: 3043 - 1966 Code of practice for Earthing.
- 2) Indian Electricity Act and Rules
- 3) IEEE 80

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice or the British Standard Codes of Practice in absence of Indian standard.

4.0 TYPE OF EARTHING STATION

4.1 PLATE EARTHING STATIONS

The Equipment neutral earthing shall be with copper plate earthing station and equipment body earthing shall be with hot dip galvanized iron earthing station. The plate electrode shall be 600 x 600 x 3.25 mm copper plate for neutral earthing and shall be of hot dip galvanized iron plate having dimensions 600 x 600 x 6.3 mm thick for body earthing.

The other earth stations shall be as per the standard drawing in IS 3043.

The earth resistance shall be maintained with suitable soil treatment as shown in the drawing.

The collective resistance of each earth station should not exceed 1 ohm.

The earth lead shall be connected to the earth plate through Hot Dip G.I. bolts.

The earthing conductors shall be of copper strip in case of copper earthing and hot dip galvanized iron strip in case of G.I. earthing.

G.I. pipe with funnel of approved quality shall be used for watering the earthing electrodes / stations.

The block masonry chamber with Chequered plate shall be provided for housing the funnel and the pipe for watering the earthing electrodes / stations.

The hardware and other consumables for earthing installation shall be of copper/brass in case of copper earthing and shall be hot dip galvanized iron material in case of G.I. earthing.

Test link / test pit cover through Chequered plate.

4.2 PIPE ELECTRODE EARTH STATION:

The earth station shall be as shown on the drawing and shall be used for equipment earth grid and / or street light pole earthing.

The earth electrode shall be 3 M long 50 mm dia class "B", Galvanized steel pipe.

The earth resistance shall be maintained with a suitable soil treatment as shown on the drawing.

The total earth resistance should not exceed 1 ohm.

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

The earthing grid and the earthing conductor shall be hot dip Galvanized iron strips of the size as shown in the drawing.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station. Alternatively, maintained type earthing with ground enhancing materials shall be provided to meet the required effective earth resistance value.

The block masonry chamber with chequered plate shall be provided for housing the above referred funnel and pipe.

The hardware and other consumables for earthing installation shall be hot dip Galvanized iron material as shown on the drawing.

5.0 METHOD OF MEASUREMENT:

Provision of earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

The following items of work shall be measured and paid per unit length covering the cost of the earth wires / strips, clamps, labor etc.

- a) Main equipment earthing grid and connection to the earthing station.
- b) Connection to the switch board, power panels, DB, motors etc.

14.0 LIGHTING SYSTEM

1.0 SCOPE

This covers supply, installation and commissioning of all equipment necessary for a complete indoor and outdoor lighting system as per the drawings enclosed with the specification and in accordance with relevant Indian Standards, codes of practice, Indian Electricity rules and safety codes in the locality where the equipment/system is to be installed.

Nothing in this specification shall be construed to relieve the contractor of his responsibility.

The equipment in lighting system shall generally include lighting distribution boards (LDB's), sub-lighting distribution boards (SLDB's), lighting fixtures, street light poles, junction boxes, lighting fixture supports, switches, receptacles, ceiling fans, exhaust fans, conduits, wires, cables, and miscellaneous accessories as necessary for a complete system.

1.1 LIGHTING DISTRIBUTION BOARDS (LDB's)

The lighting distribution boards or sub-lighting distribution boards shall be suitable for wall mounting arrangement unless indicated and shall be supplied along with brackets, nuts and bolts necessary for mounting arrangement.

Sheet steel used for fabrication of LDB's shall be cold rolled and comprise of rigid welded structural frames made of structural steel sections. The thickness of the same shall be as per the technical data sheet.

Gland plates shall be provided from the top as well as from the bottom of LDB or SLDB so that conduit or cable termination can be possible from either side.

All the MCB's, switches, control switches, timers, contactors, metering and indication shall be housed in a metal enclosed cubicle.

The material of bus bars shall be tinned copper with phase identification by PVC sleeves of red, yellow and blue colors.

The bus bar shall be sized for fault level of 10kA for 1 sec. and rated current equal to the rating of incomer MCB, if not specifically mentioned.

All control wiring shall be carried out with 1100/650 V grade, 1.5 sq. mm, single core, stranded copper conductor wires with PVC insulation.

All meters, indicating lamps, control switches and MCB's shall be flush mounted.

All selector switches, MCB's shall be operable without opening the door of LDB.

The degree of protection of LDB shall be minimum IP42, unless indicated.

The bus bar supports shall be of SMC / DMC.

The front doors shall be hinged type with concealed hinges & door locks while rear covers shall be bolted type.

The earth bus shall be of copper and extended outside by 50mm from both sides of LDB for earthing connection to main grid. The size of earth bus shall be 25x3 mm, if not specifically mentioned.

LDB's shall be provided with a powder-coated paint. The finished painted appearance shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

The average lighting levels shall be as per the table below:

Areas	Lux (<i>average</i>)
General Process/operating/maintenance Indoor areas/Outdoor areas	300
Mechanical equipment rooms	250
Electrical rooms	300
Process control rooms (CRT screens)	350
Electrical Switchyard	150
Offices	300
Laboratories	500
Workshop with machinery	300
Walkways and stairways	200
Parking lots, yard, plant roads	20

1.2 LIGHTING FIXTURES

The lighting fixtures offered shall comply with the following requirements.

The fixtures shall be suitable for operation on a nominal supply of 240 V, 1-Ph, 50 Hz, AC with a voltage variation of +/- 10 %.

All lighting fixtures shall be supplied complete with lamps and all necessary accessories such as ballast, capacitor, igniter etc. for their satisfactory operation.

Starter of the fluorescent light fixture shall be replaceable without disturbing the reflector or lamps and without the use of any tool.

The capacitor of the lighting fixture shall have adequate value of capacitance to correct the power factor of its fixture to 0.98 lag.

Lamp holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or lamp holding quality.

Lamp-holders for HPSV lamps shall be of GLS type, manufactured in accordance with the relevant standard and designed to give long and satisfactory service.

Lighting fixture reflectors shall generally be manufactured from steel or aluminum sheet of not less than 20 SWG thicknesses.

Polystyrene or aluminum egg-box type louvers shall be provided wherever specified.

Each fixture shall be complete with a four way terminal block for connection and looping of incoming and outgoing cables. Each terminal shall be able to accept two 2.5 sq.mm copper stranded conductors.

Each lighting fixture shall be provided with an earthing terminal suitable for connecting 16 SWG copper stranded conductor.

All metal or metal enclosed parts of the housing shall be bonded and connected to the earth terminal to ensure satisfactory earthing continuity throughout the fixture.

The enamel finish shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surfaces. The finish shall be non-porous and free from blemishes, blisters and fading.

All reflectors and louvers shall be finished to the same standard as the fixture housing.

1.3 STREET LIGHT POLE

The street lighting pole shall be of MS steel welded/sewage tubular type. The cross arm shall be of 1200mm long of 40mm dia. MS pipe. A MS top cap shall be provided at the top of the pole. The pole shall be fixed on a MS base plate of 400x400x6mm size. The work

for electrical contractor includes excavation of pit and filling the same with cement concrete of 1:3:6 from the bottom of the pole and up to a height of 500mm above the ground level with the help of steel frame with 400mm diameter around the pole including painting with red oxide primer and aluminum paint/enamel paint in two coats.

The details of pole is given below,

Length in mtrs.	Length of each steps (mtrs)			Outer Dia./Thickness of each step (mm)		
	Top	Middle	Bottom	Top	Middle	Bottom
7.5	1.50	1.50	4.50	76.1/3.25	88.9/3.25	114.3/3.65
8.5	1.75	1.75	5.00	76.1/3.25	88.9/3.25	114.3/3.65
9.0	2.00	2.00	5.00	76.1/3.25	88.9/3.25	114.3/3.65
10.0	2.40	2.40	5.20	88.9/3.25	114.3/4.50	139.7/4.50
11.0	2.70	2.70	5.60	88.9/3.25	114.3/4.50	139.7/4.50
12.0	3.10	3.10	5.80	114.3/3.65	139.7/4.50	165.1/4.50
14.5	4.00	4.00	6.50	139.7/4.50	165.1/4.85	193.7/5.40
16.0	4.50	4.50	7.00	139.7/4.50	165.1/4.85	193.0/5.40

The pole shall be supplied with cross arm, galvanized junction box, its internal wiring, clamps, nuts, bolts and 2nos. 50 dia. GI conduits embedded in base concrete block for power cable etc.

The junction box shall have hinged door with mechanical lock. The junction box and its clamps shall be painted with red oxide primer and aluminum paint/enamel paint in two coats. The junction box shall be painted internally as well.

The degree of protection for junction box shall be IP 55.

1.4 RECEPTACLE UNITS

Decorative and industrial type receptacle units of 5 A, 15/16 A and 32 A rating with switches/MCBs shall be supplied. The units shall be suitable for mounting flush on GS sheet boxes.

