

Chapter 14

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CHAPTER 12: GENERAL SPECIFICATIONS - MECHANICAL

12.01 APPLICABILITY

The following clauses shall specify general mechanical requirements and standards of workmanship for Plant and its installation and must be read in conjunction with the particular requirements of the Contract. These general specification clauses shall apply wherever appropriate, except where redefined in the particular requirement sections of the Special Specification, which shall be applicable.

12.02 LIST OF STANDARDS

Titles of various standards referred to in the specifications are indicated below. This list does not necessarily cover all the standards referred to the following:

| Standard No. | Title |
|----------------------|---|
| IS:814-1991 | Specification for arc welding of carbon manganese steels |
| IS 9137 - 1978 | Specification for acceptance tests for centrifugal, mixed flow and axial pumps - Part 1 – Class ‘C’ Tests |
| IEC-189 (Part 1 & 2) | Low frequency cables and wires with PVC insulation and PVC sheath |
| IS: 5 | Colours for ready mixed paints and enamels |
| IS: 210 | Grey Iron Castings |
| IS: 318 | Leaded Tin Bronze Ingots and Castings |
| IS: 325 | Three Phase Induction Motors |
| IS: 807 | Code of Practice for design, manufacture, erection and testing (structural portion) of cranes and hoists |
| IS: 1239 | Mild Steel tubes, tubular and other wrought steel fittings |
| IS: 1536 | Centrifugally cast (Spun) iron pressure pipe for water, gas and sewage |
| IS: 1537 | Vertically cast iron pressure pipes for water, gas and sewage |
| IS: 1538 | Specification for cast iron fittings for pressure pipes for water, gas and sewage |
| IS: 1554 | PVC insulated (heavy duty) electric cables |
| IS: 2062 | Steel for general structural purposes |
| IS: 2147 | Degrees of protection provided by enclosures for low voltage switchgear and control gear |
| IS: 3109 | Short link chain, Grade M (4) |
| IS: 3177 | Code of practice for electric overhead travelling cranes and gantry cranes other than steel work cranes |
| IS: 3618 | Phosphate treatment for iron and steel for protection against corrosion |
| IS: 3624 | Vacuum and Pressure gauges |
| IS: 3815 | Point hooks with shank for general engineering purposes |
| IS: 3938 | Electric wire rope hoists |
| IS: 4029 | Guide for testing three phase induction motors |

| Standard No. | Title |
|--------------|---|
| IS: 4460 | Method for rating of machine cut spur and helical gears |
| IS: 4691 | Degrees of protection provided by enclosure for rotating electrical machinery |
| IS: 6005 | Code of practice for phosphating of iron and steel |
| IS: 8329 | Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage |
| IS: 11592 | Code of practice for selection and design of belt conveyors |
| IS: 13349 | Cast iron single faced thimble mounted sluice gates |
| BS: 436 | Spur and helical gears |
| BS: 466 | Specification for power driven overhead travelling crane, semi-goliath and goliath cranes for general use |
| BS: 1400 | Specification for copper alloy ingots and copper alloy and high conductivity copper castings |
| BS: 2903 | Specification for higher tensile steel hooks for chains, slings, blocks and general engineering purposes |
| BS: 2910 | Methods for radiographic examination of fusion welded Circumferential butt joints in steel pipes |
| BS: 3017 | Specification for mild steel forged ramshorn hooks |
| BS: 3100 | Specification for steel castings for general engineering purposes. |
| BS: 3923 | Methods for ultrasonic examination of welds |
| BS: 4360 | Specification for weldable structural steels |
| BS: 4772 | Specification for ductile iron pipes and fittings |
| BS: 4870 | Specification for approval testing of welding procedures |

| Standard No. | Title |
|--------------|--|
| BS: 4871 | Specification for approval testing of welders working to approved welding procedures |

12.03 MATERIALS

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfection, and selected for long life and minimum maintenance and their manufacture, composition shall conform to concerned IS/ASTM codes and also qualify the necessary quality tests during the pre and post construction stages.

12.04 DESIGN AND CONSTRUCTION

Design, fabrication, workmanship and general finish shall be of the highest quality standard in accordance with sound engineering practices. Design shall be robust and rated for continuous service, at specified duties, under the prevailing site conditions.

The general design of mechanical and electrical equipment, particularly parts that are subject to severe wear and tear, shall be governed by design period, without room for failure or symptoms thereof during period of service and providing access for routine maintenance.

Similarly installed equipment including their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as that of the original. No welding, filling or plugging of defective work will be permitted. However, modification or site related welding or fitment shall be performed only with prior written permission of the Engineer.

It shall be the responsibility of the Contractor to ensure that the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation. It shall be the responsibility of the Contractor to ensure that equipment installed interfaces with existing plant or control units in an accurate manner. Interfaces shall neither affect integrity of the equipment nor invalidate any warranties or guarantee that are normally applicable and provided by the manufacturer.

Each component or assembly shall have been proven in service in a similar application and under conditions similar to the project area. Equipment shall be compatible with the civil structure when installed and shall be installed in a way to provide sufficient space for operator access & general maintenance.

Materials supplied shall be of the best commercial quality, free from defects or imperfections and corrosion resistant.

12.05 PACKING AND DELIVERY

All equipment, appurtenances and accessories as applicable shall be packed in first quality containers. Second-hand timber shall not be used. All packing shall be suitable for several stages of handling via sea or air freight, inland transport and movement on site.

Flanged pipes shall have the open ends protected by adhesive tape or jointing and shall be covered with a wooden blank flange secured by service bolts.

Sleeves and flanges of flexible couplings shall be bundled by wire ties. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 500 kgs gross.

Precautions are to be taken to protect the shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings of sufficient strength impregnated with anti-rust composition or vapour phase inhibitors shall be used to resist changing and indentation due to movement, which is likely to occur in transit. The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.

Lids and internal cross battens of all packing cases shall be fastened using screws. Nails shall not be used in place of fasteners. Hoop metal binding of cases shall be sealed where ends meet and if the material is not corrosion resistant, adequate corrosive resistance coating shall be provided. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended to down after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber shall be strengthened by means of a pad. All stencil marks on the outside of the casings are to be either of a waterproof material or protected by Shellac or varnish to prevent obliteration during transit, storage and handling. Wood wool is to be avoided as far as possible. Waterproof paper and felt lining shall have an overlap of 12 mm at seams and secured together in an approved manner. Enclosure shall be provided with screened openings to obtain ventilation.

Where applicable, indoor items such as electric motors, switch and control gear, instruments and panels, machine components shall be completely encased or covered in polythene sheeting, sealed at the joints and the enclosures shall be equipped with an approved desiccant.

Bright metal parts are to be covered before shipment with an approved protective compound or coating and protected adequately during transport to site. After erection these parts are to be cleaned by the Contractor.

Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forwarded to the Engineer; prior to dispatch. All items of material are to be clearly marked for ready identification against the packing list. All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings, and are to bear an indelible identification mark relating them to the appropriate shipping documents.

Structural steelwork pipes, valves, encased fittings and metalwork shall be similarly marked. One in each lot of 10 items shall have a distinguish dispatch mark with suitable paint. When in the opinion of the Engineer the dispatch marks cannot be applied satisfactorily to any item they shall be stamped on a metal label attached to the item or part by means of a piece of wire passing through holes at either end of the label and secured so that it lies flat with the item.

The Engineer in-charge shall inspect and approve the packing before items are dispatched. However, the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit, and such inspection shall not relieve the Contractor from any loss during transit or damage due to faulty packing.

12.06 WORKMANSHIP

Workmanship and general finish shall be of first class commercial quality and in accordance with best practice. All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted

12.07 METAL WORKING & FORMING PROCESSES

12.07.1 Forging

Carbon steel forging shall be manufactured, heat-treated and tested in accordance with BS.29.

12.07.2 Castings and Metals

All castings shall have a homogenous composition and shall be free from blowholes, flaws and cracks. Any casting having a thickness in parts in excess of 3 mm to that which it is purported to be, shall be rejected. No repairs or patchwork to castings shall be allowed other than that approved by the Engineer in-charge.

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working field pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed. Where not otherwise specified steel castings shall be selected from the appropriate grade of IS: 9731-1980.

All grey iron castings shall conform with IS: 21. The Contractor shall replace any casting, which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or "burning on" will be acceptable.

All spheroidal graphite or modular graphite iron conform to grade of IS: 9630-1980. Where not otherwise specified, bronze used shall be made of a strong and durable zinc free mixture as per IS: 318.

Aluminum and aluminum alloys shall not be utilised unless alternative materials are considered unacceptable. The use of aluminum requires the approval of the Engineer in all cases. Bars and extruded sections shall be as per NE8 of BS.1474. Aluminum and aluminum alloy castings shall be manufactured as per IS: 6751:1972 and subjected to a chill cast to increase tensile strength. Immersed structures or structures that are periodically immersed shall not be constructed from aluminum or aluminum alloys. All chromium plating shall comply with IS: 1986.

12.07.3 Painting and Metal Protection

The surface preparation and painting or application of corrosion protection coatings to the following materials shall be carried out in accordance with the specification.

- Mild steel
- Cast and Ductile iron
- Aluminum
- Non ferrous parts

- Other small parts

12.07.4 Galvanising

Steel or wrought iron wherever required is to be galvanised, by the hot-dip process and shall conform with IS: 2629. Attention shall be paid to the details of members in accordance with the requirements of BS 4479. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanising.

