VADODARA SMART CITY DEVELOPMENT LTD.

VOLUME – II – PART - 1

TECHNICAL SPECIFICATION OF MECHANICAL WORKS

TENDER FOR

"Design, engineering, procurement, supply, erection, testing, commissioning and demonstration of performance guarantees for sewage pumping sets along with associated electrical equipment, manifold with C.I. piping system, required civil works, for Sewage Pumping Stations for Vadodara City -Part-1"

DECEMBER -2019

1 Scope of Works

This section provides brief description of the Mechanical requirement, up gradation for fifteen (15) numbers of sewerage pumping stations for Vadodara Municipal Corporation (VMC).

The brief scope includes: The scope of mechanical works for the downstream which include the following equipment;

(a) Dismantling of existing old Pumping Machinery (HNC/ Sub type) along with pipe, fittings & valves etc for Suction, Delivery & Common header.

(b) SITC of New Pumping Machinery (HNC/ Sub type) along with pipe, fittings & valves etc for Suction, Delivery & Common header.

(c) SITC of HOT Crane.

(d) SITC of Drain Pump Set.

(e) Required Fabrication Work.

(f) Required all allied Civil Work.

Refer Table below for detailed scope.

SL NO	NAME OF PUMPING STATION	ZONE	DETAIL SCOPE OF WORK
1	**APS-1 KALAGHODA APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of New Pumping Machinery - 1 Nos (Submersible type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. IV. SITC of HOT Crane. V. SITC of Drain Pump Set. VI. Required Fabrication Work. VII. Required Civil Work.
2	**APS-3, SSG HOSPITAL APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane.

SL NO	NAME OF PUMPING STATION	ZONE	DETAIL SCOPE OF WORK
			IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
3	**APS-5, SARDAR BHUVAN APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
4	**APS-6, KALUPURA APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
5	**VIP APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
6	**SARADNAGAR APS**	TARASALI ZONE	I. Dismantling of existing old Pumping Machinery - 2Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane.

SL NO	NAME OF PUMPING STATION	ZONE	DETAIL SCOPE OF WORK
			IV. Required Fabrication Work. V. Required Civil Work.
7	**GAYATRINAGAR APS**	ATALADARA ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 5 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.
8	**APS-8, YAKUTPURA APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) & 2 Nos (Sub. Type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of New Pumping Machinery - 3 Nos (Submersible type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. IV. SITC of HOT Crane. V. SITC of Drain Pump Set. VI. Required Fabrication Work. VII. Required Civil Work.
9	**NIZAMPURA APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.

SL NO	NAME OF PUMPING STATION	ZONE	DETAIL SCOPE OF WORK
10	**GIDC APS (NEW)**	TARASALI ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.
11	**GIDC APS (OLD)**	TARASALI ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
12	**NEW GOTRI APS**	ATALADARA ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.
13	**KALALI II APS**	ATALADARA ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.

SL NO	NAME OF PUMPING STATION	ZONE	DETAIL SCOPE OF WORK
14	**APS-13, NARHARI HOSPITAL APS**	GAJARAWADI ZONE	I. Dismantling of existing old Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 2 Nos (HNC type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. SITC of Drain Pump Set. V. Required Fabrication Work. VI. Required Civil Work.
15	**TANDALJA APS**	ATALADARA ZONE	I. Dismantling of existing old Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. II. SITC of New Pumping Machinery - 3 Nos (Sub. type) along with pipe, fittings & valves etc for Suction, Delivery & Common header. III. SITC of HOT Crane. IV. Required Fabrication Work. V. Required Civil Work.

SPECIFICATIONS FOR MECHANICAL ITEMS (SPECIAL)

1.0 PUMPSETS:

1.1 SUBMERSIBLE NON-CLOG SEWAGE PUMP

A. GENERAL

The Pump shall be submersible, non clog, single stage, centrifugal, wear resistance with vertical shaft suitable for permanent installation in wet-pit / sump along with Submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump shall be designed to pump sewage and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head- Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15 % of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameter shall not be accepted.**

The manufacturer shall ensure while selecting pump that require Net Positive Suction Head (NPSH) is less than available NPSH w.r.t. minimum submergence required for the pump to ensure pumps' operation without cavitations under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 m and 0.5 m, less than the available NPSH respectively at the lowest liquid level in the sump / minimum submergence required for the pump.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitations or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The pump shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 4.5 mm/sec. Noise level shall be limited to 80 dBA at a distance of 1.0 m.
The Sole plates / auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

The power rating of motor to drive pump shall be suitable to meet max. requirement of power for the rated impeller throughout its' performance range and specific gravity of the liquid.

B. FEATURES OF CONSTRUCTION

PUMP

Pump shall be Vertical Submersible centrifugal, single stage, Non Clog suitable for permanent installation in wet-pit / sump. The pump shall have bottom suction and side discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor. The pump having delivery size upto 100 mm shall be designed to handle solids of min. 35 mm to 80 mm size and pump having delivery size above 100 mm. shall be capable of handling solids of minimum 100 mm size.

CASING

Pump casing shall be volute type of robust construction and designed for high efficiency. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings / wear plates.

IMPELLER

Impeller shall be enclosed/semi-open, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two / three vanes max. and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt & ash. Hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. The Impeller shall have back vanes or suitable features to balance axial thrust.

Pump having semi open impeller shall be provided with suitable wear plate fixed in casing with adjusting bolts & nuts.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helical insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction

SHAFT SLEEVE

Replaceable shaft sleeves if provided, shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber 'O' ring or CAF / Teflon gaskets shall be provided between impeller and shaft sleeve to prevent liquid passage between shaft and sleeve. In no case shaft shall be in the contact with liquid.

MECHANICAL SEALS

Double mechanical seals shall be provided to protect the motor from ingress of Sewage along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary

seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with an electrical monitoring system for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

BEARINGS

Pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hrs of operation. Bearings shall be greased for life –i.e. shall not require any re-greasing. Bearings shall be of SKF / FAG make only.

AUTO COUPLING / GUIDE PIPE / LIFTING CHAIN

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket with rubber diaphragm to make leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into double guide rails / wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI Duck Foot Bend. It shall be provided with all necessary fixtures like guide wire / guide pipe (preferably two nos) for guiding the pumps during lifting/lowering.

Each pump shall be provided with a stainless steel lifting chain conforming to BS 1663 and BS 4942 and stainless steel guide pipe / wire rope of required length.

Portable Non clog submersible pump set shall be provided with sturdy CI / SS mounting stool capable of taking static and dynamic load of pumpset and operate without undue noise and vibration.

LIFTING HOOK

To “fish out” a vertical submerged pump set from the wet well (even if a chain has not been attached to the lifting hook prior to the pump set being lowered) the pump shall have a self centering lifting hook. Its design shall 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 well. This hook shall be of corrosion resistant stainless steel.

INDUCTION MOTOR (Submersible)

The submersible motor shall be Induction, Squirrel Cage, and Dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in liquid immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following ele. Supply conditions:

(i) Variation of supply voltage from rated motor voltage	+/- 10% (
ii) Variation of supply frequency from rated frequency	+/- 5%
(iii) Combined voltage and frequency Variation	+/- 10%

Degree of protection of motor shall be IP 68. The power rating of the motor shall be min. 110% of power required by the rated impeller on its entire performance range.

The starting current of motor shall not exceed 200% of rated full load current for star/delta starting under any circumstances. Motor shall be suitable for full voltage & star-delta starting. Motor shall be capable of starting and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit 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 standards.

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

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS 8783-1978 for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 (part-VII): 1970 for dry type motors. The corresponding Class of insulation shall be “F” for motor ratings upto 120hp & Class ”H” for larger ratings – however for motors to be operated on VFD’s , only Class “H” insulation is allowed.

The temperature-rise test of the motor may be taken with the pump at the duty point at the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall not exceed 80ºC even for Class “F” or Class “H” insulated motors.

As the cable resistance method, due care is taken to account for the correct hot and cold resistance of windings.

If these pump’s motors are to be used with Variable Speed Frequency drives (VFD’s) then :

- The motor insulation shall be Vacuum Varnish Impregnated instead of Dip Varnishing or Trickle Varnishing with double insulation coating.
- The motor insulation is to be of Class “H” only
- Current insulated bearing/s (preferably NDE) are desired & compulsorily required for motor ratings above 200kW.

Terminal box shall be of IP 68 type construction to eliminate entry of sewage and dust. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

PROTECTION

Protection against increase in stator winding temperature (15 Deg. C) shall be provided. Minimum three number thermostats / bimetallic switches in series shall be provided to sense the stator winding temperature.

Sensors are to be provided to detect if leakage of sewage into the oil housing is above 30% concentration. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The required control unit to process these safety signals & with potential free contact o/p for alarm / trip shall be provided by vendor for suitable interlocking in starter circuit and/or PLC.

SUBMERSIBLE CABLE

A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables. The cable shall be of sufficient length and shall be brought out of the submerged motor without joint to terminate in junction box / control panel, located in LT panel room /outside the wet well.

Power as well as Control Cables shall be of Dual Sheathed EPRS / PVC Armored type with required no. of Copper Core, round type and of required size as per design requirement.

The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5/4.0 core round type. The size of the conductor shall be adequate for continuous use under water and air. Cable half/full core as per design to be used for earthing. The size of the conductor and length of cable shall be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

The control cable shall be PVC insulated PVC sheathed, flexible, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor (Thermostats/ bimetallic switches) of 3 core X 1.5/2.5 sq.mm copper conductor and for bimetallic thermal switch with 2 core X 1.5/2.5 sq.mm copper conductor shall be provided or as required as per design. Similarly control cable for level sensor shall be 2 core X 1.5/2.5 sq.mm copper conductor shall be provided or as required as per design. Accordingly suitable multi core control cable shall be provided with minimum 1 spare core.