The receptacle shall be suitable for 240 V, 1 Ph, (or 415 V, 3 Ph), 50 Hz AC supply. 1-Phase decorative receptacle shall be provided with a switch of the same current rating while Single phase industrial receptacle shall be associated with a MCB of the same current rating, housed in the same enclosure. Three phase receptacles shall be associated with a MCB of the same rating, housed in the same enclosure.

The enclosure for all outdoor receptacles shall be provided with degree of protection of IP 55.

1.5 EXHAUST / SUPPLY FANS

The fans shall be of heavy-duty type with the whole body, blades, frame shall be made from CRCA steel. It shall be powder coated and painted with light grey or brown color to appear aesthetically pleasant.

All blades shall be aerodynamically balanced and can provide high efficiency, smooth and silent operation.

The type of insulation shall be class E. The maximum temperature rise over the ambient temperature shall not exceed 75 deg. C in any case.

The rated speed shall be 900 rpm unless specified in technical data sheet.

The fan shall be provided with louvers or bird guard to avoid any accident.

The fans shall be provided with two ball bearings to meet the heavy-duty requirements for continuous running.

1.6 CEILING FANS

The ceiling fans shall be of made from CRCA steel with powder coated and painted in chocolate or off-white shade.

All blades shall be aerodynamically balanced and can provide high efficiency, smooth and silent operation.

The type of insulation shall be class E. The maximum temperature rise over the ambient temperature shall not exceed 75 deg. C in any case.

The rated speed and sweep shall be 300 rpm and 1200mm respectively unless specified in technical data sheet.

The fan shall be provided with speed regulator, suspension rod (12mm G.I), canopy, cotter pin, nut and bolts and other accessories required to proper and safe suspension and operation.

The fans shall be provided with two ball bearings to meet the requirement of continuous running.

2.0 LIGHTING SYSTEM INSTALLATION

2.1 APPLICABLE STANDARDS

IS 732, 3646, 6665

2.2 TECHNICAL DATA SHEET

Sl.	Description	Particulars
1.0	Type of wiring	Wall surface conducting
2.0	Conduit type	Minimum 20mm dia., G.I
3.0	Space factor	40%
4.0	Fixture wiring material & size	2.5 sq. mm, 1100/650 V grade, stranded copper conductor PVC insulated with FRLS compound flexible wire.
5.0	Receptacle wiring material & size	4 sq. mm, 1100/650 V grade, stranded copper conductor PVC insulated with FRLS compoundflexible wire.

2.3 SCOPE

The scope includes installations, testing and commissioning of lighting distribution boards, sub-lighting distribution boards, lighting fixtures, ceiling fans, exhaust fans, street light poles, flood light towers, battery operated emergency lighting fixtures, call buzzers, receptacles with switch and lighting control switches, multi core power cables for street and boundary lighting and point wiring for all of the above at locations as per the drawing enclosed with the specification.

Taking over the material/equipment from purchaser's store and transporting to the erection site in case of equipment supplied by purchaser.

Maintaining equipment/materials during storage and being responsible for the equipment/material until they are handed over to purchaser.

Cleaning and clearing the area of work due to contractor's installation.

All work associated with installation such as providing and fixing of wooden blocks, ball sockets, ceiling hooks, drilling holes in walls, ceilings or any civil work including scaffolding, provision of ladders together with supply of hardware shall form part of the Contractor's work.

All work items necessary for completing earthing connections shall be included in the scope of work.

2.4 INSTALLATION REQUIREMENTS

The Contractor shall work in coordination with other Contractors at site.

The Contractor shall touch-up the painting for lighting panels / boards if the same is damaged during installation handling.

Supply and installation of power cables in a built-up trench or in a directly buried manner or clamped on wall or clamped on steel columns between switchboard and LDB, LDB and street light pole/flood light tower junction box, between the two poles or flood lighting towers shall be in the scope of electrical contractor.

The accessories required for termination work such as crimping type cable lugs and cable glands at each junction box and fixtures shall be supplied and installed by electrical contractor.

Contractor's scope of work also includes excavation of soil, preparation of riddles, soil bedding, supply and installation of protective covers or bricks over the cable, backfilling, ramming, supply and installation of route markers, removal of surplus earth (if necessary).

Earthing of street light pole / flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of point wiring. Contractor shall earth street light pole / flood light tower to the nearest earthing grid provided by others.

Contractor shall provide all the necessary foundation material & hardware for erecting street light pole / floodlights tower and install the same.

Lighting distribution boards shall be installed in the location indicated in the layout drawings. Installation rates quoted for installation of lighting distribution boards shall include supply and installation of base channels, foundation bolts, etc.

Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000mm (min.) above the grade level. Cost of construction of concrete plinth shall be included in the unit rates quoted for installation of outdoor lighting distribution board. No cement and steel will be supplied by the client. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.

Unless specifically noted otherwise, lighting panels, light control switches and receptacles shall be installed at the following mounting heights (up to their bottom) from finished floor/ ground levels.

- | | |
|---------------------------|-----------------------------------|
| a) LDBs | : 1200 mm |
| b) Light control switches | : 1200 mm |
| c) Receptacle units | : 1200 mm for indoor and outdoor. |

All lighting panels located indoor/outdoor on walls / columns / concrete pedestals shall be installed by the Contractor by fastening to suitably grouted studs of not less than 12 mm diameter.

It shall be possible to terminate incoming and outgoing circuits from top and bottom of LDB. Knock-out for cable / conduit entries for all the circuits shall be provided.

Separate circuits shall be provided for control of lighting fixtures and receptacles. Each phase shall have at least one spare circuit.

Any minor civil work such as chipping / concreting / embedding, etc. required for installation work shall be carried out by the Contractor together with supply of necessary materials.

Minimum size of rigid conduits used for wiring shall be 20 mm diameter in case of exposed systems and 25mm diameter in case of concealed / embedded systems. The conduits shall be supported by means of saddles as follows,

- a) Rigid Metallic Conduits : Spacing between saddles not to exceed 1 m. In addition, saddles shall be located on either ends of couplers / bends or similar fittings / accessories. In such cases the saddles shall be located at a distance not exceeding 300mm from the fitting / accessory.
- b) Rigid Non-metallic Conduits : Spacing between saddles < 750 mm. In addition, saddles shall be provided as stated as above.

It is also in the scope of Electrical contractor to supply & install the required accessories like solid steel suspension rod. It is also scope of electrical contractor to do minor civil work like drilling in concrete or in steel or in wood, grinding, suspension conduit for fixture, Bakelite or wooden base plate, nuts, screws, washers and GI round junction boxes.

Supply of items including 650 V grade, 2.5/4 sq. mm stranded copper conductor PVC insulated flexible wires; 5 / 15A switches; GI / PVC conduits and accessories such as junction boxes, tees, elbows, 16 SWG GS boxes complete with gasket, knockouts for conduit entries, earthing terminal with bolts, nuts and washers; 16 SWG copper earthing wire; flexible conduit etc. shall be included in the Contractor's scope. All work necessary for fixing boxes and conduits together with supply of necessary accessories hardware, shall also be included in the Contractor's work.

For street lighting fixtures, steel tubular poles complete with fixing brackets shall be used. These poles shall be coated with bituminous preservative paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be painted with one coat of red oxide primer. After completion of installation, two coats of aluminum paint shall be applied.

Contractor shall supply and erect the poles (including excavation & foundation work), mount the assembled fittings and install the necessary cabling.

Contractor shall earth street light pole and junction box with 8 SWG GS wire tapped off from the 25x3 mm MS flat earthing grid to be laid along the street lighting cable. The Contractor shall interconnect this earthing grid to plant main earthing grid. Height and type of pole shall be subject for an engineer's approval.

2.5 WIRING

The work shall comprise wiring in heavy gauge (minimum 16 SWG) GI/ PVC conduits, fixed and supported at intervals of 500 mm on walls, ceiling etc.; installation of light control

switches and receptacles housed in GS boxes; earthing with 16 SWG copper wire run along the conduit and clamped to it at every 500 mm; and termination of cables/wires at lighting panels, light control switches, receptacles, lighting fixtures etc., as required. The minimum size of conduit shall be 20 mm. Space factor (ratio of total wire area to internal conduit area) shall be 40 %.

The point wiring shall include supply, installation and testing commissioning of 2.5 / 4 sq mm copper PVC flexible wires and their terminations including supply of GI/ PVC conduits with all accessories such as bends, reducers, coupler, switches for control, junction boxes, 16 SWG wires, etc.

Wiring for lighting, ceiling fans, exhaust fans and call buzzer circuit shall be done by minimum 2.5 sq. mm, 1100/650 V grade, stranded copper conductor PVC insulated flexible wire.

Wiring for receptacle circuit shall be done by minimum 4 sq. mm, 1100/650 V grade, stranded copper conductor PVC insulated flexible wire.

No motor load shall be supplied from any LDB.

There shall be a circuit breaker or a linked switch on each live conductor of supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in neutral wire in the form of switch or fuse unit.

For long conduit wiring runs, inspection/pull boxes shall be provided at intervals not extending 10m. Such facilities shall also be provided at conduit bends.

Receptacle and lighting fixtures shall be fed from different circuits and wiring for the same shall be done in different conduits.