All surface defects in the steel including cracks, surface laminations, laps and folds shall be removed in accordance with IS: 6159. All drilling, cutting, welding, forming and final fabrications of unit members and assemblies shall be completed before the structures are galvanised. The surface of the steelwork to be galvanised shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulphuric or hydrochloric acid, followed by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten Zinc and wire brushed, so that the whole of the metal shall be evenly covered. The additional weight thereof after dripping shall not be less than 610 gm / sqm of surface galvanised, except in the case of tubes to IS.4736-1986, where it shall not less than be 460 gm / sqm.

On removal from the galvanising bath, the resultant coating shall be smooth, continuous, free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross. Edges shall be clean and surfaces bright.

Bolts, nuts and washers shall be hot-dip galvanised and subsequently centrifuged in accordance with IS: 2629. Nuts shall be tapped up to 0.4 mm oversize before galvanising and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nuts.

During off-loading and erection the use of nylon slings shall be used. Galvanised work, which is to be stored in Works or on Site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanised coating damaged in any way shall be restored by:-

- Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
- The application of two coats of zinc-rich paint (not less than 90 per cent zinc, dry film), or the application of a low melting-point zinc alloy repair rod or powder to the damaged area, which is heated at 300 °C.

12.08 AUXILIARY COMPONENTS

12.08.1 Fasteners

All bolts, nuts, washers and anchor plates, except high tensile, for fastening ferrous parts for use in dry areas shall be steel galvanised as per IS: 1367-2002 primed and painted as per standard specification.

All bolts, nuts, washers and anchor plates, for fastening galvanised components or aluminum alloy components and all fixings in wet wells and sumps shall be stainless steel of IS 1367 (Part 14) - 1984 and shall remain unpainted.

All holding down and anchor bolts, nuts, washers and anchor bolts for use externally or in internal areas, which are in 'wet' areas including above the top water level shall be stainless steel as per IS: 1367-1984. All holding down and anchor bolts, nuts, washers and anchor plates for use internally in areas not subject to contact with 'wet' areas shall be galvanised as per IS: 10632 (Part 1) - 1983 or sheradised as per BS: 4921-1988 Class 1 and all exposed surfaces shall be painted after assembly and tightening. PTFE washers and spacers shall be fitted beneath stainless steel washers for both bolt head and nut, when used to fix dissimilar metals.

Fasteners shall be torqued down in accordance with manufacturer's recommendations. Thread lubricants used shall be in line with the manufacturer's recommendations and the torque loading shall take this into account.

Where safety is dependent on correct torque loading, the Contractor shall produce documentation to certify that these loadings have been imposed on the fasteners.

Should it be necessary to use left handed fasteners, these shall be clearly marked up, by marking or engraving the fastener, and by means of a warning painted on the plant, on which they are used. Fasteners used in areas, where they are exposed to chemicals, should be unaffected by the chemicals they are likely to be exposed to.

Drilled anchor fixings for use on concrete structures shall normally be stainless steel and of a type approved by the Engineer. The positions of all drilled anchors shall be approved by the Engineer and any Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit.

Locking washers or locking nuts shall be used wherever necessary, and shall be of a type, suitable for the duty to which they will be subjected. The type used shall be approved by the Engineer.

Where the use of chemical anchors is approved, the Contractor must provide copies of the manufacturer's installation instruction to the Engineer and must demonstrate that his operatives are following those instructions. A proof load must be applied to all bolts fixed in this manner by applying the required torque against nut or stud after curing. The Contractor must give an advance notice to the Engineer for his presence, to witness those tests.

All nuts and bolts shall be threaded in accordance with IS: 4218 (part 4) - 2001 "ISO General Purpose Metric Screw Threads" Part 4 and fitted with 3 mm thick washers beneath bolt and nut.

All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such that, when fitted with a nut and tightened down, the threaded portion shall fill the nut and not protrude from the face thereof by more than half diameter of the bolt.

Wherever it is necessary for assembly reasons, or for jacking screws, to leave portions of thread exposed, these shall be protected. Protection shall consist of a plastic tube filled with suitable anti-seize material.

12.08.2 Couplings

Flexible couplings shall be couplings rated at, not less than the stalling torque load of the motor. Couplings liable to impregnation by oil shall be metal flexible type.

General service couplings shall be the flexible multi-pin and resilient bush type, having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the bosses.

Bosses shall be a tight fit on the shafts and secured by hard keys.

Couplings shall be supplied by matching balanced sets and shall be machined, balanced and marked before leaving the manufacturer's works.

Flexible couplings shall be supplied in matching balanced sets machined, balanced and marked before leaving manufacturer's works. The couplings shall be a tight fit on the shafts and secured with hand fitted keys and fully checked for correct alignment. All necessary equipment for checking alignment shall be supplied by the Contractor. Wherever flexible couplings are used, the Contractor shall fully describe the arrangements proposed for ensuring that the desired freedom of relative movement between the shafts is obtained when transmitting a torque corresponding to the continuous maximum rating of the motor.

Solidly bolted couplings shall be subject to accurate alignment and the Contractor's proposed alignment procedure shall be approved by Engineer. In particular, alignment procedures which involve rotating one half coupling only will not be accepted. The coupling alignment procedure shall include a final check in the "bolted-up" condition for "cranking".

Overload release couplings shall not rely on shear pins. Release torque shall be adjustable over a wide range and preferably without the need to change components. The coupling shall be capable of angular mis-alignment of one degree maximum and one millimeter displacement of shafts.

Hydraulic couplings shall be oil filled with thermal overload protection device. The coupling shall be fully rated to transmit the motor full load power without exceeding normal working temperature and due regard shall be taken to ambient temperatures. An enclosure around the coupling shall be provided to prevent oil spray in the event of operation of the thermal overload device.

Final alignment of all types of coupling shall be checked by the Contractor in the presence of the Engineer's Representative.

12.08.3 Bearings and Lubricators

The size of bearing shall be not less than that calculated for Bearings and a minimum L10 basic rating life in accordance with IS: 3824-2002 taking into account all considerations of reliability, materials of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running. They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic conditions prevalent at the site. All bearings shall be to IS/ISO standard with SI unit dimensions where

practicable.

All ball or roller bearings, except those supplied as "sealed for life" shall be arranged for grease gun lubrication and a suitable high pressure grease gun shall be supplied.

Adequate "Stauffer" screw top pressure grease lubricators with 'tell tale' stems or "Tat" grease nipples shall be provided for all moving parts. The position of all greasing and oiling points shall be arranged so as to be readily accessible for routine servicing. Wherever necessary, suitable access platforms shall be provided.

The type of lubricant and intervals of lubrication, which shall be kept to a minimum (not less than nine days), for each individual item of plant shall be entered on a working schedule, which shall form part of the Operation and Maintenance instructions.

A list of recommended Lubricants and their equivalents for each type of Bearings shall be entered in the Operation and Maintenance instructions.

12.08.4 Foundation and Setting of Machinery

The Contractor shall arrange the necessary provision for all types foundations and plinths required for the plant and machinery and shall ensure that it is in accordance with the approved drawings and conforming to IS 2974 (Part 3 & 4) 1979 & IS 13301 : 1992.

The Contractor shall provide all necessary templates for suspension of the holding-down bolts during grouting of same.

The machinery shall be mounted on flat steel packing of a thickness selected to take up variations in the level of the concrete foundations. The packing shall be bedded by chipping or grinding of the concrete surface.

Only one packing of selected thickness shall be used at each location, which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3mm.

The machinery shall be aligned, leveled and pulled down by the nuts of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration.

12.09 HANDRAILING AND SAFETY CHAINS

12.09.01 Hand railing

Hand railing shall be galvanized mild steel of circular hollow section and shall comply with the relevant requirements of IS 4736-1956. Mild steel toe boards shall be provided, 100 mm, height by 3 mm thick positioned above the platform level and fixed securely to the standards. All items shall be galvanized in accordance with Clause 12.07.04.

Standards shall not be less than 38 mm external diameter and rails shall not be less than 25 mm external diameter. Horizontal handrails shall be 1100 mm. high with an intermediate rail at mid height. Handrail height shall be measured vertically from

finished floor level to the handrail centreline.

Hand railing and fixing shall be designed to withstand a horizontal force of 740-N/m run without permanent distortion or failure of components. When a horizontal force of 360-N/m is applied at handrail level the deflection at any point on the handrail shall not exceed 1/125 of the distance between the centre lines of adjacent standards or 10-mm, whichever is the least.

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the hand railing and vertical flanges drilled for not less than two bolts the line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.50 m centres. When provided in sections, hand railing shall be joined together with purpose made fittings secured by screws or grub screws. All ladders, stairway or other openings shall be guarded on three sides by hand railing conforming to the requirements stated above. Access to the ladders or openings shall be guarded by two removable galvanized hanging chains. The Contractor shall ensure that unless specified hereinafter to the contrary, all hand railing shall be of uniform appearance.

12.09.02 Safety Chain

Mild Steel safety chain shall be 8 mm nominal size grade (M 4) non calibrated chain Type 1, complying with IS 7889-1992, part 2. After manufacture, mild steel safety chains shall be hot-dip galvanized.

Stainless Steel safety chains shall be manufactured conforming with IS:570 Part 1. Chain links shall be welded and have an internal length not exceeding 45 mm and an internal width of between 12 mm and 18 mm. Fins caused by welding shall be removed and the weld area shall be smooth finished all round. When tested in accordance with clause IS: 8324-1984 each chain shall withstand a breaking force of 30 kN and a proof force of 15 kN.