Earthing of the motors shall be done in accordance with the relevant provisions of IS:3043-1966 for the purpose of earthing these motors, earthing connection may be made to discharge pipe.

C. MATERIAL OF CONSTRUCTION

The specific requirement shall be considered as under:

Casing, Casing Cover	CI IS210 Gr FG 260 with 2 % Ni
Casing wear ring/wear plate	CI IS210 Gr FG 260 with 2 % Ni Oil
chamber (if forming a part of Casing)	CI IS210 Gr FG 260 with 2 % Ni
Oil Chamber/Motor casing	CI IS210 Gr FG 260
Shaft	AISI 410
Shaft sleeve (if Provided)	AISI 316
Impeller / Impeller Nut	CF 8 M

Shaft Seal	Mechanical Seal
Auto Coupling Unit	CI
Min. Permissible solid Size	80 mm size
Motor Cooling	By surrounding sewage
Motor Rotor	Aluminum Die cast
Guide rail pipe	SS 304 Heavy duty of suitable length SS
304 Lifting Chain	Min. equivalent to sump depth + 5 m Cable
length	25 m min.

D. NAME PLATE

Each pump shall be provided with a stainless steel name plate indicating the following details.

- Model
- Manufacturer's special number
- Rated capacity in LPS / M^3/HR
- Total head in MWC
- Speed in RPM
- Motor Rating.
- Weight of equipment
- Material of impeller

1.2 HORIZONTAL NON CLOG CENTRIFUGAL PUMP

A. GENERAL

The Pump shall be Centrifugal, Horizontal shaft, Non Clog, end suction, back pull out, designed and manufactured for pumping contaminated liquid containing suspended solids, like sewage / effluent. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts and all other required accessories.

The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continuously rising head characteristic with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15% of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameter shall not be accepted.**

The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSH) is less than available NPSH to ensure pumps' operation without cavitations under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 m and 0.5 m, less than the available NPSH respectively at the lowest water level in the sump.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitations or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 4.5 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.0 m.

The power rating of motors to drive pumps shall be suitable to meet maximum requirement of power for the rated impeller throughout its' performance range and including reserve power margin as specified elsewhere in the tender.

B. FEATURES OF CONSTRUCTION

PUMP

Pump shall be horizontal shaft centrifugal, single stage, Non Clog, End Suction, back pull out type suitable for dry-pit installation with wear rings / wear plates. The pump shall have side suction and top/side discharge nozzle. The maximum speed of pump shall be 1500 RPM.

CASING

Pump casing shall be of robust construction self venting type with central/side delivery. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings / wear plates. Casing drain connection with collard plug shall be provided at lowest part of casing. Tapping shall be provided at side center of suction and discharge nozzles for pressure gauge connection.

Casing shall have inspection hole with cover so as to facilitate removal of clogged material from impeller vanes without dismantling the whole pump.

IMPELLER

Impeller shall be enclosed/semi-open, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two / three vanes max. and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt & ash. Hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. Impeller shall have suitable features to balance the resulting axial thrust during operation.

Pump having semi open impeller shall be provided with suitable wear plate fixed in casing with adjusting bolts & nuts.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helical insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

SHAFT SLEEVE

Replaceable shaft sleeve shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber 'O' ring or CAF / Teflon gaskets shall be provided between impeller and shaft sleeve to prevent liquid passage between shaft and sleeve. In no case shaft shall be in contact with liquid. The surface hardness of the shaft sleeve shall be minimum 250 BHN.

STUFFING BOX

Pump shall be provided with **stuffing box arrangement as mentioned in specific requirement** for shaft sealing.

Pump required with gland packed Stuffing box shall be of such design that it can be repacked without removal of any part other than gland and lantern ring. Stuffing box drain with pipe connection shall be provided at the lowest point so that no leakage accumulates in it. Lantern ring shall be sandwiched between packing and shall be easily removable. Lantern ring shall be axially split type and shall be sealed with self liquid being pumped or as recommended by manufacturer. Necessary pipe connections and piping for this shall be provided by pump manufacturer. Gland shall be of split type. Gland bolts and nuts shall be of SS.

Pumps required with Mechanical Seals shall be provided with necessary piping for cooling, flushing and lubrication of seal faces as recommended by seal manufacturer. Seal shall be designed and selected for the specified application in order to perform the equipment trouble free and working life not less than 20,000 hours of operation. Seals shall be covered with SS 304 mechanical seal cover and shall be tightened with SS fasteners as per the specifications.

Pumps shall be supplied with Rubber liquid deflector to prevent liquid entry to bearings, in case of failure of mechanical seal / leakage through stuffing box.

BEARING HOUSING

The Bearing housing shall hold DE/NDE bearings firmly and shall support complete rotating assembly of the pump. It will be designed to provide sufficient span to support rotating assembly so as to reduce the vibration and deflection of rotating assembly. The bearing shall be hold in position with necessary fixing arrangement to ensure no axial movement. Bearings shall be covered by bearing covers. Bearing housing shall have suitable arrangement to feed grease to bearings for lubrication. Grease hole shall be plugged to prevent entry of harmful foreign materials.

BEARINGS

Pump shall be supplied with anti friction grease lubricated bearings. The rotating assembly of pump shall rest on minimum two bearings located at DE / NDE for smooth operation. Bearings shall be

easily accessible for inspection and maintenance. Bearings shall be of SKF / FAG make only.

COUPLING

The pump shall be coupled with electric motor mounted on a common base plate. The coupling shall be spacer type flexible jaw coupling with spacer of suitable length (as recommended by pump manufacturer) of KTR / Rathi / Fenner make only. Coupling shall be statically and dynamically balanced at rated speed.

COUPLING GUARD

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Coupling guard design shall be such that coupling is covered from both the sides as well apart from top cover. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and SS fasteners.

BASE PLATE

The pumping unit shall be provided with a common drain rim type base plate with 25mm dia. drain pipe , terminated to nearest drain pit/trench. The base plate shall be of sufficient size and rigid sufficient to maintain the pump and motor in proper alignment and position. Base plate shall be supplied by pump manufacturer only. The base plate shall be grouted on the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

C. MATERIAL OF CONSTRUCTION

The specific requirement shall be considered as under:

Casing/Casing Cover/Stuffing Box housing	CI IS210 Gr FG 260 with 2 % Ni
Shaft	AISI 410
Shaft sleeve	AISI 410
Impeller	SS Gr. CF 8M
Casing wear ring/Wear plate	CF8
Shaft Sealing	Gland Packed Base Plate
(Drain Rim type)	CI Epoxy Coated Min.
Size of Solid handling (Min.)	80 mm

D. NAME PLATE

Each pump shall be provided with a stainless steel name plate indicating the following details.

- Model
- Manufacturer's special number
- Rated capacity in LPS / M^3/HR
- Total head in MWC
- Speed in RPM
- Material of impeller

1.3 VERTICAL NON CLOG CENTRIFUGAL PUMP

A. GENERAL

The Pump shall be Centrifugal, Vertical shaft, Non Clog, end suction, back pull out, designed and manufactured for pumping contaminated liquid containing suspended solids, like sewage / effluent. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts and all other required accessories.

The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continuously rising head characteristic with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15% of BEP flow on either side meeting NPSH requirement. **Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.**

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. **The pump selected for rated performance below minimum Impeller diameter shall not be accepted.**

The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSH) is less than available NPSH to ensure pumps' operation without cavitations under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 m and 0.5 m, less than the available NPSH respectively at the lowest water level in the sump.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitations or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts & assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 4.5 mm/sec. Noise level shall be limited to 85 dBA at a distance of 1.0 m.

The power rating of motors to drive pumps shall be suitable to meet maximum requirement of power for the rated impeller throughout its' performance range and including reserve power margin as specified elsewhere in the tender.

B. FEATURES OF CONSTRUCTION PUMP

Pump shall be vertical shaft centrifugal, single stage, Non Clog, End Suction, back pull out type

suitable for dry-pit installation with wear rings / wear plates. The pump shall have side suction and top/side discharge nozzle. The maximum speed of pump shall be 1500 RPM.

CASING

Pump casing shall be of robust construction self venting type with central/side delivery. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings / wear plates. Casing drain connection with collard plug shall be provided at lowest part of casing. Tapping shall be provided at side center of suction and discharge nozzles for pressure gauge connection.

Casing shall have inspection hole with cover so as to facilitate removal of clogged material from impeller vanes without dismantling the whole pump.

IMPELLER

Impeller shall be enclosed/semi-open, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two / three vanes max. and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt & ash. Hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration. Impeller shall have suitable features to balance the resulting axial thrust during operation.

Pump having semi open impeller shall be provided with suitable wear plate fixed in casing with adjusting bolts & nuts.

IMPELLER NUT

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helical insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

SHAFT SLEEVE

Replaceable shaft sleeve shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber 'O' ring or CAF / Teflon gaskets shall be provided between impeller and shaft sleeve to prevent liquid passage between shaft and sleeve. In no case shaft shall be in contact with liquid. The surface hardness of the shaft sleeve shall be minimum 250 BHN.

STUFFING BOX

Pump shall be provided with **stuffing box arrangement as mentioned in specific requirement** for shaft sealing.

Pump required with gland packed Stuffing box shall be of such design that it can be repacked without removal of any part other than gland and lantern ring. Stuffing box drain with pipe connection shall be

provided at the lowest point so that no leakage accumulates in it. Lantern ring shall be sandwiched between packing and shall be easily removable. Lantern ring shall be axially split type and shall be sealed with self liquid being pumped or as recommended by manufacturer. Necessary pipe connections and piping for this shall be provided by pump manufacturer. Gland shall be of split type. Gland bolts and nuts shall be of SS.