The maximum load on any circuit shall not exceed 1000 W for 6A MCB backed circuits and 1800 W for 16A MCB backed circuits.

In large rooms, the lighting system shall be distributed over three phases.

Wherever lighting system has three-phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires the following color wires shall be used.

- a) R - Phase : Red
- b) Y - Phase : Yellow
- c) B - Phase : Blue
- d) Neutral : Black

Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. color of the wires used shall be as follows,

- a) Positive : White
- b) Negative : Black

Wires belonging to different phases shall not be run in the same conduit. However, more than one circuit on the same phase can be run in the same conduit. For every phase wire, a separate neutral wire shall be run. Neutral wire shall not be looped.

Size of wire chosen shall be such as to limit the voltage drop to within 3 %.

Generally, not more than 8 to 10 lighting points shall be wired in one circuit. For calculating connected loads of various circuits, a multiplying factor of 1.25 shall be assumed on the rated lamp wattage for sodium vapor and fluorescent lamp fixtures to take into account the losses in the ballast.

A loading of 100 watts and 300 watts shall be assumed for each single-phase 5 amps and 15 amps receptacles respectively.

The light control switches and receptacle units shall be mounted flush in one common GS sheet steel box.

Switches/receptacles wired on different phases shall be separated by a minimum distance of 1.8 m

Before a completed installation is put into service, installation tests stipulated in the latest edition of IS:732 and other codes of practices shall be carried out by the Contractor in the presence of the Engineer's Representative.

2.6 POINT WIRING

Internal wiring within any cubicle of switch box, receptacle box, lighting fixtures, LDB & main junction box shall not be considered as point wiring.

Contractor shall prepare a detailed measurement sheet of point wiring indicating each point and get it approved from consultant's site in charge.

15.0 PRESSURE GAUGE

Industrial Model Heavy Duty Pressure gauges shall be provided on discharge of each pump and on common discharge header of each pump. Pressure gauge shall be bourdon type with a dial size of 150 mm in diameter and calibrated for the required range of duty heads of pumping machinery to be installed as per range available in the market unless specified otherwise in the price bid. The gauge shall be supplied complete with impulse tubing, two valve manifold with drain cock / calibration valve, fittings etc. The pressure gauges shall have an accuracy of $\pm 1\%$ full scale and weather protection class IP 65 or better. All wetted parts material shall be SS 316.

Pressure gauge shall comply with IS 3624 / BS 1780 / EN837-1. Pressure gauge shall have siphon & cock arrangement. Glycerin filled dial shall be provided as the gauge is subjected to pressure pulsation and / or vibrations. The internal parts of pressure gauge shall be stainless steel.

The minimum diameter for round pressure gauge shall be 150 mm unless specified otherwise in data sheet.

The zero and span of pressure gauge shall not change by more than $\pm 0.1\%$ of the span per 0°C changes in ambient temperature.

The pressure gauge shall have to be fitted on individual delivery of pump as well as on the common discharge header.

16.0 SAFETY EQUIPMENTS

The contractor shall provide safety equipment as per IE rules / as specified in BOQ, on the HV panels, Generator panels, Control panels and main MV panel rooms. Generally following shall be provided:

- Rubber mat conforming to IS 5424 in front of all the HT and MV panel for their entire length – 1000 m. wide.
- Pairs of electrically tested rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in English and local language duly framed as detailed in IS: 1355. Detail of the nearest medical facility available with phone number shall also be kept.
- First aid box containing of medicines for treatment of electrical burns in the main switch room.
- Portable fire extinguishers of dry powder (Store type) as per IS: 935 to suit the individual substation, panel rooms requirement.
- Caution notices in English shall be fixed permanently on the equipment to comply the requirement of IE rules.
- Safety posters for vigilance against electrical accidents as detailed in IS: 1255.
- Fire buckets with MS angle stand and with 4 Nos. round bottom fire buckets marked fire shall be provided in the HT substation.
- 3 Mtrs and 6 Mtrs. long folding aluminum ladders for safe maintenance of lighting system, etc.

17.0 OTHER EQUIPMENT AND ACCESSORIES SPECIFICATIONS:

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

- All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make and shall conform to the specification given here under.
- The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification, the materials shall be as approved by the owner / consultant or his authorized representative.
- All similar materials and removable parts shall be uniform and interchangeable with one

another. Makes of bought out items selected by the contractor must be approved vender list of tender.

Cable Trays:

- These shall be channel type, fabricated from structural steel, hot dip galvanized, complete with all accessories such as bends, tees and reducers.
- MS / Aluminum flat clamps with G.I. / Chrome plated bolts, nuts/screws to be used for clamping cables.
- Sizes of these trays shall be as specified in bill of quantities/ drg. or approved by client.

Cable Glands:

- Cable glands shall be heavy duty double compression type of Ni-Plated brass. These shall be suitable for armoured / Unarmoured cables, which are being used.

Cable Connectors:

- Cable connectors, lugs/sockets, shall be of copper/aluminum alloy, suitably tinned, solder less, crimping type.
- These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

Cable Indicators

- All cables shall be identified by cable tag of 2 mm. thick, 15 mm wide of enough length of Aluminum straps securely fastened to the cable. PVC identification number, ferrules shall be used for each wire.

G.I. Pipe for Cables:

- For laying of cables under floor, Med. Duty G.I. pipes shall be used.
- Pipe shall be laid at an angle of max. 45 deg. to trench wall. Both ends of pipe shall be sealed with approved W.P. Sealing plastic compound after cabling work.
- Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe.
- To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

Erection, Testing & Commissioning

TESTING, ERECTION AND COMMISSIONING OF PLANT & MACHINERY

1.0 TESTING - GENERAL

Tests of the plant at the manufacturer's premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate standards.

All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 3 months prior the test in which they are used. The engineer's representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the contractor prior to carrying out every test showing the readings obtained, calculations and full details of the calibration certificates referred to.

If the engineer's representative witnesses a test he shall be given a copy of the test results and certificates immediately. Whether he witnesses a test or not, copies of test certificate shall be sent to the engineer's representative. No item of the plant shall be forwarded to the site until its test certificate has been approved writing by the engineer's representative. Six copies of the test certificates shall be supplied in suitable folders with proper index.

Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.

2.0 INSPECTION AT MANUFACTURER'S PREMISES

The inspection of all equipment required to be supplied to complete the works shall be done as detailed in this specification. Only defect free and sound material meeting the technical requirements of this specification and in accordance with a high standard of engineering would be acceptable to the engineer's representative.

For meeting these requirements of inspection, testing (including testing for chemical analysis and physical properties) shall be carried out by the contractor and certificates submitted to the engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Calibration certificates or test instruments shall be produced for the engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of plant or control systems not covered by standards shall be tested in accordance with the details and programme agreed between the engineer and contractor.

If during or after testing, any item of the plant fails to achieve its intended duty or otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the engineer.

At least 21 days' notice shall be given to the engineer before the specified tests are carried out.

No material is to be delivered to site without the above described inspection having been carried out or officially waived in writing by the engineer's representative.

3.0 TESTS AT MANUFACTURER'S PREMISES

3.1 Pump Sets

Pump testing and inspection shall confirm to latest standard

(a) Hydrostatic testing

A standard hydrostatic test shall be conducted on all the pressure parts of the pumps at 1.5 times the shut-off head of the pump or twice the rated head whichever is higher. The hydrostatic test shall be conducted for a minimum duration of 30 minutes.

(b) Balancing Test

Impeller and pump rotating assembly shall be dynamically balanced.

(c) Performance Test

Each pump shall be tested for full operating range individually. Test shall be carried out for performance at rated speed with minimum NPSH as available at site.

3.2 Motors

Motors shall be offered for routine and type tests in accordance with IS : 325-1978 or latest applicable standard at the manufacturer's works. Test certificates shall be endorsed to the effect that the motors are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

4.0 ERECTION -

GENERAL

- 4.1 The contractor's staff shall include at least one competent erection engineer with proven suitable, previous experience on similar contract to supervise the erection of the works and sufficient skilled, semiskilled and unskilled labor to ensure completion of the works in time. The contractor shall not remove any representative, erector or skilled labor from the site without the prior approval of the engineer's representative.

- 4.2 One erection engineer who shall be deemed to be the contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the contractor shall inform the engineer's representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.
- 4.3 The contractor's erection staff shall arrive at the site on date to be agreed by the engineer's representative before they proceed to the site, however, the contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on site so that there will be no delay on this account.
- 4.4 The contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labor in connection therewith. The checking of setting out of any line or level by the engineer or engineer's representative shall not in any way relieve the contractor of his responsibility for the correctness thereof.
- 4.5 Erection of plant shall be phased in such a manner so as to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the contractor shall check the dimensions of structures where the various items of plant are to be installed and shall bring any deviations from the required positions, lines or dimensions to the notice of the engineer. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the engineer, the contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the contractor during the course of erection to new or existing plant or buildings or any part thereof, the contractor shall, at no additional cost to the employer, make good, repair or replace the damage, promptly and effectively as directed by the engineer and to the engineer's satisfaction.
- 4.6 During erection of the plant the engineer will inspect the installation from time to time in the presence of the contractor's site representative to establish conformity with the requirements of the specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the engineer.
- 4.7 **LEVELLING AND GROUTING OF MACHINERY**
The pumps and motors shall be properly and accurately leveled and aligned on the concrete plinths by means of tapered metal wedges and metal packing pieces before any

grout is poured. After correct alignment and leveling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the contractor's responsibility to check that the position is maintain an approved expanding agent will be mixed and poured by the contractor. ACC Shrink 200 grout mix or equivalent is to be used for grouting.