12.09.2.1 Open Mesh and Chequered Plate Flooring

Open mesh flooring and gratings shall generally comply with IS: 5961: 1970 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slippery and shall be mild steel galvanised.

Flooring shall be provided to span between the supporting members as shown on the Contract Drawings. Where necessary intermediate support members shall be provided and fixed. Galvanized mild steel toe plates 100 mm high and not less than 3 mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the Contract drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be positioned symmetrically around the centre lines of the panels in both directions, so that when the panels are fixed in extensive areas or in long runs, the bars of all panels are in line.

Chequer plate flooring shall be galvanised and of the non-slippery type, shall not be less than 10 mm, thick measured excluding the raised pattern. The flooring shall be secured to its frame by stainless steel countersunk

set screws. All flooring shall be designed to carry a loading of 750 kg/m² and deflection shall not exceed 1/200 of the span or 10-mm whichever is the least. All flooring shall be removable and set flush in mild steel galvanised frames. All frames shall be provided with lugs for building in.

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cutouts to permit its removal without disturbing or dismantling spindles, supporting brackets, cables or pipe work. Flooring spanning wide openings shall be supported on removable bearers and fixings to provide the required rigidity and these shall be supplied and fitted by the Contractor. These members shall be removable to afford clear access to the openings, which include ducts. Lifting keys shall be supplied for each location and the type of key shall be such that inadvertent release is avoided.

12.09.2.2 Stairways

Stairways shall be detailed, fabricated and erected to the dimensions shown on the drawings to carry a load of 750 kg/m². Treads shall be rectangular open mesh fixed to the stringers, not directly to concrete. Sloped hand railing shall be as specified for horizontal hand railing but with the top rail positioned 850 mm, vertically above the line of pitch and standards shall be vertical and spaced at not more than 1500 mm, measured parallel to the line of pitch.

Staircases shall be constructed to the size and position shown on the Drawings or as instructed by the Engineer. They shall be steel galvanised at works after manufacture and shall comprise stringers supporting the open mesh stair treads and shall be supplied complete with handrails and stanchions conforming to the above except the height which shall be 900 mm above the pitch line.

12.09.2.3 Ladders

Ladders shall conform to IS:8172-1976 unless otherwise specified and shall be in galvanized mild steel. The stringers shall be flat section not less than 65 x 13 mm, spaced 380 mm, apart and shall be flanged and drilled for wall fixing at both ends. The stringers shall be radiused over the top where they shall be not less than 600 mm, apart. Ladders over 3.0 m. long shall have additional intermediate stays at not more than 2.5 m centres.

Rungs shall be 20 mm, diameter round bar at 250 mm, centers shall be shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225 mm from the wall. All ladders shall have safety cages, which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750 mm. The hoops shall be at approximately 700-mm center and the first hoop shall be 2,400 mm above ground or the lower platform level. Where the rise exceeds 6,000 mm, an intermediate landing shall be provided.

12.09.2.4 Multiple Duct Covers and Frames

Multiple duct covers and frames shall be of cast iron, waterproof, non-rocking and recessed for filling with concrete or similar material. They shall be of the type incorporating integral, removable, intermediate beams to give the required clear pit opening as shown on the Contract Drawings. A heavy grease seal is to be formed between the cover and frame to prevent ingress of grit. All covers, frames and supporting metalwork shall be designed for loadings to as per standards. All supporting steelwork shall be hot dipped galvanized.

12.09.2.5 Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract.

All warning labels shall comply with IS/ISO 14021:1999 and of screw fixed rigid construction. Designation labels shall be of 5 mm Traffolyte with black lettering on white background. Embossed materials and techniques shall not be accepted. The Contractor shall provide two enameled iron plates worded "Caution: Men at Work". The plates shall be 200 x 75 mm with red lettering on a white background.

The Contractor shall also provide and fit warning labels for machinery that is operated under automatic control. All identification and warning labels shall be in English and in the language local to that state or region.

12.09.2.6 Guards

Adequate guards shall be supplied and installed throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be securely shrouded to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction they shall also be readily removable for gaining access to the plant without the need for first removing or displacing any major item of plant. The guards shall be of the open mesh type except where retention of fluid spray is required.

12.09.03 Piping, and Appurtenances

12.09.3.1 Piping Installation – General Requirements

The Contractor shall supply, deliver and install all piping, valves and appurtenances within the structures and externally to the limits indicated on the Contract drawings and in accordance with each section of the Specification as directed by the Engineer.

All piping, valves and appurtenances shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of pumping mains shall be equal to the summation of closed valve head of the pump (shut-off head) and the maximum

suction static head. Maximum surge pressure shall be limited to 125% of the maximum working pressure. All piping, valves and appurtenances shall be of adequate strength to accommodate the maximum surge pressure of the system.

The minimum pressure rating of pipe work and fittings shall be 10 bar with the exception being DI pipes and appurtenances which shall have a minimum pressure rating of 16 bar.

A sufficient number of mechanical joints shall be provided to enable mechanical equipment and valve disconnection from the built-in pipe work. Such joints shall be adequately supported and shall not be allowed to sustain the weight of any pipe work.

All pipe work and fittings shall be sized for the required capacity at a velocity limit depending on the nature of the fluid or substance to be conveyed. Under no circumstances the velocity shall exceed 2.50 m/sec. All piping, valves and appurtenances shall be adequately supported by approved supports and mountings and shall not be directly mounted or supported by the associated equipment.

The position of any thrust blocks required shall be indicated on the Contractor's detailed drawing together with the position of any sleeving required through partition walls in buildings. Puddle flanges shall be provided for building in at locations in which pipes 80 mm diameter and above pass through structural concrete below ground level.

Where pipe work is connected to plant and equipment readily mountable fittings in the form of unions or flanged adaptors shall be provided. The flanged adaptor on the delivery pipe of pumps shall be located upstream of the reflux valve where appropriate.

Flexible joints shall be provided in all pipe work subjected to linear constraint. All jointing work including the provision of suitable full-face gaskets not less than 9-mm in thickness and galvanised fastenings shall be included.

Pump suction bell-mouths shall be standard castings in cast iron. Unless otherwise specified, tee pieces shall have a radial branch to enable a more streamlined flow from branch to body. Due allowance shall be made for reinforcement in the vicinity of the branch.

Prior to dispatch, each item of pipework or associated fitting shall be clearly identified in paint with the item number indicated on the Contractor's arrangement drawing. Puddle flanges shall be provided on all pipes where they pass through pumping station walls. Each puddle flange shall be continuously welded to the pipe on both sides of the flange.

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout or other extraneous material into the joint annulus after the joint has been made. The dimensions of gaskets shall comply with IS: 12820 – 2004. Gaskets

shall be manufactured from material complying with IS: 11149-1984 for type 1 rings.

Pump suction and delivery manifolds shall be provided with a drain valve for maintenance purposes.

Hydraulic testing shall not be carried out until all fabrication has been completed, when the pressure applied and sustained without further pumping shall be twice the working pressure.

The Contractor shall be responsible for cleaning the internal surface of all pipes prior to installation particularly, in the case of removal of weld deposits. Initial capping of the ends for protection during transport and storage shall not be removed until installation.

12.09.3.2 Materials & Wall Thickness

- Cast iron pipes shall conform to IS: 1536.
- Cast iron fitting shall conform to IS: 1538.

All spheroidal graphite or modular graphite cast iron pipe work and fittings shall be to the appropriate grade of BS: 4772. Carbon steel pipe work for pressure purposes shall be to BS.3601 and assemblies shall be manufactured from pipe to this specification. The type of pipe shall be hot-finished seamless steel. The wall thickness shall be not less than that required in BS.534 Table 1. ABS pipe work shall be provided and installed for special purposes where hereinafter specified. The pipe work shall conform to IS: 3114: 1994

12.09.3.3 Fabrication of Carbon Steel Pipe work and Fittings

The Contractor shall fabricate the pipeline by butt welding without utilising a backing ring in accordance with IS: 7174-1974 metal arc welding of carbon steel pipe work. Branches shall be formed as per standard drawings, depending on operating conditions and shall be welded before the pipe is erected.

All pipe bends shall be formed so that at any point along the bend, ovality will not reduce bore size by more than 2½ percent. Radii of hot bends for all pipes shall not be less than 5 times the outside diameter. Gussetted, “cut & shut” and wrinkle bends shall not be used.

All pipe flanges shall be of the wrought steel “slip-on” type, conforming to IS: 3516-1966, welded-on in accordance with IS.2856: 1999. No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or victaulic coupling as necessary.

12.09.3.4 Welder Qualification

Before welding work commences on pipe work, the Contractor shall satisfy the Engineer's Representative that the welders have previously carried out similar welding work within recent months. The standard for welders shall be as required by IS: 817-1966

12.09.3.5 Cast Iron Pipes & Fittings

Cast Iron pipes shall generally conform to Class B IS: 1537 / IS: 1536 / IS: 7181 and pipe fittings shall conform to IS: 1538. The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr. FG 200.

The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance of ± 3 mm. The flanges of the straight pipes shall be square to the axis of the pipe. The faces of the flanges shall be parallel. The bolt holes in one flange shall be located in line with those in other.

The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centre line. The intersecting axes of the tees shall be perpendicular to each other.

The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled. The dismantling joints shall be of cast iron with EPDM seal ring.