Pumps required with Mechanical Seals shall be provided with necessary piping for cooling, flushing and lubrication of seal faces as recommended by seal manufacturer. Seal shall be designed and selected for the specified application in order to perform the equipment trouble free and working life not less than 20,000 hours of operation. Seals shall be covered with SS 304 mechanical seal cover and shall be tightened with SS fasteners as per the specifications.

Pumps shall be supplied with Rubber liquid deflector to prevent liquid entry to bearings, in case of failure of mechanical seal / leakage through stuffing box.

BEARING HOUSING

The Bearing housing shall hold DE/NDE bearings firmly and shall support complete rotating assembly of the pump. It will be designed to provide sufficient span to support rotating assembly so as to reduce the vibration and deflection of rotating assembly. The bearing shall be hold in position with necessary fixing arrangement to ensure no axial movement. Bearings shall be covered by bearing covers. Bearing housing shall have suitable arrangement to feed grease to bearings for lubrication. Grease hole shall be plugged to prevent entry of harmful foreign materials.

BEARINGS

Pump shall be supplied with anti friction grease lubricated bearings. The rotating assembly of pump shall rest on minimum two bearings located at DE / NDE for smooth operation. Bearings shall be easily accessible for inspection and maintenance. Bearings shall be of SKF / FAG make only.

COUPLING

The pump shall be coupled with electric motor mounted on a common base plate. The coupling shall be spacer type flexible jaw coupling with spacer of suitable length (as recommended by pump manufacturer) of KTR / Rathi / Fenner make only. Coupling shall be statically and dynamically balanced at rated speed.

COUPLING GUARD

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Coupling guard design shall be such that coupling is covered from both the sides as well apart from top cover. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and SS fasteners.

BASE PLATE

The pumping unit shall be provided with a common drain rim type base plate with 25mm dia. drain pipe , terminated to nearest drain pit/trench. The base plate shall be of sufficient size and rigid sufficient to maintain the pump and motor in proper alignment and position. Base plate shall be supplied by pump manufacturer only. The base plate shall be grouted on the RCC foundation with the

help of "J" type foundation bolts of manufacturer's recommended / approved size.

C. MATERIAL OF CONSTRUCTION

The specific requirement shall be considered as under:

Casing/Casing Cover/Stuffing Box	CI IS210 Gr FG 260 with 2 % Ni housing
Shaft	AISI 410
Shaft sleeve	AISI 410
Impeller	SS Gr. CF 8M
Casing wear ring/Wear plate	CF8
Shaft Sealing	Gland Packed Base Plate
(Drain Rim type)	CI Epoxy Coated Min.
Size of Solid handling (Min.)	80 mm

D. NAME PLATE

Each pump shall be provided with a stainless steel name plate indicating the following details.

- Model
- Manufacturer's special number
- Rated capacity in LPS / M^3/HR
- Total head in MWC
- Speed in RPM
- Material of impeller

1.4 SUBMERSIBLE DREDGING PUMP WITH ALL ACCESSORIES

The submersible dredging pump set shall be of solid shaft motor above the pump. It shall be of mono block construction such that the impeller is mounted directly onto the extended motor shaft & the agitator is coupled onto this shaft (below the impeller allowing for suction clearance). The extended shaft coupled agitator allows for continuous use on heavy concentrations of solids up to 60 % by weight. Complete unit shall include supply, installation, testing & commissioning of accessories of high quality & required capacity like control panel board, submersible round copper power & control cables, delivery pipe & required miscellaneous items.

A) Pump Design

Since intake well have large amount of solids (plastics, contraceptives, jute, cotton waste etc.) the impeller shall be of vortex type only. Enclosed impellers & single / double bladed impellers (which can choke up in stringy fibrous waste) are not allowed.

Due to high content of silt & the associated abrasive wear the pump design should be of wear resistant type & hence no wearing / supporting parts (wearing rings, impeller support bushes / rings, soft metal parts) are allowed in the pump end. The wearing plates (suction cover & the back wear plate) should be of hardened SS only. Cast Iron material is not allowed.

B) Agitator

The pump shall be equipped with an agitator external to the casing and below the strainer which shall be directly connected to the common pump and motor shaft.

The purpose of the agitator is to churn up settled solids which are then sucked / picked up by the impeller thereby increasing the concentration of slurry entering & discharged by the pump.

The mounting design of the agitator (& the pump impeller) should be fool proofed to prevent it from unscrewing (in case of accidental reverse rotation say by supply mains phase reversal or other cases). Hence there should be a central locking bolt (or any other suitable device) which ensures that in case of accidental reverse running the agitator does not unscrew & fall down in the pit.

The agitator must have the following characteristics:

It shall be comprised of a central supporting member housing the central locking bolt.

It shall have a plurality of vanes attached along their inner edges to the main hub and extend from there for a substantially uniform distance throughout their lengths.

Speed of pump set shall be 1450 / 2900 rpm as indicated in Table A

C) Motor

The motor shall be a heavy duty submersible design with reserve service factor (in built) of at least 1.25 unless specified otherwise in price bid and / or data sheet.

Rating of motor shall be such that even if the liquid specific gravity goes up to 1.5 (due to silt clogging) the motor shall still not be overloaded.

Under no circumstances should its rating be below recommendation given in **Table A** - such a high service factor & margin is required to assure motor from non overloading & a stall free starting even in the event of heavy concentrations of sand pumping. Standard Dry motors (for submersible pumps for water / sewage / non clog pumps) shall not be considered as equivalent.

It shall be supplied with factory fitted power & control cables. For length of cable please refer **Table A.** It shall be of dry type (air filled) fully submersible, oil filled motor only. PVC wound motor shall not be considered as equivalent. The windings shall be of Class "H" insulation (capable of withstanding up to 185^0 C maximum winding hot spot temp) as the motor is expected to be buried under silt.

The motor shall have a high starting torque.

Motor bearings shall be grease lubricated with EP type high temperature & long life grease requiring no maintenance for 40,000 working hours.

Motor cooling shall be by submergence in water @ intake well.

The motor construction shall be suitable for easy disassembly and reassembly. Hence both the bearing end shields / brackets should be removable from the stator body (like TEFC motors) to facilitate rewinding.

D) Shaft and bearing design

The solid oversized shaft shall be preferably of Stainless Steel 410 only.

It shall be supported by heavy duty ball / roller bearings with an L_{10} life of more than 40,000 hours.

The motor side bearings are lubricated for life by super premium quality lifelong grease of high temperature & EP grade.

E) Sealing

The motor is sealed off from the pump pressure by two separate mechanical seals. Use of Lip seals is not allowed.

The mechanical seals should be bi directional & mounted in Tandem mode only. The main seal (in contact with water) is of Solid Silicon Carbide faces (shrink fitted Silicon Carbide in SS carrier OR Tungsten Carbide is not allowed).

Back to back modes (which open up at higher pressures) are also not allowable.

Conical springs for these seals (since they are unidirectional) are also not allowable.

To facilitate maintenance & prevent seal breakage the design of the oil chamber & the location of the primary seal should be such that the seal can be removed without the dismantling of the oil chamber.

General recommendations for submersible dredging pump set for cleaning jack or intake well

Table A

Nominal Head (Meter)	≤ 30	≥ 50
Maximum speed of pump set (rpm)	1450	2900
Material of Construction	Refer **Table B**	
Motor Rating (HP)	Min. 30	Min. 30
DN Size (mm)	≥ 65	≥ 65

Flexible Rubber Canvas Fire Hose Pipe (mm)	≥ 65	≥ 65
Cable Length (Meter)	≥ 40	≥ 40
Orientation of Pump Set	Vertical	

Table B

Materials of construction for submersible dredging pump for cleaning jack / intake well.

Materials of Construction		
Pump Casing, Impeller, Agitator, Suction Cover & Back Wear Plate		Hardened Cast Martensitic Stainless Steel (**CA 15**)
Motor Casing, Oil Chamber & other parts		C I grade 260 as per IS:210-1962
Pump Motor Shaft & Agitator shaft		Stainless Steel (SS 410)
Mech anical Seals	Faces	Primary (Inboard): Silicon Carbide v/s Silicon Carbide (solid rings without shrink fitting)
		Secondary (Outboard): Carbon v/s Cast Chrome Molybdenum Steel
	Elastom ers	All "O" rings of Viton only & Bellows of either Viton or Nitrile
Fasteners		Stainless Steel (SS 304)
Portable Stand (Skirt Base)		M. S. fabricated (CI not allowed due to cracking tendency)
Suction Strainer		SS 304
Power & Control Cable		Dual Sheathed PVC round submersible copper cable

1.5 SUBMERSIBLE DEWATERING PUMPS

Dewatering pumps shall be of the semi open / open-impeller type, vertically-mounted and close coupled to their fully submersible electric motors.

Dewatering pumps shall be supplied along with starter comprising of SFU / MCCB as isolator and required Thermal Over Load Relay, contactor etc. as per Type 2 co-ordination, winding protection relay, moisture controller relay, single phasing preventer etc. motor protection control. Starter panel shall be installed near the pump. Starter panel shall be provided with A/M and/or L/R selector switches as required for manual operation through panel mounted on/off push

buttons as well as in auto mode through level switches or other applicable method.

The dewatering pump shall operate in auto mode through Low & High level float switches to be supplied with pump and suitably interlocked with control circuit for turning ON the pump at high level and turning OFF the pump at low level. High- High level float switch shall also be provided along with pump for necessary alarm at control panel. Necessary junction box and cables in required length from level switch up to junction box and from junction box to starter panel & control panel, as applicable, shall be included in the scope of supply of this item.