The horizontality of base plate top shall be within 0.05 mm / meter. The base plate top surface and pump motor base are to be blue matched to bet a contact area of at least 80%.

After the grouting mixture has set hard the foundation bolts shall be pulled up hard and the alignment and level rechecked. The engineer shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the engineer or his intimation that the alignment or level of the machines is to his satisfaction shall in no way relieve the contractor of his obligation under contract to properly install and align the machines and pipe work and shall in no way prejudice the engineer's rights to order rectification of any installation work later found to be improperly carried out.

5.0 RECORD, PROCEDURES AND REPORTS

The contractor shall maintain records pertaining to the quality of installation/erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting formats shall be in the approved formats. The contractor shall submit such records to the engineer after the completion of any particular work before submitting the bill of supply/progress of work. Such report shall comprise of shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, all the quality control reports of welding, erection and alignment records.

All the above mentioned records shall be submitted in the final form duly countersigned by the engineer's representative attesting conformity to specifications and is approval of installation and duly incorporating all the additions, alternations and information as required by the engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding any records submitted earlier with bill of supply/progress etc. shall be duly bound and submitted to the engineer in six copies by the contractor on his notification of the mechanical completion of erection.

6.0 COMPLETION OF ERECTION

The completion of plant under erection by the contractor shall be deemed to occur, if all the units of the plant are structurally and mechanically complete and will include among other such responsibilities the following:

- (a) Plant in the scope of the contractor has been erected, installed and grouted as per specifications.

- (b) Installation checks are completed and approved by the engineer.
- (c) The erected plant are totally ready for commissioning checks.

At the stage of completion of erection, the contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the plant is fit and bound to undergo commissioning checks/tests on completion.

Upon achieving the completion as described above, the contractor shall notify the engineer by a written notice intimating such mechanical completion of units and notify the engineer for inspection and acceptance of mechanical completion. The engineer/engineer's representative shall proceed with the inspection of such units within 14 days of such a notice. Thereafter:

- (a) The engineer shall certify completion when there are no defaults in the works and the plant is acceptable or
- (b) The engineer shall inform the contractor list of deficiencies for rectification hereinafter referred as Punch List and the contractor shall complete the rectification work within a jointly agreed period before tests on or approval of the same before proceeding with the Tests on Completion or
- (c) The engineer may inform the contractor that the works are accepted with the 'punch' list (Items which do not hamper operability, safety or maintainability) and allow the contractors to proceed with the pre-commissioning checks followed by Test on Completion when the contractor undertakes to complete such outstanding works within an agreed during Defects Liability Period.

Taking over shall be based on rectification of all deficiencies as advised by punch lists.

The erection period indicated by the contractor would be deemed to cover all the activities up to completion as stipulated in previous paragraphs, notice of completion by the contractor, inspection by the engineer for completion, and contractor rectification of all deficiencies as noticed by the deficiency/punch list, and acceptance by the engineer of such rectification, prior to Test on Completion.

Minor defects, which in the opinion of engineer which do not hamper operability and maintainability will not be taken in to account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before Test on Completion. However, the engineer's decision in this regard is final.

The commissioning period as notified by the contractor shall be deemed to occur beyond the date of completion and shall include all period of pre-commissioning, trials and Test on Completion.

It is in the contractor's interest to offer the sections/units/systems, progressively under identified milestones within overall erection period, duly completed for inspection by the engineer's representative, obtain his 'punch' list, for rectification of any deficiencies pointed out by the engineer and to achieve mechanical completion before undertaking the Test on Completion within the specified erection period. The engineer also reserves a right to withhold the cost is estimated to be equivalent to the rectification of deficiencies pointed out to the contractor until such a time such deficiencies are rectified to the satisfaction of the engineer.

Erection work should be completed as per instruction of Engineer-in-charge & Header connection should be fit with rising main line as per instruction of EIC.

7.0 SETTING TO WORK

On completion of erection, the contractor shall request the engineer's representative to carry out the installation inspection. After the plant has been set to work, the contractor shall continue to operate the plant for a period of one week.

8.0 INSTALLATION INSPECTION

In addition to the progressive supervision and inspection by the purchaser the contractor shall offer for inspection to engineer, the completely erected plant/part of plant on which tests are to be carried out. After such inspection by engineer, each equipment/sub-system shall be tested by the contractor in accordance with the applicable standards in the presence of engineer. Such tests shall include but not be limited to the tests specified in following clauses.

PUMPS

- (a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapings etc. for carrying out these tests shall be included in the contract.
- (b) Leakage tests shall be carried out on all erected work immediately after erection and where possible before being built in.
- (c) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specified limits.

PUMP MOTORS

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

INSTRUMENTATION

Performance of the instrumentation shall be checked as per the design requirements.

9.0 COMMISSIONING

9.1 SCOPE

At the time of commissioning, the engineer will appoint his representative as commissioning engineer. The contractor shall carry out commissioning tests in the presence of the commissioning engineer. Though the mechanical completion may have been checked and clarified by the site engineers, the commissioning engineer may verify any mechanical completion checks to satisfy himself that the plant is fit and sound, if such checks had not been witnessed by him. It will be the responsibility of the contractor to make all arrangements for carrying out these tests. The evaluation of test results and decision passed by the commissioning engineer regarding the test results will be final and binding on the contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the contractor at no extra cost.

9.2 MISCELLANEOUS

Completion checks and commissioning tests on items not covered under above shall be carried out by the contractor as per the instructions of the engineer's representative.

10.0 TAKING OVER

No item of plant will be certified for taking over by the purchaser unless it has successfully passed all the tests called for under the contract. If nevertheless the employer uses any part of the works, that part which is used shall be deemed to have been taken over at the date of such use.

A Taking-Over Certificate for plant shall not be issued unless the following documentation are duly compiled and submitted in final formats in duly bound volumes.

- (a) A compilation of all shop inspection results/reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (5 copies).
- (b) All erection/construction quality control checks in appropriate approved formats for all installation works with attestation that installation has been carried out as per acceptable/stipulated standards (6 copies).

11.0 TENDER / CONTRACT DRAWINGS

Sr. No.	Description	Preliminary drawings to be submitted	Drawings to be submitted after award of work
1.0	Outline dimensional drawing		
(a)			
2.0	Cross Sectional Drawing with Materials of Construction		
(a)	Pump		
(b)	Expansion Bellows		
3.0	Pump performance Curves		
(a)	Pump (Q vs H, P, η & NPSH)		
4.0	Motor Curves		
(a)	Starting Current vs time		

Sr. No.	Description	Preliminary drawings to be submitted	Drawings to be submitted after award of work
(b)	Characteristic under cold and hot conditions		
5.0	GA drawing of the pumping plants with all dimensions		
6.0	'As built' GA drawing		
7.0	Instrumentation Diagrams		
(a)	Dimensional drawings and installation sketches of instrument		
(b)	Catalogues for all the instruments		

Note: * Indicates the document required to be submitted.

ERECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

1.0 SCOPE

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like transformer, M.V panels, Cables, earthing network, Internal and External lighting, Light fixtures etc. Requirement of this project shall be as specified in bill of quantities / approved drawings / general specifications or as per the battery limits fixed by the owner / consultant.

STANDARDS

- 2.1 The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specification / codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the authorized representative, from time to time. Some of the relevant Indian Standards are listed elsewhere in this tender document.
- 2.2 In addition to the standards mentioned in 2.1, all works shall also conform to the requirement of the following :
- Indian Electricity Act and Rules framed there under.
 - Fire Insurance Regulations.
 - Regulations laid down by the Chief Electrical Inspector of the State / State Electricity Board / Union Territory.
 - Regulations laid down by the Factory Inspector of the State / Union Territory.
 - Any other regulations laid down by the local authorities.
 - Installation & operation manuals of original manufacturers of equipment.

3.0 EQUIPMENT AND ACCESSORIES SPECIFICATIONS:

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make and shall conform to the specification given here under. The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS

standards are available. In the absence of any specification, the materials shall be as approved by the owner / consultant or his authorized representative.

All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be furnished by him as per the proforma given in elsewhere in this tender document.

3.1 CONTROL CABLES:

Control cables for use on 415 V system shall be of 1100 volts grade, copper conductor, PVC insulated, PVC sheathed, armored and overall PVC sheathed, strictly as per IS: 1554 (Part-I) 1976. Unarmored cables to be used only if specifically mentioned in schedule of quantities.

The size of these cables shall be as specified in bill of quantities or as per approved drawing. The minimum conductor size shall be 2.5 sq.mm. (Cu.).