12.09.3.6 Pipe work Installation

All pipe work, pipe fittings, jointing materials etc., shall be the conform with IS 1538-1976 and of the best quality, free from defects and obtained from a supplier approved by the Engineer. The installation of the pipe work shall be as per IS 3114-1985 carried out using skilled personnel and pipe work shall be installed according to the drawings provided by or approved by the Engineer. Where valves are incorporated in pipe work, the valves shall be provided with their own supports, such that no excess loading is exerted on pipe work. All pipe work materials shall be off-loaded, stored on site and handled thereafter in such a manner that they are adequately protected from damage or deterioration.

Unless otherwise stated all underground pipes shall be buried in trenches, which have been excavated in accordance with the relevant section of the Specification.

Before being used, each pipe casting or fitting shall be properly examined and should it appear defective in any way, it shall be set apart and not used until it has been examined and passed by the Engineer. All metal pipes, which shall be buried in the ground, shall, prior to their installation, be slung and sounded in an approved manner. Any pipe found to be faulty by this method, shall be set aside for examination by the Engineer. All pipe work shall be cut with proper pipe cutting tools. The use of hammer and chisel for this purpose shall not be permitted. Great care shall be exercised when cutting concrete/bitumen lined spun iron and ductile iron pipes, to ensure that there is no damage to the lining. Should any damage to the lining take place, which is to an extent, which the Engineer deems to be undesirable, then the pipe shall be rejected. The Contractor shall then prepare another pipe for incorporation into the works. All pipes which have been cut shall have the edges dressed and debarred.

12.09.3.7 Pressure and Vacuum Gauges

Pressure and compound gauges of approved manufacture, shall be provided and fixed directly to and at the same level as the delivery and suction branches of each dry well pump. The gauges shall be fitted with diaphragm type isolating valves, but syphon pipes will not be required. Gauges shall not be connected to air release or auxiliary suction pipes.

A diaphragm type pressure vacuum transmitter shall be connected to the delivery piping of each submersible pump, on the upstream (pump) side of the sluice and reflux valves and within the valve chamber. These shall then be connected by means of small bore tubing to the pressure gauge, mounted within the control panel.

A flushing pin shall be provided to clear the hole in the delivery pipe where pressure tube is connected.

All gauges shall have concentric dials of 150mm diameter, pressure gauges being graduated in metres head, and compound gauges in cms of mercury and metres of water head. Gauge graduations shall be such that the gauge is never used continuously beyond 60 per cent of the maximum graduation. The face of the dial shall have a warning label marked in red attached thereto reading in English:-

"IMPORTANT: TURN OFF WHEN NOT IN USE"

The gauge mechanism shall be of the Bourdon tube type, having stainless steel movements and shall comply with BS: 1780. It shall be sealed from the liquid being measured by means of a diaphragm or capsule and be filled with silicone oil.

All gauges shall be fitted with a pressure snubber to dampen pressure pulsations.

Before the gauges are delivered to site, each gauge shall be tested in accordance with IS: 3624-1987 and a test certificate for each gauge, confirming that they are of the required accuracy, shall be sent to the Engineer. Further copies of the test certificates shall be incorporated in the operating and maintenance manuals.

12.09.04 Gearboxes

The gearboxes shall be totally enclosed dust, weather and hose proof. Suitable lifting lugs shall be provided. They shall be robustly constructed and suitable for continuous and arduous duty.

The gearcase shall be manufactured from grey cast iron to IS:210 and of a grade to ensure high strength and wear resistance. Inspection covers shall be provided together with protected oil level indication, breather, with oil mist preventer, and drain plugs.

The gearboxes shall be designed for operation at the ambient temperatures specified without the assistance of a cooling fan.

The mechanical service factor shall be not less than 1.75 when applied to the rated

motor power.

The gears shall be manufactured from steel to IS: 2535-2004 of grade selected by the Contractor and entered in the Schedule of Particulars. The teeth shall be profile ground and lapped to a high standard of accuracy and finish.

Rolling bearings shall be adequately rated to ensure a running life of not less than 50,000 hrs.

The input and output shafts shall have oil seals fitted to prevent the ingress of lubricant when the gearbox is mounted in the required orientation. For example, inclined when applied to screw pump installations.

The seals shall also prevent the ingress of dust, sand and moisture.

Lubrication of the gears shall be by a splash or forced system.

An anti-run back device shall be supplied and fitted to all gearboxes involved in screw pump installation.

Each gear unit shall be subjected to a full load test at the inclinations specified for duration of 3.00 hrs. during which time temperature, vibration and noise levels together with oil tightness shall be recorded in the presence of the Engineer's Representative.

After satisfactory completion of the tests each unit shall be drained of lubricant. All internal surfaces shall then be coated with a suitable preservative.

An identity plate stamped with full rating particulars shall be securely fixed to the gearbox.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

Steelwork General

The Contractor shall design, fabricate and erect all steelwork, including stairways, ladders, handrailing, chequer plate and open mesh flooring, frames and curbing as detailed in the Specification and as shown on the Drawings.

Unless otherwise specified all steelwork shall be constructed in mild steel and shall be galvanised after manufacture.

For all prefabricated metalwork, including multiple duct covers, external ladders, open mesh flooring, chequer plating, handrailing, staircases, structural steelwork and the like, the Contractor shall submit fabrication drawings for the approval of the Engineer prior to the manufacture of any of these items.

12.10 OPEN MESH AND CHEQUER PLATE FLOORING: NOT USED**12.11 MULTIPLE DUCT COVERS AND FRAMES: NOT USED****12.12 PIPEWORK INSTALLATION: NOT USED****12.13 ELECTRIC ACTUATORS****12.13.1 General**

Actuators shall have a design life of 30 years, modular in design and be capable of renovation during overhaul, making maximum use of readily replaceable components.

The actuator design shall be specifically selected to suit the valve being actuated and be equipped for the selected type of operation defined in the Specification.

The actuator shall be capable of opening or closing the valve or penstock against an unbalanced head equal to the maximum working pressure.

The actuator shall incorporate devices to provide protection to the valve spindle and motor in the event of valve jam.

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the 3-phase power supply connected to the actuator.

It shall be the responsibility of the actuator manufacturer in conjunction with the valve supplier to select the product from the range, which fully satisfies the maximum power requirements for the valve to be operated. However, in order to accommodate possible deterioration of operation between maintenance events a factor of not less than + 10% of the as new valve operational power requirement shall be applied during the selection process.

Two basic types of actuator are acceptable:

- i) Machines designed to operate from a multi motor control board and provided simply with a driving motor, travel, torque and auxiliary limit switches.
- ii) A fully equipped machine capable of stand alone operation from a distributed electrical power supply and remote control and indication facilities.

12.13.2 Environment

The actuator shall be Watertight, dust-tight complying with the requirements of IS: 9334-1986 or better.

Sealing of static joints shall be 'O' ring on moving components to prevent leakage of lubricant from the machine.

The actuator shall provide Double Sealing between the terminal compartment and the internal electrical elements of the actuator, fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when terminal cover is removed on site for cabling.

12.13.3 Monitoring and Control

Actuators shall be complete with all the features necessary to monitor performance and through in-built components the position of the valve being controlled. Additionally, all the necessary control equipment for the operation of the actuator shall be provided.

Torque setting can be made from 40% to 100% of rated torque. Limit switches shall be provided to indicate valve travel limits and for interlocking purposes. Switch contact rating on inductive circuits shall be 5 Amps, 250 VAC, 30 VDC. The setting of the torque and limit switches must be able to be carried out without the need to remove any electrical compartment covers.

A mechanical latch shall be provided to prevent the open torque switch tripping while the initial unsealing hammer blow is applied.

A device shall be provided which measures the torque being exerted by the actuator such that overloading is detected the motor will be de-energised to prevent damage to the component of the valve and actuator itself.

12.13.4 Mechanical Construction

The actuator shall be flange mounted on the valve to be operated suitably orientated on the top or side.

The attachment of the actuator output shaft to the valve spindle shall be detachable yet fully capable of transmitting the power necessary to operate the valve in all circumstances without damage to the coupling.

The actuator motor gearbox shall be of the total enclosed oil bath lubricated type suitable for operation at any angle and provided with appropriate filling and drain plugs. The drive shall incorporate a lost motion hammer blow feature. The output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type. The design shall permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the valve out of service.

Valve stems and threads shall be provided with grease lubrication; rising spindle valves being protected with a totally enclosed, grease packed cover tube.

The actuator shall be fitted with a drive bushing which is easily detachable for machining to suit the valve stem or gearbox input shaft. Bushing shall be fitted in the base of the actuator to enable standard length valve stems to be used.

12.13.5 Hand Wheel Operation

A hand wheel shall be provided for manual operation of the valve. This hand wheel shall not be operated during powered actuator movement by a positive means of disconnection from the motor driven mechanism.

The wheel shall be maintained in its engaged position once this is selected until powered movement takes place when it shall automatically disconnect and “free wheel”.

Where hammer blow facilities are specified as part of the power driven mechanism, they shall also be available for hand wheel operation.

The hand wheel gearing shall be selected to allow valve operation without undue effort i.e. not exceeding 25 kg.

It shall be possible to secure hand or powered operation by means of padlocking in the selected mode.

Where necessary to present the actuator hand wheel at a convenient operating height, flange mounted pillars are to be provided which fully enclose the necessary valve stem extension spindles. Supplementary support of the extension spindle within its pillar shall be provided for long shafts.

The open/close direction of rotation shall be clearly indicated on the hand wheel.

A visual position indicator shall be provided within the actuator complete with a pointer showing open/closed and in travel positions, and a sealed potentiometer to transmit continuous remote position.

Where specified this indicator shall be illuminated.