Dewatering pump shall also be suitably provided with LCS to START / STOP from operating platform simultaneously along with ON / OFF operation from starter panel located near the pump in manual mode. The pump shall operate through level switches only when selected in auto mode at starter panel.

Pumps shall be supplied with all necessary pipe work to discharge to surface drainage. Each pump shall be provided with delivery reflux and isolating valves, and suitable lifting gear for lowering and lifting the pump from the sump in case of fix installation .

Pumps weighing 40 KG or more shall be lowered in to the sump on guide rails and be located to their respective discharge pipe work with an angle flange connection and self-locating clamps.

Pump impellers shall be designed to pass solids of the sizes which pass through the inlet ports of the pump and shall be capable of pumping solids of up to 25 mm diameter.

Material of Construction		
Impeller		CI, IS 210 GR FG 260
Casing		CI, IS 210 GR FG 260
Shaft		SS410

2.0 VALVES:

GENERAL

Valves shall be as per relevant IS or internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS 6392 or BS 4504. Flange drilling should confirm to IS 1538, Table-IV & VI.

Valves shall be double flanged type and the faces shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the bolt head and nut.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

The valve stem, thrust washers, screws, nuts and all other components exposed to the sewage shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

Valves shall have pressure rating min. PN 1.6 in general.

The Contractor shall provide Operating platform for easy open / close operation of valves wherever the valves hand wheel is higher than 1.25 m above floor level.

2.1 SLUICE VALVE:

A. GENERAL:

Ductile Iron Sluice Valves shall be manufactured strictly in accordance with and conforming to Indian standard specification IS : 14846 – 2000 or its latest amendment.

The valves are intended to be used in vertical / horizontal position. Valve shall be rising / non rising spindle type as specified having pressure rating PN 1.6 in general or higher as required as per application as specified in these specifications and free from sharp projections which are likely to catch and hold stringy materials. Bolts and nuts shall conform to IS 1363: 1967 and IS 4218: 1967. Over all dimension like, face to face distance, height of valve etc shall conform to IS 14846.

B. FEATURES OF CONSTRUCTION:

BODY & BONNET

Body & Bonnet shall be designed so as to withstand the rated test pressure as specified in IS: 14846. Bodies of the valve shall be fitted with seat rings securely fixed in machined recesses by proper engineering practice.

Reasonable clearances shall be provided behind the rear faces of the flanges on body and bonnet to provide free access to use spanners for assembling & dismantling. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Valves shall have Gun metal/SS 304 drain plug of required size as per IS to facilitate drain of trapped water from the valve body.

FLANGES

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS 1538, Table IV & VI. The rear side of the flanges shall be machined or shall have spot face to provide proper tightening of Nut & Bolts.

STUFFING BOX

The gland and stuffing box which come in contact with spindle shall be provided with bushing of minimum 3 mm thickness and of material as specified in IS-14846 or specified in specific requirement of this specification as anti frictional device. The minimum inside dimensions of the

stuffing box shall be in accordance with IS 14846.

Valve shall be provided with back seat bush to facilitate repacking of valves in pressurized condition without disturbing the pump operation.

WEDGES

The Valves shall be with equal tapered solid DI wedge made in one piece. Valves shall have perfect machined and pressed Wedge seat rings securely fixed in to machined recesses. The wedge seat ring shall ride high on the body seat ring to allow for wear, when shut. The minimum wear travel shall be 25 % of the face width of the seat rings as specified in IS.

SEAT RINGS

The dimensions of the body seat rings and wedge seat rings shall conform to IS 14846. The wedge seat rings & body seat rings shall be securely riveted over and above sufficient hydraulic press fittings.

GUIDES & LUGS

All valves shall be provided with the guides and lugs to guide the wedge through its full travel in body. The channel and shoe arrangement shall be secured by non – protruding rigid rivets of non ferrous metals. The clearance between lugs and guides for different sizes of sluice valves shall be as specified in IS 14846.

STEM & WEDGE NUT

Valve Stem shall have a machine cut, single start trapezoidal threads of such length that the wedge can be raised to a position so as to ensure full flow passage through the valve's bore. In fully closed position of the valve the stem shall remain in full contact with wedge nut for its entire length with at least 10 mm projection. The length of the stem particularly below the collar shall be kept accordingly. The dimensions of stem and wedge nut shall be in accordance with IS : 14846.

The stem of valve shall be so screwed as to close the valves when the cap, hand wheel or crank handle is rotated in clockwise direction. The direction of closing shall be marked on the Cap / hand wheel.

Wherever extended spindle is provided, the valve shall also be provided with suitable headstock.

Rising Spindle Sluice Valve shall be with the Yoke and Yoke Sleeve (Spindle Nut) placed in the Yoke, in such a way that the axial movement of the Yoke Sleeve is avoided in the yoke along direction of spindle axis and but it cannot rotate. Integrally formed end of the Spindle shall be locked in Wedge and Rotation of the yoke sleeve shall Open / Close the wedge responding to direction of rotation. The design shall offer minimum operating torque to operate the valve.

The ball type thrust bearing may be provided above and below the collar of the yoke sleeve to minimize the operating torque as per manufacturer design. The spindle threads shall be engaged in

the operator drive sleeve for the rising spindle sluice valve offered with gear box and / or electric actuator.

GEARS

Gears shall be of suitable design (IS 2535: 1978) and workmanship, so as to ensure satisfactory working of sluice valve.

ACCESSORIES:

1. Valves above 300 mm size shall be provided with Repacking arrangement as per IS 14846.
2. The Valves 600 mm & above size shall have channel and shoe arrangement as per IS 14846.
3. The Valves above 500 mm size shall have by pass arrangement as per IS 14846.
4. The Valves 350 mm size & above shall have spur / bevel gear arrangement as per IS 14846.
5. All Valves shall have valve's OPEN / CLOSE indicator arrangement as per IS 14846.
6. Valves above 300 mm size shall be provided with Position Indicator indicating extent of opening / closing of gate/wedge.

C. MARKING:

The following information shall be embossed on each valve body:

- ISI Certification Mark.
- The manufacturer's name or Trade Mark.
- Pressure Rating of valve.
- The size of valve in mm.
- Heat number of cast.

2.2 SWING CHECK NON RETURN VALVES

A. GENERAL

Ductile Iron double flanged non return valves shall be manufactured as per IS 5312 or its latest amendment for pressure rating PN 1.6 in general or higher as required per application. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials.

The dimensions and shape of the body, door, cover etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve.

The design of the hinges, hinge pin, door, door suspension, etc shall ensure free swinging of the door. The door face shall have close face contact with the body ring in close position. Valves shall be designed for horizontal and vertical mounting position. The minimum thickness of metal for body, door & cover shall be as per directives given in the IS 5312 and shall be maintained throughout any section uniform to avoid strain s set up by sudden change s in cross section.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever / damping arrangement.

B. FEATURES OF CONSTRUCTION

BODY & COVER:

Valve body shall be double flanged. Body of the valve shall be fitted with seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut. Each reflux valve shall carry an embossed ARROW to indicate the direction of flow.
The internal parts shall be easily accessible for inspection through inspection hole just by removing cover

Valves shall have Gun metal/SS 304 drain plug of required size as per IS to facilitate drain of trapped water from the valve body.

FLANGES:

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS 1538, Table IV & VI. The rear side of the flanges shall be machined or shall have spot face to provide proper tightening of Nut & Bolts..

BODY RING:

The inside diameter of the body seat ring shall not be less than the nominal bore of the valves and not more than it by 1.5 mm. The face of the body seat rings shall protrude
clear of the surrounding not less than by 1.5 mm. Body seat ring shall be secure riveted over and above sufficient hydraulic press fittings. Seat rings shall be renewable.

DOORS & HINGES:

Doors and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Door shall be securely bolted to the hinge/s and whole assembly shall be fitted with the help of hinge pin and bushes in the body to keep it in swing position.

ACCESSORIES:

1. Valves above 300 mm size shall be provided with by-pass arrangement as per IS 5312
2. Valves above 300 mm size shall be provided with drain plugs as per IS 5312.

C. MARKING:

The following information shall be embossed on each valve body:

- The manufacturer's name or Trade Mark.

- Pressure Rating of valve.
- The size of valve in mm.
- Direction of the flow
- Heat number of cast.

2.3 BALL TYPE NON RETURN VALVE

A. GENERAL

Supply, erection, testing and commissioning of the S.G.Iron/D.I./ Cast Steel WCB Grade double flanged heavy duty Ball type Non Return Valve having following material of construction. N. R.V. shall be suitable for 16 Kg. /sq. cm. working pressure.

B. FEATURES OF CONSTRUCTION

Body	:	S.G.Iron/"D.I.Grade 400/12"/Cast Steel WCB Grade Suitable for 16 kg./sq.cm pressure.
Cover	:	Suitable to Body M.O.C.
Ball	:	Nitrile reinforced
Cover ring	:	Nitrile Rubber
Ball seat ring	:	L.T. Bronze.
Fasteners	:	Stainless Steel (SS-304)

Contractor should design the Ball type Non Return Valve as per site requirement. Contractor should consider total vertical lifting in this system and design the N.R.V. such that in any case there should be no abnormal slamming during sudden closing operation of N.R.V.

Tests should be carried out as per relevant I.S.

Contractor should have to supply 01 Nos. extra Ball for each of the NRV supplied without any extra cost.

Ball type Non Return Valve must be supported with R.C.C. Block

The body seat rings shall be hydraulically press fitted as well as riveted.

Tests should be carried out at mfg. site as per approved QAP & relevant I.S.

C. DESIGN REQUIREMENTS FOR NON RETURN VALVES:

- The Ball type non-return valves shall be provided with soft seating and designed for minimum head loss. The valve shall be mounted horizontally.
- Hydraulic passage shall be designed to avoid cavitations.
- It should be without bypass arrangement but rated for PN 1.0 class and confirming to IS 5312:1986 or latest standards.
- The net head loss across the Ball type reflux valve at pumps rated flow must be clearly specified.