3.2 CABLE TRAYS:

These shall be channel type, fabricated from structural steel, hot dip galvanized, complete with all accessories such as bends, tees and reducers. Only aluminum flat clamps with G.I. / Chrome plated bolts, nuts/screws to be used for clamping cables. Sizes of these trays shall be as specified in bill of quantities or approved by client.

3.3 CABLE GLANDS:

Cable glands shall be heavy duty compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and check nut. These shall be suitable for armored/Unarmored cables, which are being used.

3.4 CABLE CONNECTORS:

Cable connectors, lugs/sockets, shall be of copper/aluminum alloy, suitably tinned, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

3.5 CABLE INDICATORS

These shall be self-sticking type of 2 mm. thick lead strap for overall cable. PVC identification number, ferrules shall be used for each wire.

3.6 G.I. PIPE FOR CABLES:

For laying of cables under floor, G.I. class "A" pipes shall be used. M.S. conduits are not acceptable for this purpose. All accessories of pipes shall be threaded type. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. NO G.I. pipe less than 40 MM. I.D. Shall be used for this purpose. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

3.7 PUSH BUTTON STATIONS:

These shall be floor / wall mounted type as specified in bill of quantities. These shall be fabricated from 1.6 mm. thick stainless steel sheets (SS 304). In case of floor mounted station, these shall be supported on 51 mm. "A" class G.I. pipe. Front cover shall be removable type with suitable rubber gaskets to make them dust vermin and moisture proof.

Each feeder shall be provided with "ON" (green) push button, "OFF" (red) push button, name plate (white Bakelite), indication lamp etc. Green & red push buttons shall have contact elements having 1NO + 1NC. "OFF" push button shall be provided with lockable (key operated) arrangements to prevent accidental starting. No. of feeders shall be specified in bill of quantities. The indication lamp can be combined with "ON" push button.

4.0 ERECTION

The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. Equipment shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the client / consultant or his authorized representative. The empty packing cases shall be returned to the stores and any document if found with the equipment shall be handed over to the client's representative. Any damage or shortage noticed shall be reported to the client / consultant in writing immediately after opening of packing cases.

4.1 ONAN TYPE TRANSFORMER

(a) ERECTION

Before erection of transformer, the level of rails on foundation shall be checked and minor corrections if necessary shall be carried out. After the completion of erection, necessary stoppers shall be provided at the wheels. All loosely supplied fittings / accessories shall be cleaned and mounted on the transformer and connections made. After completely assembling & installation, the transformer shall be cleaned and touched up with a paint supplied by the manufacturer applied wherever necessary. All cover bolts shall be checked for proper tightness. All the civil foundation work required shall be in the scope of contractor.

(b) TESTING :

Winding insulation resistance shall be measured from primary and secondary to ground and between primary and secondary.

Check the polarity of terminals and the phase sequence.

(c) Proforma for transformer tests :

- Transformer name plate.
- Insulation resistance test with 1000 V meager.

- a) between primary to earth
- b) between secondary to earth
- c) between primary and secondary

- Operation of the tap changer.

Operation of the tap at tap No. 1

Operation of the tap at tap No. 2

Operation of the tap at tap No. 3

Operation of the tap at tap No. 4

Operation of the tap at tap No. 5

- Polarity marking and phase sequence.
- Earth resistance : Body as well as Neutral link.

[This proforma shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

MOTOR CONTROL CENTER, DISTRIBUTION BOARDS:

(a) ERECTION:

Electrical panels his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. The contractor shall be responsible for final assembly and interconnection of busbars / wiring. Foundation channel shall be delivered in convenient shipping section by the manufacturer. The contractor shall make shall be grouted in the flooring by the contractor. Switchgear shall be aligned and levelled on their base channels and bolted to them as per the instructions of the client / consultant. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on

the switchgear. The contacts of the draw out circuit breaker shall be checked for proper alignment and inter changeability.

After erection, the switchboard shall be inspected for dust and vermin proof. Any hole which might allow dust or vermin etc. to enter the panel shall be plugged suitably at no extra cost. If the instrument transformers are supplied separately, they shall be erected as per the direction of the client / consultant. The contractor shall fix the cable glands after drilling the bottom / top plates of all switchboards with suitable holes at no extra cost.

Range of overload relays / timers etc. shall be checked with requirement of motor actually to be connected at site and if the same is undersized / oversized, it shall be brought to the notice of the client / consultant, who shall arrange procurement of corrected components. However, the contractor shall not charge anything extra for labor for such replacements.

(b) TESTING :

Before electrical panel is energized, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contacts open.

Before switchgear is energized, the insulation resistance of all control circuits shall be measured from line to ground.

The following tests shall be performed on all circuit breakers during erection.

- Contact alignment and wipe shall be checked and adjustment where necessary in accordance with the breaker manufacturer's instructions.
- Each circuit breaker shall be drawn out of its cubicles, closed manually and its insulation resistance measured from phase to phase and phase to ground.
- All adjustable direct acting trip devices shall be set using values given by the consultant/ manufacturer.
- The dielectric strength of insulating oil wherever applicable, shall be checked.

Before switchgear is energized, the following tests shall be performed on each circuit breaker in its test position.

- Close and trip the circuit breaker from its local control switch push button or operating handle. Switchgear control bus may be energized to permit test operation of circuit breaker with A.C. closing with prior permission of the client / consultant.
- Test tripping of the electrically operated circuit breaker by operating mechanical trip device.

- Test proper operation of circuit breakers latch, check carriage limit switch if provided. Test proper operation of lockout device in the closing circuit. Wherever provided by simulating conditions which would cause a lockout to occur.
- Trip breaker either manually or by applying current or voltage to each of its associated protective release.
- Before switchgear is energized, the tests covered above shall be repeated with each breaker in its normal operating position.
- Capacitor banks shall be tested as per manufacturer's instructions. In addition, test for output and/or capacitance, insulation resistance test and test for efficiency of discharge device shall be carried out.
- All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

(c) PROFORMA FOR PCC, MCC, DB, CONTROL PANEL TEST :

- Circuit breaker or contactor module designation / bus no.
- Insulation resistance test (contacts open, breaker racked in position)
 - a) between each phase of bus : Mega ohm
 - b) between each phase and earth : Mega ohm
 - c) DC and AC control and auxiliary circuits: Mega ohm
 - d) between each phase of CT / PT and between CT
& PT circuit if any : Mega ohm
- CT checks:
 - a) CT ratio
 - b) CT secondary resistance
 - c) CT polarity check
- Check for contact alignment and wipe.
- Check / test all releases / relays.
- Check mechanical interlocks.
- Check electrical interlocks.
- Check switchgear / control panel wiring.
- Check breaker / contactor circuit for:

- a) Closing - local & remote (wherever applicable)
- b) Tripping - local & remote (wherever applicable)

➤ Opening time of breaker / contactor.

➤ Closing time of breaker / contactor.

[This preform shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

4.3 INSTALLATION OF CABLE NETWORK :

Cable network shall include power, control and lighting cables which shall be laid in underground trenches, cable trays, G.I. pipes, or on building structures as detailed in the relevant drawings, cable schedules or as per the client / consultant's instructions. Supply & installation of cable trays, G.I. pipes / conduits, cable glands and sockets of both end isolators, junction boxes, remote push button stations, etc. shall be under the scope of the contractor.

(a) General requirements for handling cables:

Before laying cables, this shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500 / 1000 V megger.

The cables shall be supplied at site, wound on wooden drums as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on as it produces kinks which may damage the conductor.

Sharp bending of cable shall be avoided. The bending radius for PVC insulated and sheathed, armored cable shall not be less than 10 D, where "D" is overall diameter of the cable.

While drawing cables through G.I. pipes, conduits, RCC pipes, ensure that size of pipe is such that, after drawing cables, 40% area is free. After drawing cables, the end of pipe shall be sealed with cotton / bituminous compound.

High voltage (11 kV and above), medium voltage (240 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes / trays.

Armored cables shall never be concealed in walls / floors / roads without G.I. pipes, conduits or RCC pipes.

Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin tight joint shall be made, without any additional cost.

A minimum loop of 3 mtr. shall be provided on both ends of the cable, and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.

Cable shall be neatly arranged in the trenches / trays in such manner so that crisscrossing is avoided, and final take off to the motor / switchgear is facilitated. Arrangement of cable within the trenches / trays shall be the responsibility of the contractor.

All cable routes shall be carefully measured, and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings are indicative only and the same may be rechecked with the client / consultant before cutting of cables. While selecting cable routes interference with structures, foundations, pipelines, future expansion of buildings etc. should be avoided.

All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tapes. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

Wherever cable rises from underground / concrete / masonry trenches to motors / switchgears / push buttons, these shall be taken in G.I. pipes of suitable size, for mechanical protection up to 300 mm. distance of concerned cable gland or as instructed by the client / consultant.

The cable pass through foundation / walls of other underground structures, the necessary ducts for opening will be provided in advance for the same. However, should it become necessary to cut holes in existing foundation of structures the electrical contractor shall determine the location and obtain approval of the client / consultant before cutting is done.

(b) LAYING OF CABLES (UNDERGROUND SYSTEM)

- Cables shall be so laid in trench that this will not interfere with other underground structure. All water pipes, sewage lines or other structures which become exposed by excavation shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded / diverted as directed by the owner / consultant.