12.13.6 Electrical Construction

Motors

- i) The actuator shall incorporate an electric driving motor suitable for use on the supply defined in this Specification.
- ii) The electric motor shall be Class 'F' insulated, with a time rating of at least 15 minutes at 400C or twice the valve stroking time, whichever is the longer, at an average load of at least 33% of maximum valve torque.
- iii) The motor shall be designed specifically for use on valve operation, having high torque capacity coupled with low inertia.
- iv) In order to ensure minimum power requirement, especially for valve opening and closing, maximum rating shall be possible with a voltage drop at the actuator of 10%.
- v) Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase.
- vi) Where actuators are required for modulating purposes continuously rated motors shall be provided.
- vii) Protection shall be provided for the motor as follows:-
 - The motor shall be de-energised in the event of a stall when attempting to unseat a jammed valve.
 - Motor temperature shall be sensed by a thermostat to protect against overheating.
 - Single phasing protection.

12.13.7 Integral Control Actuators

Where actuators to the requirements of General (g) (ii) are specified, the means of control shall be contained within a separate bolt on enclosure and shall consist of the following:

- i) The reversing contactor starter and local controls shall be integral with the valve actuator housed to prevent breathing and condensation build-up. The starter shall be suitable for 60 starts per hour and shall comprise mechanically and electrically interlocked reversing contactors of approximate rating to the motor size with coils fed from a 120 volt control transformer of 40VA minimum rating. The common connection of the contactor coils at the transformer shall be grounded so that the contactors drop out on the event of leakage to earth. The primary winding shall be separate from the secondary by a grounded screen and shall be protected by two easily replaceable cartridge fuses. Secondary winding shall also be protected by cartridge fuses.
- ii) Local controls shall comprise pushbutton switch for Open, Close and Stop, and a Local/Off/Remote selector switch padlock able in any one of three positions:-
 - Local control only
 - Off/No electrical operation
 - Remote Control with local stop.
- iii) It shall be impossible to operate both open and close pushbuttons simultaneously. Stop pushbuttons shall be mushroom headed “Stay-put” type.

Each actuator shall incorporate the following:-

- i) Phase discriminator to prevent starting with an incorrect phase rotation and single phasing protection to prevent the motor to be energised in the event of loss of 1 phase.
- ii) Interposing Relays for remote operation. External control voltage shall be from 24 to 240 volt AC/DC.
- iii) Monitor relay with normally open contacts and having its coil energised from the control transformer only when the Local/Off/Remote switch is in the remote position to show that the actuator is electrically operable by remote control.

Internal wiring shall be of a tropical grade PVC insulated stranded cable of 5 amp. Minimum rating for control circuits and appropriate size for the motor 3 phase power. Each wire shall be clearly number identified at each end. The terminal compartment shall include a moulded “transfer back” terminal block of the stud type the 3 phase power terminals being segregated by a separate insulating cover.

12.14 PRESSURE AND VACUUM GAUGES: NOT USED

12.15 LABELS: NOT USED

12.16 GUARDS: NOT USED

12.17 SUPPRESSION OF NOISE

All plant and machinery offered shall be quiet in operation. The noise level within the building shall not be more than 85 decibels (+5 per cent on this over the audible frequency spectrum measured at mid-band.) "A" scale when measured along a contour 3 metres from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 decibels (+5 per cent on this over the audible frequency spectrum measured at mid-band.) "A" scale when measured along a contour 3 metres from the external wall. Noise test measurements shall be made on completion of the installation of the plant at Site to verify that it complies with this Clause. Plant which fails to comply with the noise level limits when tested, will be liable for rejection unless it is satisfactorily modified at the Contractor's expense by the programmed commissioning date.

12.18 PUMPS

12.18.1 References to Standards

The following standards are referred to in this Clause

- IS 1570-1978 Part IV (ISO 683) Wrought steels for mechanical and allied engineering purposes
- IS 1520-1972 – Horizontal Centrifugal Pumps for Clear, Cold, fresh water
- IS 1710-1973 – Specification for pumps – Vertical Turbine Mixed and Axial flow for Cold Water
- IS 4111 – Part 1 to IV Code of Practice for ancillary structures – Sewerage System
- IS 12075 – 1987 Part I, Mechanical vibration in rotating electrical machines
- IS 4722 – 2001 Rotating electrical machines specifications.
- IS 9137 – 1978 Acceptance tests for centrifugal mixed flow and axial flow centrifugal pumps Part I Class C tests
- IS 3824 – Part I-IV Methods of calculating dynamic load ratings and rating life of rolling bearings
- IS 3961 – Part 3 – 1968 Recommended current ratings for cables – Part 3 rubber insulated cables.
- IS 1367 – Part 14 1984 Technical Supply Conditions for threaded steel fasteners
- IS 1646 – 1991 – Code of practice for fire safety of Buildings (general)
- IS 9537 – Part I – 1980 – Conduits for electrical installations.
- IS 9283 : 1995 Motor for Submersible pumpsets – Specification
- IS 14220 : 1994 Open well Submersible pumpsets – Specification
- IS 210 – 1983 – Grey Iron Casting – Specification
- IS 5120.1977 – Technical requirements for rotodynamic special purpose pumps.

- IS 14536: 1998 – Selection, Installation, operation and maintenance of Submersible pumpsets Code of practice.
- IS 8783 – 1978 – PVC insulated winding wires for submersible motors
- IS 325 – 1978 – Three phase Induction motors.
- IS 9137 – 1978 – Code for acceptance test for centrifugal, mixed flow and axial pumps, class C.
- IS: 2685 – 1971 - Code of practice for selection installation and maintenance
- BS 4999, General requirements for rotating electrical machines
- BS 5316 (ISO-2548) Acceptance tests for centrifugal mixed flow and axial flow centrifugal pumps Part 1 Class C tests
- BS 5345, Codes of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
- BS 5512, (ISO-281) Methods of calculating dynamic load ratings and rating life of rolling bearings
- BS 6007, (IEC-245) Rubber insulated cables for electric power and lighting
- BS 6105, (ISO-3506) Corrosion-resistant stainless steel fasteners
- BS 6861, (ISO-1940) Balance quality of requirements of rigid rotors
- BS 7671, Requirements for electrical installations IS 8034 : 2002 Submersible pumpsets-Specification

12.18.2 Submittals

In addition to the other requirements of the Specification the Contractor shall provide data and information described in the following paragraphs

The Contractor shall provide manufacturer's published pump curves, system curves and the necessary hydraulic calculations to justify the sizes of any pumps selected.

The Contractor shall provide the following on the shop drawings:

- impeller diameter
- maximum impeller diameter
- minimum impeller diameter
- velocity of liquid in pump suction at duty point
- velocity of liquid in pump delivery at duty point
- velocity of liquid in the pump casing or impeller eye at duty point
- net positive suction head (dry well submersibles only)
- the materials of construction shall be specified in detail and itemized against a sectional drawing of the pump proposed.

After approval of the pump types the Contractor shall submit the test data as required under factory inspection and testing

The Contractor shall submit O & M manuals and other Instructions manuals which shall include all the documentation provided as above and as required in the Specification.

12.18.3 Pump Requirements

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the Specification without surging, cavitations, or excessive vibration to the limits specified. All pumps and drives shall be from approved manufacturers.

The pumps shall meet maximum allowable shut-off head, and if dry-mounted submersibles, the maximum allowable required net positive suction head (NPSH) designated in the Specification.

The pumps shall not overload the motors for any point on the maximum pump speed performance characteristic curve and the pump operating range, within the limits of stable pump operation, as recommended by the manufacturer, to prevent surging, cavitation, and vibration.

To ensure vibration-free operation, all rotative components of each pumping unit shall be statically and dynamically balanced to IS: 9137-1978 and the following requirements shall be met:

- The mass of the unit and its distribution shall be such that resonance at normal operating speeds is within acceptable limits
- In any case, the amplitude of vibration as measured- at any point on the pumping unit shall not exceed the below limits
- At any operating speed, the ratio of rotative speed to the -critical speed of a unit, or components thereof, shall be less than 0.8 or more than 1.3.

Vibration levels shall not exceed the levels given in IS: 9137-1978 for Class 11 machines, quality bands A and B.

The completed units, when assembled and operating, shall be free of cavitations, vibration, noise, and oil or water leaks over the range of operation.

All units shall be so constructed that dismantling and repairing can be accomplished without difficulty.

The Contractor shall be responsible for proper operation of the complete pumping system, which includes the pump, motor, variable speed drive unit (if designated), and associated controls furnished with the pump.

The Contractor shall ensure that the controls and starting equipment are suitable for use with the pump motor, taking into account all requirements including starting currents and number of starts per hour.

For the performance curve of the selected pump impeller, the head shall continuously rise as flow decreases throughout the entire curve from run out to shutoff head.

The Contractor shall ensure that drive motors, variable speed drive systems (if specified) and pumps shall be supplied and tested together by the pump

manufacturer, who shall supply full certification for the proper function of the entire pumping system.

If variable speed drive systems are specified, motor and drive system shall be fully compatible, and shall be of sufficient power and torque, and be capable of sufficient heat transfer for starting, accelerating and continuously operating over the entire range of head/capacity conditions, from minimum to maximum pump operating speed, as designated. The motor shall be derated to take into consideration the reduced cooling effect when running at the lowest speed with the variable speed drive.

12.18.4 Design Conditions

Pumps shall be designed and constructed to satisfactorily operate and perform within the designated design conditions and the requirements specified herein. They shall be designed for a life of 100,000 hours with service intervals at 20,000 hours.