D. MARKING:

The following information shall be embossed on each valve body:

- The manufacturer's name or Trade Mark.
- Pressure Rating of valve.
- The size of valve in mm.
- Direction of the flow
- Heat number of cast.

3.0 DI / CI / MS / GI PIPES & FITTINGS

DI PIPES, FITTING & SPECIALS:

DI Pipes shall be manufactured as per IS 9523-2000 with latest amendments. The scope shall include manufacture, testing and supply of DI Pipes and Fittings.

The double flanged pipes shall be with integral flanges and of appropriate class rating of pipes. The flanges shall be drilled to IS 1538, T-4 & 6 as a standard unless specified.

DI fittings / specials shall be confirming to IS 8329/2001 with latest amendments.

The fitting shall be stripped with all the precautions necessary to avoid warping or shrinking defects. The fitting shall be free from defects other than any unavoidable surface imperfection which results from the method of manufacture and which do not affect the use of the fittings.

The fittings shall be such that they could be cut, drill or machined.

The mass of DI. Pipes, fittings / specials shall strictly conform to relative IS with latest amendments.

CI PIPES AND SPECIALS / FITTINGS

The scope includes manufacture, delivery at site, storage at site, installation, testing and commissioning of double flanged cast iron pipe with fittings, flanges, nuts, bolts and gaskets at suction, delivery & header pipe.

This specification gives the general requirement of pipes/fittings. However, **it is the responsibility of the bidder to take the actual measurement and obtain client's approval prior to the placement of orders** to the main supplier / manufacturer as per site conditions during execution of work.

Quantity shall be verified as per actual site condition. Bidder shall be paid only for installed quantity as per actual measurement at site. In case if pipes/fittings are not used or installed, bidder shall not be paid for the same and bidder shall take back the same without any dispute.

In case of tender quantity is less than the actual, bidder has to arrange for the excess quantities and rate for the same shall be as per original tender rate.

All pipes and fittings shall be flanged.

Pipe work

The pipe works for the plant involves manufacturing, supplying, laying and jointing of suitable size cast iron, ductile iron pipes along with matching special etc as required. All piping / fittings within the pump house shall be of cast iron / ductile iron as specified. The specifications for manufacturing, supplying, laying and jointing of pipes shall generally conform to the standard specification.

All pipe work and fitting shall be of class rating in excess of the maximum pressure attained in service including any surge pressure.

The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipments. C.I. dismantling joints which can take radial and axial misalignment of minimum 1 percent of valve nominal size with tie bolts shall be provided. All pipe work shall be adequately supported with purpose-made fittings. When passing through walls, pipe work shall incorporate a puddle flange. Flange adapters and unions shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment.

The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to Site welding. Before dispatch from the manufacturer's work, the ends of the pipe, branch pipe, etc., shall be suitably be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instrumental and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer-in-Charge.

CAST IRON PIPING:

Providing and supplying lowering, laying to line, level and slope, cast iron pressure pipes (Class B confirming to IS : 1537 / IS : 1536 with latest amendment) and jointing with specials such as Tees, Bends, Reducers including and other safety provision, cutting the pipes and making joints and hydraulic testing after laying etc. comp.

The Cast Iron pipes shall be Class B conforming to IS:1537 / IS:1536 with latest amendments bearing ISI Mark.

The pipes shall be free from the defects resulting from raw materials, loading, handling, carting and unloading. The pipes shall be free from load, bents or bulges greater than 3 mm in depth and extending over a length in any directions greater than twice the thickness of barrel.

Each lot of pipes supplied by the contractor must be accompanied by the test certificates as specified in IS 1537 / 1536 with latest amendments. The contractors shall have to make arrangement for inspection/testing of the pipes at manufacturer's factory at contractor's own risk and cost.

Each pipe shall have cast, stamped or indelibly painted on it the following marks.

a) Manufacturer's name, initials or identification mark.

b) The nominal diameter.

c) Class reference.

d) The last two digits of the year of the manufacture.
e) I.S. Certification mark.

The materials shall be carted to the site by the contractor very carefully. The handling, while carting the pipes, specials, valves etc. shall be done carefully.

In case of heavy pipes, specials etc. lowering shall be done with the help of the chain pulley block.

Caulking:

After a section of convenient length has been leaded, caulking shall be commenced. The lead shall be free from the leading pipe, outside of the socket of the other pipe with flat chisel, and then caulked round 3 separate times with the proper caulking tools of increasing thickness and hammer 4 to 5 lbs. in weight in such manner as to make the joints sound and water tight.

Joints under water shall be made with lead wool inserted in strings not less than 6 mm thick and very thoroughly caulked.

New Flanged Joints:

Flanged joints should be made by painting the facing of the flanges with red lead freesly and belting up evenly on all sides.

A thin fibre, of lead wool may be very useful in making the joints water tight, where facing of the pipes is not true.

Where packing must be used, it should be of rubber insert cloth three ply and of approved thickness. The packing should be of the full diameter of the flange with proper pipe hole and bolt holes cut and even at both inner and outer edges.

Where the flange is not fully faced, the packing may be of the dimension of the facing strip only. Its proper placing should be tested before another pipe is jointed on.

Testing:

After each section of the pipe line has been completed, it shall be tested for water tightness before being covered in. This can be done by closing each end by means of a reliable guage. When the pipe is laid on any appreciable gradient, the test should be carried out at the lower end of the section. Any leaking joints should be made good, and the above test reapplied until no further leaks are apparent.

Tyton Joints:

After the pipes are examined for line and levels, the C.I pipes shall be jointed with rubber gaskets (tyton joints) as follows:

The socket and spigot end shall be cleaned with kerosene oil, then grease has to be applied to the spigot and socket ends, duly after inspection of rubber gasket. Then the rubber gasket shall be jacked and fixed in perfect condition such that the gasket will fall in groove correctly and the joint become water tight.

Tyton / Lead jointing shall be carried out after the C.I. pipes and specials are properly laid and approved by the Engineer-in-charge.

The lead shall be more than 99%. It shall be soft bluish grey pig lead free from admixtures of tin or other impurities. The lead shall confirm to the Indian Standard 3114/1965.

The spun yarn shall be clean hemp and soaked in hot tar or bitumen, cooled and dried before use.

The outside of the spigot and the inside of the socket shall be thoroughly cleaned with a brush. The spigot shall be carefully centered in the socket by spun yarn twisted into ropes of uniform thickness. The rope shall be well caulked in to the back of the socket to leave a sufficient depth for lead as directed by Engineer-in-charge. The lead shall be used as specified in Table-1 of Indian Standard 3114/1965.

The proper depth of each joints shall be as specified and tested before running the lead by passing completely around it a wooden gauge notched out to the correct depth of lead.

The leading of joints shall be done by means of ropes covered with clay or a by using special leading rings. The lead shall be melted rendering it thoroughly fluid and each joints shall be filled in one pouring.

After a section of convenient length has been leading pipe outside of the socket of the other pipe, with a flat chisel and then caulked round three separate time with the proper caulking tools of increasing thickness and hammer 2 to 3 kg. weight in such a manner as to make the joints sound shall be left flush neat and even with the socket.

The item includes all materials tools, tackles etc. required to carry out the work including fire wood etc.

After each section of the pipe line has been completed it shall be tested for water tightness. The ends shall be suitably closed with a valve, cap or plug or a blank flange. The pipe line shall then be filled with water, pressure shall then be supplied with a hand force pump up to 7 kg./sq.cm. (above 100 lbs/sq.inch.) or 15% above. If the pipe is laid on an appreciable gradient, the test shall be carried out at the upper end of the section.

Any leaking joints shall be made good and the test repeated until a perfectly leak proof pipe line obtained.

Consumption of lead for jointing of pipe lines:

The purity of lead must be more than 99% and the contractor shall have to furnish the test certificate and get approval from Engineer-in-charge. The consumption of lead and the depth of jointing shall be as per table listed below:

Sr. No.	**Size of pipe line for joint**	**Consumption of lead in kgs.**	**Depth of lead joint in cm.**
1.	80 mm	1.86	5.00
2.	150 mm	3.62	6.00
3.	200 mm	5.00	6.00
4.	250 mm	6.12	7.75
5.	300 mm	7.70	8.00
6.	350 mm	10.45	8.12
7.	400 mm	11.20	8.25
8.	450 mm	14.30	8.40

9.	500 mm	16.25	8.50
10	600 mm	19.00	9.15
11	700 mm	21.00	10.00
12	800 mm	31.50	10.50
13	900 mm	41.00	10.50

HYDRAULIC TEST:

It shall be incumbent upon the contractor to give a successful hydraulic test of each and every pipe line before filling of the trench. The test shall be carried out in the approved manner by an approved testing machine and pressure gauge to be supplied by the contractor. All the arrangements for such test shall be made by the contractor at his cost including filling the pipe with water etc. and giving a successful hydraulic test.

Testing of the pipe line in the field shall be carried out after the completion of whole length or in parts as directed by Engineer-in-charge. The trenches shall be partially refilled except at the joint before starting the test. In each case, the contractor has to plug the both ends of the section of pipeline to be tested either by providing caps or by sluice valves as per direction of Engineer. No extra payment will be made for providing, fixing and removing caps used for testing purpose. If necessary, both the ends shall be properly anchored by providing 1:3:6 c.c. blocks of required dimensions. Contractors shall provide required number of plug points with ferrules of required diameters to serve as injection points, air relief points etc. No payment shall be made for this work. On the completion of the test these points shall be closed by plugs by the contractors without any extra cost.