- Cable shall be laid at minimum depth of 750 mm. in case of L.T. and 1200 mm. in case of H.T. from ground level. Excavation will be generally in ordinary soil. The width of trench shall be sufficient for laying of required no. of cables.
- Sand bedding 75 mm. thick shall be made below and above the cables. Layer of bricks (full size) shall be laid above sand bedding on the sides and above the cables to cover cables completely. More than one cable can be laid in the same trench. However, the relative location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction of the client / consultant.
- For all underground cables, route markers should be used :
 - a) Separate route markers should be used for LT, HT and telephone cables.
 - b) Route markers should be grounded in ground with 1:2:4 cement concrete pedestal size 230 x 230 x 300 mm..
 - c) Cable markers should be installed at an interval not exceeding 30 mtr. along the straight routes of cables at a distance of 0.5 mtr. away from centre of cable with the arrow marked on the cable marker plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.
- RCC Hume pipe for crossing road in cable laying shall be provided by employer. No deduction shall be made for cable laying in Hume pipe for not providing bricks, sand and excavation. RCC hump pipe at the ends shall be sealed by bituminous compound after laying and testing of cables by electrical contractor without any extra charge.

(c) LAYING OF CABLE IN MASONRY TRENCHES

Masonry / concrete trenches for laying of cables shall be provided by employer. However, steel members such as M.S. angles / flats etc. shall be provided and grouted by electrical contractor to support the cables without any extra charge. Cables shall be clamped to these supports with minimum saddles / clamps. More than one tier of cables can be provided in the same trench if the no. of cables are more.

Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches.

(d) LAYING OF CABLES IN CABLE TRAYS

Cable trays and steel members such as M.S. angle / channel / flats etc. shall be provided and fixed by the contractor.

Cable shall be fixed in cable trays in single tier formation and cables shall be clamped with flat clamps and galvanized bolts / nuts.

Earthing flat / wire can also be laid in cable tray along with cables.

After laying of cables, minimum 20% area shall be spare.

(e) TERMINATION AND JOINTING OF CABLES:

i. a) For HT cables suitable size of push on type termination kit shall be used.

b) Use of glands:

All PVC cables up to 1.1 kV grade, armored or Unarmored shall be terminated at the equipment / junction box / isolators / push buttons / control accessories, etc. by means of suitable size single compression type cable glands. Armour of cable shall be connected to earth point. The contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type.

In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit holes should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the center line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

ii. USE OF LUGS / SOCKETS :

All cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs / sockets.

The following is the recommended procedure for crimped joints and the same shall be followed :

- a) Strip off the insulation of the cable and with every precaution, not in severe or damage any strand. All insulation's to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.
- b) The cable should be kept clean as far as possible before assembling it with the terminal / socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminum conductors, the socket should be filled with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.
- c) Correct size and type of socket / ferrule / lug should be selected depending on size of conductor, and type of connection to be made.

- d) Make the crimped joint by suitable crimping tool.
- e) If after crimping the conductor in socket / lug, some portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.
- f) For HT cable the manufacturer's recommendation should be followed.

iii) DRESSING OF CABLE INSIDE THE EQUIPMENT :

After fixing of cable glands, the individual cores of cable shall be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of aluminum cables, the erector shall modify the same without any additional cost.

Cables inside the equipment shall be measured and paid for on lug to lug basis.

iv) IDENTIFICATION OF CABLES / WIRES / CORES :

Power cables shall be identified with red, yellow and blue PVC tapes. For trip circuits identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear / control panels and control switches.

In case of control cables all cores shall be identified at both ends by their wire numbers by mean of PVC ferrules or self-sticking cable markers, wire numbers shall be as per schematic / connection drawing. For power circuit also, wire numbers shall be provided if required as per the drawings of switchgear manufacturer / supplier.

(f) TESTING OF CABLES:

- i. Before emerging, the insulation resistance of every circuit shall be measured from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
- ii. Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Repeat measurements after splices and/or terminations are complete.
- iii. **DC high voltage test shall be made after installation on the following :**
 - a) All 1100 volts grade cables in which straight through joints have been made.
 - b) All cables above 1100 V grade.

For record purpose test data shall include the measured values of leakage current versus time.

The DC high voltage test shall be performed as detailed below :

Cables shall be installed in final position with all the straight through joints complete. Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

iv. PROFORMA FOR TESTING CABLES:

DATE OF TEST

- a) Drum No. from which cable taken.
- b) Cable from to
- c) Length of run of this cable meter
- d) Insulation resistance test
 - i) between core-1 to earth mega-ohm
 - ii) between core-2 to earth mega-ohm
 - iii) between core-3 to earth mega-ohm
 - iv) between core-1 to core-2 mega-ohm
 - v) between core-2 to core-3 mega-ohm
 - vi) between core-3 to core-1 mega-ohm
 - vii) duration used : 1 kV
- e) High voltage test Voltage Duration between corean earth.
 - I. between individual cores

[This proforma shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

4.4 EARTHING NETWORK:

(a) INSTALLATION AND CONNECTION :

The plate/pipe electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level.

The plate/pipe electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

19 mm. dia. G.I. pipe for watering, shall run from top edge of the plate / pipe electrode to the mid-level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth / ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS : 3043, Code of Practice for Earthing Installation.

The earth conductors (Strips / Wires copper / Hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivity screws / bolts. The conductors outside the building shall be laid atleast 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

(b) EARTH LEADS AND CONNECTIONS:

Earth lead shall be bare copper or Galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. G.I strips buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

(c) TEST :

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS : 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

- 1) Each earthing station
- 2) earthing system as a whole
- 3) Earth continuity conductors

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

All tests shall be carried out in presence of the client's rePmc

5.0 SURFACE CONDUIT WORKS :

5.1 CEILING / WALL OUTLET BOXES FOR LIGHTS / FANS :

Outlet boxes shall be of steel with cover and so installed as to maintain continuity throughout. These shall be protected at the time of laying by filling with jute / earth / cotton etc. so that no cement mortar finds its way inside during concreting or plastering etc. In beams conduit socket shall be provided in place of outlet boxes. The same shall be used for installation of luminaries.

For fixing light fixtures / brackets, outlet boxes complete with knock out for holding conduits shall be used. For lighting fixture suitable for 40/20 watts fluorescent tubes / incandescent lamps / mercury vapor lamps, only one outlet box is required.

For fixing ceiling fans, circular outlet boxes, 100 mm. diameter, complete with 12 mm. dia. Mild Steel rod 300 mm. long, for holding 12 mm. dia. Mild Steel cover 125 mm. dia. at bottom shall be used.

5.2 DRAW OUT JUNCTION BOXES :

Steel draws out boxes at angle dimensions shall be provided at a convenient points on walls / ceilings to facilitate pulling of long runs of cables / wires. The location of these boxes is to be decided prior to fixing, as per site requirement and following should be treated as general guidance for deciding the location of these:

- (a) These should be provided at a place where these are not in direct view. Recommended place is 400 / 450 mm. below ceiling if conduits are running vertically.
- (b) Junction box in the offset of bottom of RCC beam and vertical wall should not be provided.

- (c) If junction boxes are coming side by side for two or more conduits, one common M.S. box of proper size can be used to act as junction box.
- (d) If junction box is to be provided in ceiling, its position should be so located that it is in line with other light / fan points.
- (e) Junction boxes should never be used for splitting one conduit into two or more. Junction box for such functions is avoidable and for this, number of conduits to be connected to one switch board should be calculated correctly as per drawing before laying conduits in ceiling.
- (f) Locating junction boxes on outer surface of exterior walls of building should be avoided as these are in direct view and are also exposed to weather.

5.3 SWITCH BOXES:

Steel boxes of required sizes shall be provided to house speed regulators of fans, switches for lights, fans, plug sockets etc. as per requirement of drawings. These should be so designed that accessories on sheet could be mounted with tapped holes and brass machine screws, leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on all walls of the boxes through which the conduits are entering. These shall be completely connected leaving edges flush with finished wall surfaces. Cover should be fixed to these switch boxes by means of brass chrome plated machine screws and cup washers. Utmost care shall be taken by contractor to ensure that all switch boxes are in line and level.

Inside each switch box, one bolt shall be welded to receive earthing wire.

5.4 SWITCH AND SOCKET:

Switches shall be installed at 900 mm above finished floor level unless otherwise indicated on the drawings.

The switch controlling the light point or fan shall be connect on to the phase wire of the circuit and neutral shall be continuous, having no fuse or switch installed in the line except at the D.B. All fan regulators shall be fixed inside the switch boxes

The cover plates to the switch box shall be fixed by means of sunk head brass cadmium screws.

Where two or more switches and fan regulators are installed together, they shall be provided with one gang cover plate with knockouts to accommodate required number of switches, sockets and regulators.

The switch controlling the socket outlet shall be on the phase wire of the circuit. The third pin of the socket shall be connected to the earth continuity conductor of the circuit

The switch boxes, installed back-to-back in the same wall shall be offset from each other, 150 mm horizontally, to preclude noise transmission.