Castings, fabrications, machined parts and drives shall conform to the industry standards for strength and durability and shall be rated for continuous duty over the entire operating range.

Bearings shall be of the anti-friction type designed for an L10 life of at least 50000 h in accordance with IS: 3824: 2002

Pump maximum operating speed shall be of 1450 rpm.

Pumps shall be of non-clog design, capable of passing spheres of a minimum of 100 mm diameter unless other diameters are specified.

Pumps shall be suitable for use in the conditions specified

Renewable impeller wear rings shall be fitted, to the impeller and case, except where not available on a standard production unit. Impellers shall be single / double vane non-clog design.

The pump, motor and associated electrical equipment shall be rated for a minimum of 6 starts per hour, unless otherwise specified.

The Contractor shall ensure that the pump manufacturer provides certification, which guarantees the following:

- flow rate
- total head
- power input
- efficiency

12.18.5 Materials

Pumps shall be manufactured of the following materials as a minimum:

- volute casings shall be cast iron

- impellers shall be stainless steel as specified
- casing wear rings (where fitted) shall be brass or for abrasive applications nitrile-rubber clad steel or to the approved manufacturer's standard
- impeller wear rings shall be stainless steel BS 970 304 S15 or the approved manufacturer's standards.
- bends shall be cast iron
- motor casings shall be cast iron
- shafts shall be stainless steel, (SS-410)
- fasteners shall be stainless steel

The lifting system shall be manufactured of the following materials:

- the guide rail system shall be stainless steel;
- lifting chains and cables shall be stainless steel;

12.18.6 Fabrication

General: Pumps shall be fabricated in accordance with the following requirements:

- Pumps shall be capable of handling raw, unscreened sewage
- In the case of submersible installations no portion of the pump shall seat directly on the floor of the wet well. In the case of dry mounted pumps the pump manufacturer shall provide a substantial purpose built mounting frame

Wet well pumps shall incorporate the following features:

- pumps shall utilise a guide system to permit easy removal and reinstallation without dewatering the pump sump
- discharge connections shall be made automatically with a simple downward motion without rotation when the pump is lowered into operating position. The pump shall be capable of being removed without disconnecting any fasteners
- an appropriate length of chain shall be connected to the motor eyebolts to permit raising and lowering of the pump

Impellers shall be fabricated according to the rated motor size as follows:

- non-clog type statically and dynamically balanced, keyed to the shaft
- provided with pump-out vanes to prevent material from getting behind the impeller and into mechanical seal area
- provided with wear ring as necessary to assure efficient sealing between volute and impeller
- impellers shall not be trimmed unless approved by the Engineer
- single/multi vane or vortex type, with a cutter impeller in the case of small flows.

Discharge Connection and Guide Rails shall be fabricated as follows:

Sliding guide bracket and discharge connections shall be provided which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.

The guide rails shall not support any portion of the weight of the pump.

The pump discharge connections shall incorporate a sealing face and connection yoke to allow for automatic coupling to fixed discharge connection pipe work.

Pump shafts shall be fabricated as follows:

- pump shafts shall be of such diameter that they will not deflect more than 0.05 mm measured at the mechanical seal, whilst operating at full drive output
- the shaft shall be turned, round and polished
- the shaft shall be key-seated for securing the impeller.

Shaft seals shall be fabricated as follows:

- the drive motor and pump/motor bearings shall be sealed along the shaft with tandem mechanical seals operating in an oil filled chamber. The seals shall require neither routine maintenance nor adjustment, but shall be capable of being easily inspected and replaced.
- two back to back mechanical seals shall seal the motor off from the pump.
- the upper seal shall be oil lubricated with a carbon rotating component and fixed tungsten carbide component.
- the lower seal shall have both parts in tungsten carbide.
- a detector shall indicate when moisture is leaking past the first seal.

Bearings shall be fabricated as follows:

- bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump
- the upper bearing(s) shall be of the grease lubricated sealed for life type; the lower bearing(s) shall be lubricated by the internal oil supply
- the bottom bearing(s) shall be of the angular contact ball bearing type in combinations with roller bearing(s)
- if required in the project specification, remote indication shall be provided for bearing high temperature-, using a thermistor at the lower bearing, to provide a signal at 95 °C.

Motors shall be fabricated as follows:

- Motors shall be 415 V, three phase, 50 Hz, rated at 10% above the Break horse power requirement
- Motors shall be squirrel cage, induction, air filled, totally sealed to IP 68, suitable for the maximum immersion depth to be encountered, rated for zone 2 use with group 1 gases, to IS; 325-1996
- Motor insulation shall be Class F, limited to a Class B temperature rise

- Motor temperature shall be monitored using a thermistor, in each phase of the winding, set to stop the motor when the monitored absolute temperature reaches 130 °C
- A watertight cable junction box sealed from the motor shall be provided for the motor power and signalling cables shall be EPR insulated, Niplas sheathed flexible 450/750 volts grade, oil and grease resistant, with tinned annealed copper conductors in accordance with IS: 2892:1962. The cable shall be brought directly out of the submersible motor without joints, and shall be of sufficient length, minimum 20 m to be terminated in an IP67 junction box outside adjacent to the wet well. They shall be sized in accordance with the electricity utility regulations.
- Cables shall be supported using a proprietary 'sock' arrangement at the top of the wet well
- Wherever required Special Specification pumps shall be provided with proprietary monitoring and control units. Analogue inputs shall include the following:
 - winding temperature
 - bearing temperature
 - cooling oil temperature

Digital inputs shall include the following:

- high winding temperature
- high bearing temperature
- loss of coolant oil/seal failure
- over temperature
- moisture ingress
- Motors shall be capable of start up and operation in the event of a completely flooded wet well. Motors shall be selected to meet the maximum power required for the selected impeller at all operating conditions
- Motor cooling shall be either by means of the pumped medium or by oil. The use of external cooling water is not acceptable

Coatings and Protection shall be provided as follows:

- Cathodic protection with replaceable sacrificial zinc anodes shall be provided if required in the Special Conditions.
- All parts of the pump and motor shall be 100% holiday free fusion bonded epoxy coated to a minimum thickness of 300 microns.

12.18.7 Accessories

The following accessories shall be provided for each pump:

- Pressure gauges:- The discharge pipe work of each pump shall be provided with a 19 mm diameter tapped opening and stainless or brass isolating valves and diaphragm pressure gauges. In the case of dry-mounted submersibles a similar tapping valve and gauge shall also be provided on the suction pipe work of each pump
- Air bleed offs. - In the case of submersible pumps automatic brass air bleed ball valves shall be provided on the reflux valves, venting via a 40 mm

diameter stainless steel pipe to the wet well. In the case of dry mounted submersible pumps these valves shall be provided on the highest point of the volute casing

- Labels. Each pump shall have a stainless steel label permanently fixed to the pump and an identical label fixed to the pump starter compartment.
- Valves, Value Chambers

12.18.8 Factory Inspection and Testing

The Contractor shall secure certification from the pump manufacturer that the following inspections and tests have been conducted on each pump at the factory, and submit them to the Engineer prior to shipment:

- a. the pump casing has been tested hydrostatically to 1.5 times the maximum closed valve pressure
- b. impeller, motor rating and electrical connections checked for compliance with the Specifications
- c. motor and cable insulation tested for moisture content or insulation defects
- d. prior to submergence, the pump has been run dry to establish correct rotation and mechanical integrity
- e. the pump has been run for 30 minutes submerged under a minimum of 2 m water after the operational test above, the insulation tests (b) above has been performed again, and after the performance test (2) below
- f. NPSH (dry well mounted pumps only)

Each pump shall be tested at the factory for performance according to BS 5316 Part 1, including:

- flow
- inlet pressure
- outlet pressure
- motor power
- efficiency

The Contractor shall secure the following certification from the pump manufacturer and submit them to the Engineer prior to shipment:

- certified copies of the pump characteristic curves and reports generated by the tests described above and as required by IS: 9137: 1978
- Foundry composition certificates for all major castings (pump case, impeller, motor housing) showing exact material composition and tests conducted to ensure compliance with the pump manufacturer's material specifications.

12.18.9 Spare Parts and Tools

The Contractor shall ensure that the pump manufacturer provides all spares and special tools required during the commissioning and maintenance periods and as required below.

In addition to the spare parts required in the Specification the following spare parts for each pump shall be furnished to the Employer:

- three sets of complete upper and lower bearings
- three sets of wear rings
- three sets of gaskets and three sets of 'O' rings complete
- three sets of upper and lower mechanical seals
- additional spare parts as recommended by pump manufacturer to cover two years of operation following the maintenance period.

12.18.10 Site Inspection and Testing

The equipment delivered to the Site shall be examined by the Contractor to determine that it is in good condition and in conformance with the approved working drawings and certifications. All equipments shall be installed in strict conformance with the Specification and the manufacturer's instructions.

If required in the Specification, or in the case of submersible pumps rated at 50 kW or greater, the Contractor shall provide the services of the pump manufacturer's representative to supervise the installation, commissioning and start-up of the pumping equipment.

The commissioning tests shall include performance and reliability trials, mainly for the purpose of satisfying the Engineer that the pumpsets have been correctly assembled and installed and that their performance matches that obtained during the manufacturers works tests. In the event of an unwarranted change in the pump performance characteristics or power consumption, all necessary steps shall be taken as soon as possible to establish the cause and remove the fault. Similar action shall be taken for an undue increase in bearing or gland temperature, increased gland leakage rates, unsatisfactory vibration levels or any other fault or defect in the operation of the pumpset.