Testing will be carried out by the contractors under the guidance of Engineer-in-charge. Contractors shall arrange for required machinery, equipments and technical staff for testing the pipe line. Contractors shall also arrange for labour, other materials and tools required to attend the leakage etc. during the test.

The pipe line shall be subjected for following test:

Leakage Test:

The test shall be conducted after satisfactory completion of the pressure test.

There shall not be any leakage in the pipe or at the joint. A seepage allowance of a 2.5 litres per kilometer per hour per centimeter diameter of the pipe shall be permissible and that quantity will not be considered as leakage. If the retest is delayed for more than 48 hours after any test has proved unsuccessful the Engineer-in-charge, after giving 24 hours notice, shall have every right to get all defects rectified and carry out other necessary works and take hydraulic test/leakage test to the contractor. Any damage done to the pipes, materials, the other labour cost, etc. incurred there under shall be recoverable from the contractor either from his bill or deposit.

The responsibility of the contractor as specified above in case of unsuccessful hydraulic test shall not cease to exist by his pleading that any materials used by him in the pipe line was having cracked or was otherwise defective, as if he has a reason to believe so, he must refuse to accept such materials right at the stores.

If the first test is not found satisfactory, repeated tests will be taken and procedure mentioned above should be followed for testing till a satisfactory test is given. All testing shall be done at the risk of the contractors and they have to attend be done at the risk of the contractors and they have to attend all defects including repairing bursts, leaks at joints, sluice valve ends, caps etc. removing and replacing cracked pipes etc. These unserviceable articles shall be the property of the contractors and they shall arrange to remove the same from the site as directed by the Engineer.

Any portion of the pipe line that does not stand the specified pressure, shall be rectified by the contractor. Who should make his own arrangement for the water required for the testing.

When the section of the pipe line is tested successfully the contractor shall remove the blank flanges, pump out water from the pipes and back fill the portion as per directions of the Engineer.
CI Double Flanged Pipes / Piping within pump house shall be tested for 150 % of maximum system pressure.

The items include all materials and labour required to carry out the work as detailed above.

CAST IRON FITTING & SPECIALS:

Providing and supplying at site of work C.I. fittings/specials confirming to IS 1538/1993 with latest amendments.

The contractor shall have to procure required cast iron specials such as Tees, Bends of required degrees, reducers, collars, caps, plugs, tail pieces, etc. necessary for completion of this item as per site conditions.

The C.I. fittings and specials shall conform to IS 1538/1993 with latest amendments.

The fitting shall be stripped with all the precautions necessary to avoid warping or shrinking defects. The fitting shall be free from defects other than any unavoidable surface imperfection which results from the method of manufacture and which do not affect the use of the fittings.

The fittings shall be such that they could be cut, drill or machine. The mass of C.I. fittings/specials shall strictly conform to IS 1538/1993 with latest amendments.

The contractor shall have to procure the required C.I. fittings or specials as per the site conditions and as per direction of Engineer-in-charge.

MS PIPES AND SPECIALS / FITTINGS MS

PIPES

Provide, fabricate, test, paint, supply and installation of M.S. Pipes of specified ID / OD and wall thickness conforming to IS 3589-1981.

Pipes shall be erected on rollers / saddles / supports as required.

All the pipes shall be supplied by the contractor as per actual measurement at site jointly with client’s representative.

QUALITY OF STEEL:
Pipes shall be fabricated from steel plates conforming to IS 2062.

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.

ORIGINAL CROSS - SECTIONAL AREA OF THE SPECIMEN:
OUTSIDE DIAMETERS:
The outside diameters of the finished pipes shall be as given below:

Nominal size (in mm)	Outside Diameter (in mm)
200	219.1
400	406.4
500	508.0
600	609.6
700	711.2
900	914.4
1000	1024.0
1200	1224.0
1400	1424.0

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

TOLERANCE: OUTSIDE DIAMETER

a) Pipe Body - The tolerance on the pipe body shall be as shown below :

Nominal Size	Tolerance
Up to 500 mm	0.75 Percent
Over 500 mm	1.00 Percent

Note: Measurements may be made by any suitable instrument, such as outside calipers, diameter tapes, micrometers, etc.

b) Pipes Ends - 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
Above 250 mm	+ 2.4 mm -	0.8 mm

c) Thickness - The tolerance on specified wall thickness shall be as follows: Pipe + 10 %

d) 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.

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

THICKNESS OF PIPES:

The pipe shall have minimum specified wall thickness as per mentioned in Table-3.

TABLE - 3
MINIMUM SPECIFIED THICKNESS OF PIPES.

Nominal Size (mm)	Minimum Specified Thickness of pipe mm
Up to 300	4
above 300 to 500	5
above 500 to 600	6
above 600 to 850	7
above 850 to 950	10
above 1000 to 1500	12

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.

Carbon Steel/MS pipe after installation at site with respective joints, piping shall be tested for joint tightness at 150 % of Maximum working / system pressure it is likely to subject to.

SPECIFICATION FOR INSIDE / OUTSIDE COATING:

The pipe internal and external surface shall be coated with Zinc rich epoxy primer and asphaltic

bitumen paint of approved quality. 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 ml. 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 shall 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 Inertol or equivalent shall be applied, when one coat is applied, the date of application of this coat shall 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 inertol 49 W thick or equivalent shall give a film thickness of 3-4 mils.

The painting / coating shall be such that it shall not impart any taste or smell to water.
Only Food Grade paint shall be used for painting pipes intended for drinking water supply.

LAYING OF PIPELINE:

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

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

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

M. S. SPECIALS:

Scope shall include providing, fabricating, testing and installing M. S. Specials suitable to M. S. pipes, valves and other fittings from steel plates. MS Specials shall be confirming to IS 7322 / IS 1538 dimensionally. MS specials and fittings shall be fabricated 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.

FLANGES:

All MS flanges conforming to IS 6392, PN 0.6 and their dimensions of drilling be in accordance with IS- 1538 / IS 6392 suitable for pressure 10 kg/cm2 (specification for M.S. fittings for pressure pipes for water, gas and sewage) or its latest revision. The flanges shall be flat faced with off centre 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.

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.

G.I. PIPES & FITTINGS

All G.I. piping and Fitting shall conform to IS:1239.

The screwed end of all GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead or Teflon before jointing. The joint shall be made by winding a few threads of hemp round the ends of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipe shall be bent/offset to save fittings. The offset in GI pipes shall be made only after the permission of the Engineer-in-charge . If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads confirming to IS
554 to required length .

All fittings shall be malleable galvanised iron approved by the Engineer-in-charge. Fitting in GI line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts and rubber insertion and all other fittings to make a complete job.

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

Flanged or screwed valves shall be installed in locations as directed by engineer-in- charge and/or as shown on the execution drawings after placement of order as per specification for screwed or flanged joints. All completed G.I. lines shall be hydrostatically tested to a test pressure of $5Kg/cm^2g$.

4.0 METALLIC EXPANSION BELLOWS

Expansion bellow shall be designed as per the details furnished in the data sheet and shall be in accordance with the EJMA/ ASME standard.

The bellows shall be metallic corrugated design and shall have double flange. The material for bellow shall be SS 304. Fatigue life expectancy considered for the Expansion Bellows shall be minimum 7000 cycles.

After satisfactory testing of the Bellows, prior to dispatch, all internal and external un- machined ferrous surfaces of the Bellows shall be thoroughly clean, dry and shall be made free from rust and grease before painting.

All exposed machined surfaces 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. The inside coating

shall not contain any constituent soluble in water or any ingredient which could impart any taste or smell to water.

6.0 MONORAIL WITH ELECTRIC CHAIN HOIST AND HOT:

The design, manufacture, inspection and testing of Monorail, Electric chain Hoist and hand/manually operated traveling trolley shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. Electrically operated chain hoist shall confirm to IS 6547-1972 and shall be designed for duty service Class –II. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

IS:6547-1972	: Electric Chain Hoist
IS:2429	: Round steel short link chain
IS:6216	: Short link chain grade 80
IS:8610 / IS 15560	: Points hooks with shank for engineering purposes
IS: 808	: Indian Standard Medium Weight Beam
IS: 210	: Cast Iron castings

Electrically operated chain pulley hoist shall consist of following major components.

(a) Electrically operated Chain Hoist, motor with motor cable, hoisting block and hooks complete.
(b) Limit switch to prevent over hoisting and over lowering. (c) Erection hardware.
(d) Pendent control station suspended from hoist.
(e) Control panel mounted on wall as applicable.

Load chain shall be Grade 80 alloy steel chain as per IS -6216-1982. Chain wheel shall be made from malleable / SG Iron cast confirming to IS 107 / IS 1865 , accurately shaped pockets ensuring smooth operation of load chain.

Chain hoist shall be suitable to Fix with supporting Girder at fix location at the top (for Fixed installation) and bottom hook shall be so designed that it shall be free to swivel in the loaded conditions without twisting the load chain. Hook shall be Forged as per IS 8610 or its latest amendment.

All running shafts and wheels running on fixed axles / pins shall be fitted with antifriction bearings. Necessary provision shall be made for lubrication of all moving parts and bearings. All exposed bearings shall be suitably sealed or shielded.

Electric Chain hoist shall be with limit switch, pendant push button control switch and over load relay.

Electric motor shall be suitable for 415 V , 3 ph. 50 Hz AC electric supply designed for 40 % intermittent duty with high starting torque, TEFC confirming to IS 325.

Hoist shall be designed into two separate independent units, i.e. motor and hoist for easy maintenance.

The load hook shall be swiveling type forged circular shank section and shall be as per IS:15560 with antifriction bearing.

Further, suitable local brake shall be provided as per IS to arrest and sustain loads in all working positions.