5.5 CLEANING AND PROTECTION OF CONDUIT SYSTEM :

The entire conduit system including outlet boxes, junction boxes and switch boxes shall be thoroughly cleaned after completion of erection and tested for not blockage by air / sound or steel wire prior to finishing of building by air / sound or steel wire prior to finishing of building and before drawing in of cables / wires to safeguard conduit system against filling up with the plaster / cement slurry / water etc. all the outlet and switch boxes will have to be provided with temporary jute / cotton filling, covers and plugs etc.. Within tendered cost which shall be replaced later by hylem / sheet cover after wiring as required.

5.6 TESTING OF INSTALLATION :

Before a completed installation is put into service, the following tests shall be complied with:

(a) INSULATION RESISTANCE :

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

The insulation resistance in giga-ohms of an installation, measured shall not be less than 50 mega-ohms divided by the number of points on the circuit.

The insulation resistance shall be measured between

EARTH TO PHASE

EARTH TO NEUTRAL

PHASE TO NEUTRAL

PHASE TO PHASE

(b) EARTH CONTINUITY PATH:

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

(c) POLARITY OF SINGLE POLE SWITCHES :

A test shall be made to verify that every no-linked, single pole switch is connected to one of the phases of the supply system.

(d) COMPLETION CERTIFICATES:

All the above tests shall be carried out in presence of client and the results shall be recorded in a prescribed form. Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result from shall be submitted to the client for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

6.0 COMPLETION TESTS :

After supply and installation of complete project or a particular building / area, following tests shall be carried out by the contractor before switching on the power to installation and the results shall be recorded and submitted to the Site-Engineer. If results are not satisfactory / as per standards set herewith, the contractor shall identify the defects / short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

6.1 INSULATION RESISTANCE TO EARTH:

This is to be measured with all fuse links in place, all switches ON, all lamps and appliances in position by applying a voltage not less than twice the working voltage (subject to a limit of 500 V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 mega-ohms divided by the number of outlets (points and switch positions) except that it need not exceed one mega-ohm for the whole installation.

6.2 INSULATION RESISTANCE BETWEEN CONDUCTORS:

Tests to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put ON. The result of the test must be 50 mega-ohms divided by the number of outlets (points and switch positions) but need not exceed 1 mega-ohm for the whole installation.

6.3 POLARITY OF SINGLE POLE SWITCHES:

Tests shall be made to verify that all non-linked single pole switches are on phase conductor (live) and not on neutral or earth conductor. This can be done by connecting test lamps between two terminals of switch and earth. If the lamp lights up when switch is ON and either terminal is touched, the switch is correctly installed.

6.4 RESISTANCE OF METAL CONDUITS / SHEETS (EARTH CONTINUITY TEST):

In case of cables encased in metal whether conduit of metallic sheathing, the total resistance of the conduit or sheathing from the earthing point any other position in the completed installation shall not exceed 2 ohms. This can be carried out by following circuit:

One end of the lead is connected to the ECC and its connection with the electrode and the other to the farthest point of the ECC. First, current through the circuit is measured with the resistance of 2 ohms short circuited by the link. Next, current is measured through the two ohms resistance by disconnecting the two leads from the ECC and joining them together. If current is more in the first case, the resistance of ECC is less than 2 ohms.

7.0 HANDING OVER / TAKINGOVER:

After completion of works and tests specified above, the various installations of the project can be taken over by the employer as and when these are ready in all respects. The defect liability period of 36 months shall start from the date, when all the installations of the project have been executed, tested as described above, successfully commissioned and handed over.

MATERIALS AND WORKMANSHIP

1.0 INTRODUCTION:

This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor and mention of any specific material or Plant does not necessarily imply that such is included in the Works. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Engineer.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information shall be furnished by the Contractor.

2.0 COMPLIANCE WITH STANDARDS:

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S.') issued by the British Standards Institution of 2, Park Street, London, or to an Indian Standard Specification (I.S.) issued by the Bureau of India Standards, (earlier known as Indian Standard Institution), Mana Bhavan, 9 Bhadur Shah Zafar Marg, New Delhi 110 002, American Society for Testing and Materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or to any other equivalent standard it shall be to the latest revision of that standard at the tender opening date.

The Contractor may propose at no extra cost to the Employer, the use of any relevant authoritative Internationally recognized Reference Standard, including Indian Standard.

All details, materials and equipment supplied and workmanship performed shall comply with these standards. If Contractors offer equipment to other standards, the equipment / material should be equal or superior to those specified and full details of the difference shall be supplied.

In the event of conflict between this specification and the codes for equipment, provisions of this specification shall govern.

3.0 MATERIALS - GENERAL

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make / approved quality, free from imperfections and selected for long life and minimum maintenance. Nondestructive tests, if called for in the specification, shall be carried out.

All submerged moving parts of the Plant, or shafts, spindles, etc. of the submerged moving parts or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

4.0 WORKMANSHIP - GENERAL

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice.

All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to may be readily installed.

All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load up to the maximum there shall be no vibration due to lack of balance.

All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings.

All materials incorporated in the work shall be most suitable for duty concerned, free from imperfections, selected for long life and minimum maintenance.

All necessary accessories required for satisfactory and safe operation of the Plant shall be supplied by the Contractor unless it is specifically excluded from his scope.

All valves shall be closing on clockwise rotation of the hand wheel. The effort required to close / open under all operating conditions shall be limited to 7 kg. The direction of opening / closing shall be cast on the hand wheel.

All flanges shall be drilled in accordance with requirements of IS : 1538 or as specified

All flanges shall be full or spot faces on the back side. The flange thickness shall be uniform throughout.

Flange outside periphery shall be concentric with the bore. Flanges shall be finished smooth on periphery also.

Castings and fabricated materials shall be finished smooth all over.

5.0 WELDING

5.1 Design Approval

Welding shall comply with the latest revision of the BS 5135 code. In all welded fabrications, the Contractor shall submit to the Engineer's Representative before fabrication commences, detailed drawings of fabrication with sizes of weld and weld preparation together with the details of the application codes. No welding shall be carried out before approval of the details by the Engineer's Representative. No alternations shall be made to any previously approved details of weld preparation or size without prior approval of the Engineer's Representative.

5.2 Qualification of Welders and Procedures

Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871 part1. The Engineer shall have the right to call for further Qualification from time to time from any welder who in the opinion of the Engineer, does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each weld shall clearly be identified as to its welder marking the welder's code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Engineer's Representative shall disqualify the welder whose work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS 4870 Part 1.

5.3 General Welding Requirements

Inspection and quality of surveillance shall not be limited to the examination of finished welds. All aspects of materials, fabrication procedures and examination procedures shall be subject to the approval of the Engineer's Representative. The equipment used shall be suitable for the quality of work specified. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.

Haphazard striking of the electrodes for establishing arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag. The starting tag shall be of the same material or a material compatible with the base metal being welded. In case of any inadvertent strike on place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.

Generally, a stringer bead technique shall be used with a slight oscillation if necessary to avoid slag and to minimize the number of beads needed to fill the joint. However, the width of the deposited pass shall not exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For whenever possible, by 2 welders working simultaneously along both sides of the pipe.

All joint fit ups shall comply with the tolerances specified on the manufacturing drawings. The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive "suck back", etc. shall be cause for rejection of welds.

Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg length shall not exceed the specified size by more than 1.5 mm.

All attachments such as lugs, brackets and other non pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.

All tack welds shall be made using qualified procedure and welders, the number of size of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouging. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.

All weld repairs shall be carried out using the approved welding procedures and welders. Preparation of weld repair shall have the prior approval of the Engineer's Representative. Re-welded areas shall be re-examined by the methods specified for the original welds and repair procedures shall be duly qualified by the Engineer's Representative.

6.0 Pre-heating and Post-heating Treatment

Pre-heating and post heating treatment shall conform to the relevant application codes. Pre-heating not exceeding 121 deg. C for all carbon steel construction above 25 mm

thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches / gas rings with neutral flame. The temperature shall be checked by temperature will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870 Part 1 Table 6 to represent 30% of the long seams and each welder's performance would be mandatory.

7.0 Electrodes

The makes and types of electrodes to be used shall be submitted for approval of the Engineer. All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

8.0 Examination / NDT / Radiography

The various stages of examination and types shall be as stipulated in the respective fabrication codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910 : ultrasonic tests where called for shall be carried out as per provisions of BS 3923 ; magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

9.0 Stainless Steel Welding

All welding consumables such as electrodes, filler wires, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the Engineer. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.

All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven.

The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.

Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.

Nondestructive examination of the welds shall be carried out to ensure quality of weld.

The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

10.0 CASTINGS

Cast iron shall be of standard gray close-grained quality. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer's Representative shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Engineer / his representative. If the removal of metal for repair should reduce the stress 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then that casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified by the Engineer / or his Representative to check physical, chemical analysis of casting.

Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Castings subject to hydraulic pressure shall be pressure tested to 1 ½ times the rated pressure or, twice the working test reports shall be forwarded to the Engineer's Representative as soon as each test has been completed. Non-destructive tests as directed by the Engineer's Representative will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

Unless otherwise specified casting shall produce to the following standards or equal:

(a) Grey Iron	:	BS 1452 Grade 220
(b) Carbon Steel	:	BS 3100 Steel Alloy
(c) Stainless Steel	:	BS 3100 Steel 316 C16
(d) Copper & Copper Alloy	:	BS 1400 Group A Grade LG2 Group B Grade CT1, AB2 Group C Grade G1

11.0 FORGINGS

All major stress-bearing forgings shall be made to a standard specification. Forgings shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. An indication, which proves to penetrate deeper than 2.5 % of the finished thickness of the component, shall be reported to the Engineer giving the details like location, length, width and depth. For the magnetic particle inspection, the choice of wet or dry particles shall be at the Contractor's discretion. All forgings shall be demagnetized after test and shall be heat treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer's Representative. The Engineer's Representative or the Inspector may inspect such forgings and identify test coupons to check physical and chemical analysis and witness such tests at the place of manufacture with a representative of the Contractor.

12.0 DESIGN LIFE

For Electrical panels - 30 Years, Static electrical equipment - 30 years, Motors / Pumps - 15 Years, Instrumentation and Electronics - 10 Years, piping & mechanical equipment - 40 years.

The works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing the site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The Contractor shall be called upon to demonstrate this for an component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not require the services of highly skilled personnel.

The Plant shall be designed to provide easy access to and replacement of component parts, which are subject to wear, without the need to replace whole units. No parts in the contact with sewage shall have a life from new to replacement or repair of less than five years. Where major dismantling is unavoidable to replace a part, the life of such part shall not be less than ten years.

Design features shall include the protection of Plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Works.

Plant located outside lockable areas/buildings shall have additional features to prevent unauthorized operation.

13.0 LUBRICATION

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer's Representative for approval before incorporation in the Instruction Manuals. In case of grease lubricated roller type bearings a lithium base grease is preferred.

Contractors shall indicate indigenously available equivalent lubricants, with complete duty specification, to enable the Corporation to arrange for regular supply.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. All grease nipples shall be of the same size and type for every part of the Plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

Oil containers shall be supplied complete with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The levels shall be clearly visible in the sight glass type from the normal access floor to the particular item of Plant and they shall

be easily dismantled for cleaning. All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.

All lubrication systems shall be designed so as not to cause a fire or pollution hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential source of fire.

The Contractor shall supply flushing oil for each lubrication system when an item of Plant is ready for preliminary running and a sufficient quantity of the approved lubricants for the commercial operation of the Plant for two years after the Taking-over Certificate has been issued.

14.0 NAME PLATES

Each item of the Plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate, each of stainless steel. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as may be required by the Engineer's Representative. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

Details of proposed inscriptions shall be submitted to the Engineer's Representative for approval before any labels are manufactured. Such nameplates, rating plates and designations shall be of stainless steel with engraved or stamped lettering. Items such as valves shall have direction of rotation for closing and opening indicated.

Nameplates, rating plates and labels shall be of a non-flame propagating material, either non-hygroscopic or transparent plastic with engraved lettering of a contrasting color. Fixing shall be by means of non-corrosive screws; drive rivets or adhesives shall not be used.

Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background and to internationally recognized standards.

Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

15.0 NUTS, BOLTS, STUDS AND WASHERS

Nuts, Bolts, Studs and Washers for incorporation in the Plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut. Bolts shall be of one piece construction and shall be of sufficient length so that only one thread shall show through the nut in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary and shall be subject to the approval of the Engineer's Representative. Jointing

hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.

Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Contractor shall supply all holding down, alignment and leveling bolts complete with anchorages, nuts, washers and packings required to attach the Plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

16.0 ALLOWANCE FOR WASTAGE

The Contractor shall supply to the satisfaction of the Engineer's Representative reasonable excess quantities to cover wastage of those consumables which will be normally subject to waste during erection, commissioning and setting to work.

17.0 PAINTING - GENERAL

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out if necessary by washing with an approved dewatering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

All protective coatings shall be suitable for use in warm humid climates.

18.0 PAINTING AT PLACE OF MANUFACTURE

All stages in painting including cleaning and surface treatment in the manufacturer's works shall be available for inspection.

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting.

A primer coat of a zinc rich epoxy resin based coating with at least a 75 microns dry film thickness is to be provided. In addition the parts are to be provided with adequate number coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.

19.0 PAINTING AT SITE

Immediately on arrival at the Site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

Steel and cast-iron parts received at site shall be provided with adequate number of further coats of coal tar epoxy polyamine coating to a total dry film thickness of 275 microns including the primer coats. All sharp edges, nuts, bolts and other items difficult to

be painted shall receive a brush coat of specified paint before application of each coat of epoxy-based coal tar paint giving a total dry film thickness of at least 275 microns. In the case of fabricated steel work this work shall be done after assembly.

Before painting is commenced the Contractor shall submit for the approval of the Engineer's Representative, full details of the paints he proposes to use together with color charts for the gloss finishes.

All paint and coating thickness shall be measured by approved Alcolmeter or coating thickness gauge.

20.0 LIST OF STANDARDS

The titles of various standards referred to in the Specification are indicated hereunder for ready reference. This list does not necessarily cover all the Standards referred to:

STANDARD NO.	PARTICULAR
IS 5	Colors for ready mixed paints and enamels
IS 210	Grey Iron Castings
IS 318	Leaded Tin Bronze Ingots and Castings
IS 325	Three Phase Induction Motors
IS 14846	Sluice Valve
IS 807	Code of Practice for design, manufacture, erection and testing (structural portion) of cranes and hoists.
IS 1239	Mild Steel tubes, tubular and other wrought steel fittings.
IS 1536	Centrifugally cast (Spun) iron pressure pipe for water, gas and sewage
IS 1537	Vertically cast iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1554	PVC insulated (heavy duty) electric cables
IS 2062	Steel for general structural purposes
IS 2147	Degrees of protection provided by enclosures for low voltage switch gear and control gear
IS 3109	Short link chain, Grade M (4)
IS 3177	Code of practice for electric overhead traveling cranes and gantry cranes other than steel work cranes.
IS 3618	Phosphate treatment for iron and steel for protection against corrosion
IS 3624	Vacuum and Pressure gauges
IS 3815	Point hooks with shank for general engineering purposes.
IS 3938	Electric wire rope hoists

IS 4029	Guide for testing three phase induction motors.
IS 4460	Method for rating of machine cut spur and helical gears.
IS 4691	Degrees of protection provided by enclosure for rotating electrical machinery
IS 5312	Swing Type Non Return Valve
IS 6005	Code of practice for phosphate of iron and steel
IS 8329	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage
IS 11592	Code of practice for selection and design of belt conveyors
IS 13349	Cast Iron Single faced thimble mounted sluice gates
BS 436	Spur and helical gears
BS 466	Specification for power driven overhead traveling crane, semi goliath and goliath cranes for general use
BS 545	Specification for bevel gears (machine cut)
BS 721	Specification for worm gearing
BS 970	Wrought steels for mechanical and allied engineering purposes
BS 1397	Specification for industrial safety belts, harnesses and safety
BS 1400	Specification for copper alloy ingots and copper alloy and high conductivity copper castings
BS 1452	Specification for flake graphite cast iron
BS 1663	Specification for higher tensile steel chain Grade 40 (Short link and pitched or calibrated) for lifting purposes.
BS 2573	Specification for classification, stress calculations and design of mechanisms.
BS 2600	Radiographic examination of fusion welded butt joints in steel
BS 2903	Specification for higher tensile steel hooks for chains, slings, blocks and general engineering purposes
BS 2910	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes.
BS 3017	Specification for mild steel forged ram short hooks
BS 3100	Specification for steel castings for general engineering purposes.
BS 3923	Methods for ultrasonic examination of welds.
BS 4360	Specification for weldable structural steels.
BS 4772	Specification for ductile iron pipes and fittings
BS 4870	Specification for approval testing of welding procedures. Part - I : Fusion Welding of Steel
BS 4871	Specification for approval testing of welders working to approved

	welding procedures Part - I : Fusion Welding of Steel
BS 4942	Short chain link for lifting purposes.
BS 5135	Specification for arc welding of carbon and manganese steels
BS 5316	Specification for acceptance tests Part - 2 for centrifugal, mixed flow and axial pumps - Test for performance and efficiency.
BS 6072	Method for magnetic particle flaw detection
BS 6405	Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes : Class 1 & 2
BS 6443	Method for penetrate flaw detection
ASTM A-36	Specification for Structural Steel
ASTM A-216	Specification for steel castings, carbon suitable for fusion welding for high temperature service
ASTM A-276	Specification for stainless steel and heat resisting steel bars and shapes.
ASTM A-351	Specification for castings, Austenitic-Ferritic (Duplex), for Pressure Containing Parts.
ASTM A-743	Specification for castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel Base corrosion Resistant for General Application
ASTM A-744	Specification for casting, Iron Chromium-Nickel, Corrosion Resistant
ASTM B-14B	Specification for Aluminum-Bronze Castings.
IEC - 189	Low frequency cables and wires with Part 1 & 2 PVC insulation and PVC sheath
AWWA C 501	Cast Iron Sluice Gates