The site reliability trials shall include the following:

- A record of bearing and coupling clearance and alignments shall be tabulated to show the "as-built" condition of each pump
- A record of all overload, timing relay and oil pressure relays shall be tabulated to show the "as-built" condition of each motor starter
- All cables shall be 'megger' tested to confirm the integrity of the insulation. A tabulated record of results shall be made
- The control panel shall be statically tested with motors disconnected to confirm the correct sequence of operation
- Each pump shall be operated individually over the range from closed valve to maximum emergency top water level, on a recirculation basis, using fresh water, and for a minimum of four hours continuously. During this test the following parameters will be recorded: -
 - motor phase currents
 - pump output
 - ambient and test water temperatures
 - motor/pump casing temperature (dry well submersible only)
 - power consumed
 - power factor
 - vibration (dry well submersible only)

The commissioning trials shall extend until each pump unit has run 'continuously' for at least 3 days under all operating conditions. The term 'continuously' shall include running at various speeds or on a start/stop basis as determined by the control system

The Contractor's supervisory staff, and the pump manufacturers' representative, if required by the Specification or the above, shall be present during the period of the tests and trials. The Contractor shall be responsible for any failure of the whole equipment or any part thereof, whether such failure shall be determined by the methods detailed herein or otherwise. If the Contractor interrupts the pump test or trial, or through negligence on the part of the Contractors staff, it shall be completely repeated for the pumpset concerned.

Pumps in parallel: The pumps which are designed for \parallel^{ler} operation shall be tested for the rated Head, discharge, efficiency and HP. In individual operation each pump shall have higher head than the required head.

12.18.11 Motors

All motors shall be suitable for operation on a 415v, 50 HZ, 3 phase, AC supply. Induction motor shall be in conform with IS 325 - 1978

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

- | | | |
|------|--|--------------|
| i. | Variation of supply voltage from the rated motor voltage | $\pm - 10\%$ |
| ii. | Variation of supply frequency from the rated frequency | $\pm - 5\%$ |
| iii. | Combined voltage and frequency Variations | $\pm - 10\%$ |

All motors shall be capable of starting 10 times per hour. The stalled motor current shall not exceed 6 times the full load current.

Starting current of motor shall not exceed 200% of the rated full load current for star - Delta starting and 600% of rated full load current for DOL Starting under any circumstances.

Motor shall be capable of starting and accelerating the load with the applicable method of starting without exceeding the acceptable winding temperatures, when the supply voltage is in the range of 10% above of the rated motor voltage.

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

The insulation class of motor winding shall conform to class - F and the maximum temperature rise shall not exceed 950C, when measured by winding resistance method and 850C, when measured by thermometer method for an ambient temperature of 450C.

Motor shall be offered for routine and type tests in accordance with IS: 4029 and IS: 325 at the manufacturer's works. Test certificates shall be endorsed to the effect that they are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

Pump motors shall be of the squirrel cage submersible type, protected to IP. 68 and rated at 10 per cent above the calculated maximum power required on site.

The motor shaft shall be of large diameter, lightly stressed to ensure rigidity, with impeller and bearing location shoulders and a keyway for location of the impeller.

The motor windings shall be protected with a waterproof material and shall incorporate a thermistor in each phase to safeguard against high winding temperatures. The thermistor shall be connected into the control circuit of the starter and arranged for hand reset only.

The motor shall incorporate a cut-out device to detect the presence of any liquid in the motor enclosure.

The motor frame shall incorporate lifting points and shall be fitted with a galvanised lifting chain, reaching to, and secured at the access point.

The terminal connections for the power and protective circuits shall be housed in a completely sealed and waterproof junction box, complete with all external corrosion resistant cable glands.

The pump units shall be provided with power and protection circuit cables of sufficient length to reach from the motor junction box to the local isolator, located at the access level.

The power cable shall be 600/1000V grade flexible stranded copper wire, insulated and overall sheathed with under-water grade compound flexible insulation. The cable shall be rated to take the full motor current under the prevailing liquid and ambient temperature conditions.

12.18.12 Characteristic Curves

Characteristic and system curves for the pumps shall be supplied to a reasonably large scale which shall show the capacity of the pumps under single and multiple pump operation at the duty point.

When tested through their complete range of workable heads at the maker's works, all the pumps shall give results which conform to the curves submitted with the Tender. Curves showing pump efficiency and kW loading shall also be included.

12.18.13 Performance Test

Each pump shall be tested at the manufacturer's premises for the full operating range of the pump to IS: 5120-1979/IS 9137-1978 Test shall be carried out at rated speed with minimum NPSH available at site. Pump performance shall be within the tolerance limits specified in the above said IS. The contractor shall furnish the guaranteed values of discharge and efficiency for the total head at duty point for each pump.

12.19 SEWAGE PUMPS

12.19.1 Horizontal Sewage Pumps

The pumps shall be centrifugal nonclog, wear resisting single stage type, having end suction and top discharge suitable for handling sewage of 100 mm solids. The discharge nozzle shall be oriented in horizontal direction as shown in the layout drawing.

Pumps shall run smooth without undue noise and vibration. Noise level shall be limited to 85 dBA at 1.85 M. Vibration shall be limited to relevant Indian Standards.

Liquid passage shall be smooth to allow free passage of solids of 100 mm size. A hand hole shall be provided in the casing to allow easy access to the impeller as well as the casing throat. The casing shall be provided with wearing ring.

Impeller shall be nonclog enclosed type with smooth, blunt edges with large water ways to allow free passage of large size solids. The impeller shall be dynamically balanced.

Critical speed of the rotor shall be 30% above the operating speed.

Stuffing box design shall be such that repairing can be done without removal of any part other than gland and lantern ring.

The pump and motor shall be coupled through flexible coupling and mounted on a common base plate. A coupling guard shall be provided. Tapping for the pressure gauge connection shall be provided on the suction and discharge nozzle.

Material of construction shall be as under

Materials of construction

| | | |
|----|------------------------|--|
| a. | Impeller * | Stainless steel CF 8 M |
| b. | Casing * | Cast Iron to IS - 210 Gr 220 with 1.5 to 2% Nickel |
| c. | Shaft * | St. steel to AISI - 316 |
| d. | Shaft sleeve | St. steel ASTM - 296 CA - 15 |
| e. | Casing / impeller ring | St. steel ASTM - 296 CA - 15 |
| f. | Base plate | Cast iron |
| g. | Collar plug | St. steel CF 8 |
| h. | Stuffing box packing | Asbestos yarn coated with KOS ₂ |
| j. | Gland | Bronze |

For the components marked ‘*’ material test certificate shall be furnished by contractor.

The pump shall be suitable for single as well as parallel operation efficiently at any point between minimum and maximum system resistance's indicated in the system resistance curve.

The power rating of pump motor shall be atleast 110% of the maximum power required at any operating point along the system resistance curve including the duty point.

Pump motor unit shall be suitable for starting with discharge valve open as well as closed.

12.19.1.1 Pump Motor

The motor shall be 3 phase, 50 HZ, 415 V, squirrel cage, SPDP rated for continuous duty conforming to IS 325 having class 'B' insulation protection IP 23 suitable for star delta starting to limit the startup current to 200% of rated full load current.

Motor shall be suitable for giving the rated output without reduction in expected life, when operated continuously under supply condition

- a) $\pm 10\%$ Voltage variation
- b) $\pm 5\%$ frequency variation
- c) $\pm 10\%$ combined voltage and frequency variation

The power rating of the motor shall be such that the motor is not overloaded while pumping from zero discharge to the maximum discharge at minimum head as shown in the pump performance curve and shall still have 10% reserve of the maximum power required.

The motor shall not get overloaded at any point of operation between the maximum and minimum system resistance curves.

The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at 80% voltage by atleast two seconds or 15% of the accelerating time whichever is greater.

Motors when started with the drive imposing its full starting torque under the supply voltage variations specified shall be capable of withstanding atleast two successive starts from cold condition and one start from hot condition without injurious heating of windings. The motors shall also be suitable for four equally spread starts per hour under the above referred supply conditions.

The maximum temperature rise shall not exceed 750 C when measured by winding resistance method and 650 when measured by thermostat method for an ambient temperature of 450 C.

1. The motor construction shall be suitable for easy disassembly and reassemble. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repairs. Motors shall be provided with eyebolts, lags or other means to facilitate safe lifting.

Terminal boxes shall be of weather proof construction, designed for outdoor service to eliminate entry of dust and water. Gaskets of neoprene or approved equivalent shall be provided at corner joints and between box and motor frame.

The terminal box shall be capable of being turned through 360 degrees in steps of 180 degrees.

2. The terminals shall be of the stud type with necessary plain washers, spring washers and cheek - nuts. Ample phare to phase and phase to ground clearances shall be kept. Motors shall have drain plugs so located that they

will drain water resulting from condensation or other causes from all pockets in the motor casing.

3. The earthing pads shall be of non-corrodible metal welded or brazed at two locations on opposite sides. The size of the pads shall be 75 x 65 x 25 mm with two holes drilled at 40 mm centers, trapped and provided with suitable bolts and washers for connecting the earthing cable lags.

Temperature rise of widening in degree centigrade at rated load, rated voltage, frequency and ambient conditions and the method of measuring temperature rise shall be included on the rating plate.