The velocity rates, effort on chain required to raise the safe working load and travel and speed shall be within the limit as per IS. Proof load test shall be carried out as per IS:6547.

Cast iron parts, wherever used, shall be of minimum grade 30, IS:210.

Trolley for manual/electric cross travel shall be designed to accommodate a wide range of I-beams and shall be capable of traveling on straight as well as curved monorails with the design being such to maintain uniform distribution of pressure on the flanges.

All gears and pinions shall be of hardened and tempered steel with machine cut teeth in metric modules and shall confirm to relevant Indian standard. Surface hardening of steel is not acceptable.

All running shafts and wheels shall be lifted with ball / roller bearings with a rated life not less than 20 years based on equivalent running time as per IS:3938.

Monorail 'I' beam shall be Indian Standard Medium weight Beams (ISMB) as per IS: 808-1989 (Reaffirmed 1999) for steel beam in case of providing the same.

Clear height of the monorail shall be maintained to handle one equipment over other.
Monorails shall be extended outside the building to handle the equipment to ground level. For monorail/hoist routed inside the buildings, suitable machinery well and removable handrail and grating shall be provided on various floors of buildings, as necessary, to handle the equipment.

7.0 FIX ELECTRICALLY OPERATED CHAIN HOIST:

Electrically operated chain hoist shall confirm to IS 6547-1972 and shall be designed for duty service Class –II.

Electrically operated chain pulley hoist shall consist of following major components.

(f) Electrically operated Chain pulley Hoist, motor with motor cable, hoisting block and hooks complete.
(g) Limit switch to prevent over hoisting and over lowering. (h) Erection hardware.
(i) Pendent control station suspended from hoist. (j) Control panel mounted on wall as applicable.

Load chain shall be Grade 80 alloy steel chain as per IS -6216-1982. Chain wheel shall be made from malleable / SG Iron cast confirming to IS 107 / IS 1865 , accurately shaped pockets ensuring smooth operation of load chain.

Chain Pulley hoist shall be suitable to Fix with supporting Girder at fix location at the top and bottom hook shall be so designed that it shall be free to swivel in the loaded conditions without twisting the load chain. Hook shall be Forged as per IS 8610 or its latest amendment.

All running shafts and wheels running on fixed axles / pins shall be fitted with antifriction bearings. Necessary provision shall be made for lubrication of all moving parts and bearings. All exposed bearings shall be suitably sealed or shielded.

The gears shall be machined cut and shall confirm to relevant Indian standard.

Electric Chain Pulley hoist shall be with limit switch, pendant push button control switch and over load relay.

Electric motor shall be suitable for 415 V , 3 ph. 50 Hz AC electric supply designed for 40 % intermittent duty with high starting torque, TEFC confirming to IS 325.

Hoist shall be designed into two separate independent units, i.e. motor and hoist for easy maintenance.

KEY FEATURES OF VEHICLE

Engine Displacement	3298 cc
Gross Vehicle Weight (GVW)	7450 Kgs
Maximum Power	91bhp @ 2600rpm
Maximum Speed	90 km/h
Axle Configuration	4x2

PERFORMANCE

Engine	E483 Tci CRDI with New Rating
Emission Norms	BS-IV
Engine Cylinders	4
Displacement (cc)	3298
Max Power	91bhp @ 2600rpm
Max Torque	300Nm @ 1600-1800rpm
Transmission	Manual
Clutch	275 mm dia., Single dry plate diaphragm type
Gearbox	5-Speed
Fuel Tank (Litres)	160
Turning Radius (mm)	5200
Max Speed (km/h)	90

DESIGN & BUILD

Body Option	Box Body
Chassis Type	Chassis with Cowl
Cabin Type	Customized Cabin
Axle Configuration	4x2
Tyre	7.50 x 16 -16 PR

Wheelbase (mm)	2815
Overall Length (mm)	5565
Overall Width (mm)	2125
Overall Height (mm)	1820
Ground Clearance (mm)	210
GVW / GCW (Kgs)	7450
Kerb Weight (Kgs)	4260
Payload (Kgs)	3190

SAFETY

Brakes	Hydraulic Brakes
Front Axle	Forged "I" section reverse Elliot type Axle
Front Suspension	Semi elliptical Laminated leaf s PR ings suspension
Rear Axle	Fully floating Banjo type Axle
Rear Suspension	Semi elliptical Laminated leaf s PR ings suspension

10.0 GENERAL REQUIREMENT FOR ALL ABOVE ITEMS:

A. DRAWINGS SUBMISSION:

All drawings/datasheets/tech. catalogues/documents for various piping & mechanical work/items shall be submitted by bidder as under:

(a) In Two sets in hard copy along with technical bid for review/evaluation.
(b) In five sets by successful bidder in hard copy for review & approval including revisions, if any.
(c) In six sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings
(d) In six sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of O&M manual.

In general, the document submission for various items shall be as described below:

CENTRIFUGAL PUMP:

The following drawings shall be submitted by the Bidder for review and approval prior to manufacturing:

1 Preliminary outline dimensional drawing showing the details of pump and motor, Suction, discharge connections and foundation details.
2 Performance curves showing capacity v/s total head, efficiency, NPSH-Required and KW requirements ranging from run out to pump shut off for min., max. and rated impeller dia of offered pump.
3 Typical cross sectional drawing showing internal features of pump, parts and their material.
4. Torque – Speed curve of the pump.
5. Catalogues showing type of construction.

The following documents shall be submitted along with supply of pumps:

1. 3 set of Operation & Maintenance manual.
2. 3 set of Tested Curves and records
3. 3 set of As built drawings / Documents.

SPARES ANR SPECIAL TOOLS

Vendor shall furnish following Lists:

1. The list of mandatory spares required for commissioning.
2. The list of recommended spares for two years normal operation.
3. The list of special tools and tackles required to assemble/dismantle the equipment.

VALVES (SV / NRV / BFV / DPCV/ KGV/AIR VALVE)

The following drawings shall be submitted by the Bidder for review and approval prior to manufacturing:
1. General outline dimensional drawings.
2. Cross sectional drawing showing constructional details with part list with their qty & MOC confirming relevant standards.
3. QAP of the product.
4. Catalogues showing type of construction.

In addition to above following documents shall be furnished for review and approval when valves are required with Electric Actuator for Operation.
1. Actuator Data sheet.
2. G.A. & wiring Drawing
3. Valve Torque Calculations.

The following documents shall be submitted along with supply of Valves:
1. 3 set of Operation & Maintenance manual.
2. 3 set of Test Certificates

EXPANSION BELLOWS

The manufacturer shall submit the following drawings.
- Preliminary outline dimensional drawings.
- Data Sheet

- Typical cross sectional drawing showing constructional details with the complete bill of material, MOC and relevant standards.

EOT/HOT CRANE / CPB / HOT-MONORAIL

The manufacturer shall submit the following drawings in 5 sets (hard copies) for review and approval prior to manufacturing:

- Data Sheet
- Preliminary outline dimensional drawings.
- Wiring Diagram of panel

B. INSPECTION AND TESTING AT MANUFACTURER'S WORKS:

Inspection & testing of mechanical equipments at manufacture works shall be conducted in presence of engineer-in-charge / client's representative OR third party inspection agency appointed by client.

All the charges for third party inspection shall be included under the scope of contractor. Inspection and testing at manufacturers' works' shall be carried out as specified below / applicable IS.

All instrument and equipment required for such tests shall be provided by the Contractor The instruments shall be calibrated and certified by an approved independent testing authority not more than three months prior to the test.

All the tests shall be carried out as per the relevant standard & codes. Brief description of tests to be carried out for various equipments is as follows:

CENTRIFUGAL PUMP:

HYDROSTATIC TEST:

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.
- Unless otherwise stated in Data Sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.

MECHANICAL BALANCING:

- Major rotating components of the pumps like impellers, shaft, shaft sleeve etc., shall be individually statically as well as dynamically balanced at rated speed.
- Necessary test certificates shall be furnished by vendor for purchaser's approval.

PERFORMANCE TESTING:

Pump shall be tested for its full operating range in accordance with the applicable standard and approved data sheet.

Test shall be carried out with minimum NPSH as available at site for rated discharge and maximum discharge. Each pump shall be tested at its rated speed with shop motor for its entire working range.

At least one pump shall be dismantled for internal material and undue rubbing marks verification at the time of inspection in the presence of client's representative.

During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the Data Sheet, and cover its full working range from its closed valve condition to run out condition i.e. when delivery valve is fully opened. Head-flow, Power-flow and efficiency-flow curves shall be drawn based on test readings.
The curves produced shall be used to determine the capacity of pump sets to meet guaranteed performance at site at rated speed.

MATERIAL TEST CERTIFICATE

Material test certificates for the various pumps components shall be furnished for purchaser's review & approval as stated in the Data Sheet.

VISUAL INSPECTION:

Pumps shall be offered for visual inspection by the manufacturer, before dispatch. The components of the pumps shall not be painted before inspection.

WITNESSING OF PERFORMANCE TESTING OF PUMP

Pump Rating	Pump performance Testing to be witnessed for each duty and type (Also see Note below)
upto 15 kW motors	Performance witnessing Not Required. Vendor to submit test certi. For review/approval and dispatch clearance as per Note Given Below prior to dispatch.
> 15 kW upto 75 kW motors	25 % Qty. or min. 1 No whichever is higher per duty / type .
> 75 kW upto 160 kW motors	50 % Qty. or min. 1 No whichever is higher per duty / type .
>160 kW	100 % Qty. to be Witnessed
Note: (1) Manufacturer shall test all the pumps internally and shall provide their Internal test records along with Dynamic balancing, material test certificates for all major parts as per Tender, Hydrostatic test certificate, Dimensional check certificates, etc as per approved QAP & DS of each pump for review, record and dispatch clearance prior to dispatch of material.	

VALVES (SV / NRV / BFV / DPCV/ KGV/ AIR VALVE)

Valves shall be tested at manufacturer works for visual inspection, hydro test, operational test and dimensional check as per relevant standard.

Manufacturer shall offer valves for testing & inspection as per approved QAP and shall furnish all relevant certificates including material test cert. for review and approval.

SLUICE VALVE

Closed End Test of All C.I. sluice valves shall be carried out in presence of Engineer in charge / client's representative at manufacturer works & testing certificates shall be furnished along with each lot of supply.

Valve shall be subjected to hydrostatic tests as described in appendix B of IS: 14846 for 2 minutes duration minimum.

BUTTERLY VALVE

Body & Disc of valve shall be subjected to hydrostatic tests as described in IS 13095-1991 / BS EN 593 for 2 minutes duration minimum.

NRV / DPCV

Valve shall be subjected to hydrostatic body and seat tests at appropriate test pressure specified in applicable standard (i.e. IS-5312 / API 598- Table – 2 & 3) for minimum 2 minutes duration.

AIR VALVE

Valve shall be subjected to hydrostatic tests as specified in IS 14845-2000 for Body test, High pressure orifice seat test and low pressure orifice seat test for minimum 2 minutes duration.

VISUAL INSPECTION:
Valves shall be offered for visual inspection and dimensional check before dispatch. The components of the valves shall not be painted before inspection.

Valve shall be dispatched only after visual inspection and clearing instruction for dispatch.

EXPANSION BELLOWS

Each Bellows shall be subjected to following tests:

- Hydrostatic tightness test for 10 kg /cm2 pressure for 5 minutes duration minimum.
- Compression and expansion test as per data sheet.

VISUAL INSPECTION:
Bellows shall be offered for visual inspection and dimensional check before dispatch. The components of the Bellows shall not be painted before inspection.

WITNESSING OF PERFORMANCE TESTING OF VALVES/EXPANSION BELLOWS

Size of Valves / Expansion Bellows	Performance Testing to be witnessed for each size / rating and type (Also see Note below)
upto 300 mm dia.	Performance witnessing Not Required. Vendor to submit test certi. For review/approval and dispatch clearance as per Note Given Below prior to dispatch.
> 300 mm dia. upto 600	10 % Qty. or min. 1 No. whichever is higher per size /

Note: (1) Manufacturer shall test all the valves/Expansion Bellows internally and shall provide their Internal test records for Hydrostatic test along with material test certificates for all major parts as per Tender, Dimensional check certificates, Actuator internal test records for valve, etc as per approved QAP & DS of valve type/expansion bellows for review, record and dispatch clearance prior to dispatch of material.

EOT/HOT CRANE / CPB / HOIST / HOT-MONORAIL

EOT/HOT Crane/CPB / HOIST / HOT monorail shall be tested for overload tests at 125% of the rated load, speed of lifting and deflection check at manufacturer works. All required test certificates shall be furnished for hook, wire rope, brake. etc. and complete crane/hoist/CPB/monorail.

WITNESSING OF PERFORMANCE TESTING OF EOT/HOT CRANE/ CPB/HOIST/HOT-MONORAIL

Type of Material Handling Equipment	Witnessing for each type & capacity
(Ele./Manual) CPB/HOIST/HOT-monorail/Chain Hoist	Performance witnessing Not equired. Manufacturer shall test all the CPB / Hoist & HOT internally and shall provide their Internal test records along with material test certificates for all major parts as per Tender, Dimensional check certificates, etc as per approved QAP & DS of CPB / Hoist & HOT for review, record and dispatch clearance prior to dispatch of material.
EOT / HOT Crane	100 % EOT / HOT Crane shall be witnessed at manufacturer works for performance test as per approved documents / QAP

CI/DI PIPES &

FITTINGS

CI/DI Pipes and fittings shall be offered for inspection and testing as per applicable standards. Pipes and fittings shall be subjected to Hydrostatic test, Mass/weight check and dimensional

check as per approved QAP & Bill Of Material.

WITNESSING OF PERFORMANCE TESTING OF CI / DI PIPES & FITTINGS:

Size, Class & Type of Pipes / Fittings	Performance Testing to be witnessed for each size / Class and type of pipe & Fittings (Also see Note below)
upto 300 mm dia.	Performance witnessing Not Required.
> 300 mm dia. upto 600 mm dia.	10 % Qty. or min. 1 No whichever is higher per type size / class / length and type.
> 600 mm dia. upto 900 mm dia.	25 % Qty. or min. 1 No whichever is higher per type size / class / length and type.
>900 mm dia.	100 % Qty. to be Witnessed.
Note: (1) Manufacturer shall test all the pipes & Fittings internally and shall provide their Internal test records for Hydrostatic test along with material test certificates, Mass/weight check statement, Dimensional check certificates, etc as per BOM and as per approved QAP for review, record and dispatch clearance. prior to dispatch of material.	

C. PAINTING REQUIREMENT

PUMPS

All pumps shall be provided with following painting specification. Surface preparation : Blast clean to near white metal finish.
Priming : 1 coat of red oxide primer before and after shop testing.
Finish painting : 2 coat of epoxy grey paint, minimum 200 micron DFT inclusive of priming.
Colour Code : RAL 7030 or equivalent IS

SV / NRV / DPCV /AIR VALVE

COATING:
After satisfactory testing of the valves, prior to dispatch, all internal and external un- machined ferrous surfaces of the valves shall be thoroughly cleaned, dried and shall be made free from rust and grease before painting.

All exposed machined surfaces shall be painted with one coat of aluminum oxide primer confirming to IS 5660 followed by two coat of black Japan confirming to Type B of IS 341 or paint confirming to IS 9862 / IS 2932 shall be applied by brush / spray for exterior application . The coating shall be such that it shall not impart any taste or smell to water.

BFV / KGV

PAINTING **:**
All valves shall be painted following requirement/specification.

Surface preparation : Blast clean to near white metal finish.
Priming : 1 coat of red oxide primer before and after shop testing. Finish painting : 2 coat of epoxy paint, minimum 200 micron DFT inclusive of priming.
Colour Code :RAL 5009 or equivalent IS - AZURE BLUE shed

The painting shall be such that it shall not impart any taste or smell to water when the valve is offered for potable water.

EXPANSION BELLOWS:

PAINTING:
All Expansion Bellows shall be painted following requirement/specification.

Surface preparation	: Blast clean to near white metal finish.
Priming	: 1 coat of red oxide primer before and after shop testing. Finish
painting	: 2 coat of epoxy paint, minimum 200 micron DFT inclusive of priming.
Colour Code	:RAL 5009 or equivalent IS - AZURE BLUE shed

EOT/HOT CRANE / CPB / HOT-MONORAIL

PAINTING:

Steel materials of all structural parts of Cranes shall be shot blasted to SA $2^1/_2$ finish to remove rust, mill scale and grease prior to fabrication and painted as follows:

Prior to Fabrication	: One coat of epoxy paint (primer). After
partial assembly and inspection at the supplier's works	: Two coats of enamel paint.
After erection at site	: One coat of enamel paint.
Colour Code	: RAL 1017 or equivalent IS

The final coat shall be Saffron yellow Colour with black zebra marking wherever applicable. All machined parts shall be coated with grease, varnish or other approved protective coats before dispatching from the supplier's works. Interiors of the gear casings shall be painted with one coat of oil resisting paint.

TESTING, ERECTION, AND COMMISSIONING

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.

Testing & inspection at manufacture works of all major items viz.: pumps, motors, valves, sluice gate, grit mechanism, EOT crane. shall be conducted at manufacturer's work in presence of third party inspection agency appointed by client/ or engineer-in- charge representatives of Client.

All the charges for third party inspection shall be included under the scope of contractor. 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.

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 program 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.

One pump of each rating shall be tested with shop motor at rated speed in the presence of client's representative. Shop motor efficiency and rating shall be submitted to client for approval prior to inspection call.

TESTS AT MANUFACTURER'S PREMISES

SEWAGE / WATER PUMPSET:

Pump testing and inspection shall confirm to the 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 to BS : 5316 : Part 2. Test shall be carried out for performance at rated speed with minimum NPSH as available at site.

MOTORS

Motors shall be offered for routine and type tests in accordance with IS :996-1979 and IS : 325-1978 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.

PIPEWORK

Testing of pipes/fitting shall be carried out in accordance with relevant standard.

VALVES

(a) All valves shall be hydrostatically tested close ended. Body, seat/door and back seat-test pressures shall be 24 bar, 16 bar and 16 respectively.

(b) Valves shall be tested with associated actuators for general performance.

HOISTS/CPB

(a) The hoist shall be completely assembled in the contractor's or sub-contractor's works and shall be subjected to the tests as specified in IS : 807/ IS : 3177. The contractor shall provide the test weights.

(b) In addition a vertical deflection test shall be carried out with the 'Safe Working Load' suspended from the hook with the crab in the centre of the span. The ratio of deflection to span shall not exceed that specified n IS 807. Manufacturer's test certificates for mechanical items shall be furnished.

ERECTION - GENERAL

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 labour to ensure completion of the works in time. The contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the engineer's representative. 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 that 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 Manger.

The contractor's erection staff shall arrive on 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.

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 labour 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.

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 net 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.

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.

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.

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 upto 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 as 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.

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.

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, PIPING AND VALVES

(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, tappings etc. for carrying out these tests shall be include in the contract.

(b) Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.

(c) Operating tests shall be conducted on valves.

(d) 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.

HOISTS

The hoist and lifting tackle shall be tested to 125 % of the safe working load. The contractor shall arrange the test load.

INSTRUMENTATION

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

COMMISSIONING

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.

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.

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.

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 (5 copies).