Motor Specification

| | |
|----------------------------------|--|
| Type of motor | Squirrel cage |
| Rating | As specified |
| No. of phases and frequency | 3 phase 50 Hz |
| Type of duty | Continuous |
| Class of insulation | B |
| Type of enclosure | SPDP |
| Degree of protection (IS : 4691) | IP 23 |
| Minimum power factor | 0.84 |
| Terminal box shall withstand | |
| 1) Short time current | 20 KA (RMS) |
| 2) Duration | 0.25 Sec. |
| 3) Dynamic | 40 KA (RMS) |
| External cable details | 1.1 KV grade 3 C x 25 Sq. mm. Aluminum conductor PVC armored. |

12.19.2 Submersible Pumps for Sewage

12.19.2.1 General

Submersible sewage pumps shall be mono-block, non-clog type and suitable for pumping raw un-screened sewage containing sludge, storm water, fibrous material, plastic pieces, and other floating material/debris commonly found in sewage. Pumps shall be capable of admitting soft solids of minimum 100 mm dia and capable of dealing with the sewage/sludge with specific gravity of 1.05. Motor operating speed shall be of 1450 rpm.

Impellers shall be of single/double vane non-clog design. Additionally, a special contra-block cutting and tearing system should also be incorporated on the suction side of the pump for disposing of soft material, which would otherwise clog the pump.

Maintenance free anti-friction, permanently grease filled ball bearing shall be provided and this shall withstand all axial and radial forces due to motor, pump, pipes, specials, sewage flow and live load during installation and at any point of operation. The weights of the revolving parts of the pumps including the unbalanced hydraulic thrusts of the impellers shall be carried by thrust bearings provided in each pump assembly.

The pump installation design shall be such as facilities automatic installation and removal of the pump without having to enter into the

sewage pit. Profile gasket shall be provided in automatic coupling system so to avoid metal to metal contact between the pump and delivery bend to ensure leak-proof joint.

A reverse rotation prevention system shall be incorporated in the pump design to ensure that the pump does not start rotating in the reverse direction due to wrong electrical connection.

12.19.2.2 Contractor Submittals

In addition to the other requirements of the Specification, Contractor shall provide data and information described in the following paragraphs prior to manufacture of the specified pumps for sewage service.

The Contractor shall provide manufacturer's published pump curves, system curves and necessary hydraulic calculations to justify the pump model and configuration selected and proposed for supply and installation. A shop drawing shall be submitted by the Contractor clearly outlining the following information:

- Technical Data Sheet on the pump(s) specifying the following:
 - Pump Configuration
 - Performance Curve from a factory test on a pump of similar configuration and application
- Plan, Elevation and Sectional drawing of the pump clearly indicating footprint, internal dimensions, allowed tolerances
- Velocity of liquid in pump suction at duty point
- Velocity of liquid in pump delivery at duty point
- Velocity of liquid in the pump casing or impeller eye at duty point
- Materials of construction shall be specified in detail and itemized against the sectional drawing of the pump proposed
- Material Certification sheets showing the material composition, strength and related properties such as hardness and related parameters

The technical information on the following pump and associated electrical equipment shall be furnished in the ANNEXURES 1, 2 and 3 (enclosed) formats, duly signed, stamped and enclosed with the Technical Bid by the Contractor at the time of submission of bids for this Contract.

- Submersible Pumps
- Motor for Submersible Pump-set
- Starter(s)

The format of information required as specified above is given in ANNEXURES 1, 2 and 3 respectively. O&M Manuals and Installation Instructions shall be furnished along with all the equipment documentation as above.

12.19.2.3 Pump Requirements

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the Specification without surging, cavitations, or excessive vibration to the limits specified. All pumps and drives shall be from the approved manufacturers.

The pumps shall meet maximum allowable shut-off head (minimum 150% of the head at operating point).

The pumps shall not overload the motors for any point on the maximum pump speed performance characteristic curve and the pump operating range, within the limits of stable pump operation, as recommended by the manufacturer, to prevent surging, cavitations, and vibration.

To ensure vibration-free operation, all rotative components of each pumping unit shall be statically and dynamically balanced to BS 6861 and the following requirements shall be met:

- The mass of the unit and its distribution shall be such that resonance at normal operating speeds is within acceptable limits
- In any case, the amplitude of vibration as measured- at any point on the pumping unit shall not exceed the below limits
- At any operating speed, the ratio of rotative speed to the -critical speed of a unit, or components thereof, shall be less than 0.8 or more than 1.3.

Vibration levels shall not exceed the levels given in BS 4675 for Class 11 machines, quality bands A and B. The completed units, when assembled and operating, shall be free of cavitations, vibration, noise, and oil or water leaks over the range of operation. All units shall be so constructed that dismantling and repairing can be accomplished without difficulty.

The Contractor shall be responsible for proper operation of the complete pumping system, which includes type, model of the pump, motor, variable speed drive unit (if designated), and associated auxiliary units and controls. for the intended purpose. The Contractor shall ensure that the controls and starting equipment are suitable for use with the pumps and motor selected for the said purpose taking into account all requirements and constraints on hydraulic, mechanical and electrical parameters and their standard specification.

The Contractor shall ensure that drive motors, variable speed drive systems (if specified) and pumps shall be supplied and tested together by the pump manufacturer, who shall supply full certification for the proper function of the entire pumping system.

If variable speed drive systems are specified, motor and drive system shall be fully compatible, and shall be of sufficient power and torque, and be capable of sufficient heat transfer for starting, accelerating and continuously operating over the entire range of head/capacity conditions, from minimum to maximum pump operating speed, as designated. The motor shall be derated to take into consideration the reduced cooling effect when running at the lowest speed with the variable speed drive.

12.19.2.4 Design Conditions

Pumps shall be designed and manufactured to operate and perform satisfactorily within the designated design conditions and requirements specified herein. They shall be designed for a minimum service life of 15 years.

Castings, fabrications, machined parts and drives shall conform to industry standards for strength and durability and shall be rated for continuous duty over the entire operating range.

Bearings shall be of the anti-friction type designed for an L10 life of at least 50,000 hours in accordance with BS 5512

Pump maximum operating speed shall be of 1450 rpm. Pumps shall be of non-clog design, capable of passing solids of a minimum 100-mm diameter sphere unless otherwise specified. Pumps shall be suitable for use in the conditions specified. Renewable impeller wear rings shall be fitted, to the impeller and case, except where not available on a standard production unit. Impellers shall be single / double vane non-clog design.

Submersible pumps shall have the duck foot bends flanged to NP16, BS: 4504 or equivalent IS. In the case of dry mounted pump the outlet and inlet shall be flanged to NP16 BS 4504.

The pump, motor and associated electrical equipment shall be rated for a minimum 6 starts per hour, unless otherwise specified and shall also be capable of running non-stop for maximum duration of 24 hours without exceeding the nominally allowable temperature and performance conditions. Contractor shall ensure that the pump manufacturer provides certification, which guarantees the following:

- Flow rate
- Total head
- Power input
- Pump and Motor Efficiency
- Liquid suitability for pumping

12.19.2.5 Materials

Pumps shall be manufactured of the following materials as a minimum:

- Volute Casing and Impellers shall be stainless steel (CF8M). Impeller shall be of single/double vane non-clog design with a block cutting and tearing system incorporated on the suction side
- Casing wear rings and impeller wear rings shall be Stainless steel (CF 8 M)
- Bends shall be cast iron, BS: 1452 Grade 250
- Motor casings shall be cast iron, BS: 1452 grade 250
- Shafts shall be stainless steel, (SS-410) BS: 970 Part 1
- Fasteners shall be stainless steel, BS 6105 and BS 970 304 S15.

The lifting system shall be manufactured of the following materials:

- The guide rail system shall be stainless steel; BS: 970 Type 316 S31
- Lifting chains and cables shall be stainless steel; BS: 970 Type 316 S31.

12.19.2.6 Fabrication

Pumps shall be fabricated in accordance with the following requirements:

- Pumps shall be capable of handling raw, unscreened sewage

- In the case of submersible installations no portion of the pump shall bear directly on the floor of the wet well.

Wet well pumps shall incorporate the following features:

- Pumps shall utilize a guide system to permit easy removal and reinstallation without de-watering the sump/ wet well
- Discharge connections shall be made automatically with a simple downward motion without rotation when the pump is lowered into operating position. The pump shall be capable of being removed without disconnecting any fasteners
- An appropriate length of chain shall be connected to the motor eyebolts to permit raising and lowering of the pump

Impellers shall be fabricated according to the rated motor size as follows:

- Non-clog type statically and dynamically balanced, keyed to the shaft
- Provided with pump-out vanes to prevent material from getting behind the impeller and into mechanical seal area
- Provided with wear ring as necessary to assure efficient sealing between volute and impeller
- Impellers shall not be trimmed unless approved by the engineer
- Single /multi vane or vortex type, with a cutter impeller in the case of small flows.

Discharge Connection and Guide Rails shall be fabricated as follows:

- Sliding guide bracket and discharge connections shall be provided which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.
- The guide rails shall not support any portion of the weight of the pump. The pump discharge connections shall incorporate a sealing face and connection yoke to allow for automatic coupling to fixed discharge connection pipework.

Pump Shafts shall be fabricated as follows:

- Pump shafts shall be of such diameter that they will not deflect more than 0.05 mm measured at the mechanical seal, whilst operating at full driver output
- The shaft shall be turned, round and polished
- The shaft shall be key-seated for securing the impeller.

Shaft Seals shall be fabricated as follows:

- The drive and pump/motor bearings shall be sealed along the shaft with tandem mechanical seals operating in an oil filled chamber. The seals shall require neither routine maintenance nor adjustment, but shall be capable of being easily inspected and replaced.
- Two back to back mechanical seals shall seal the motor off from the pump.

- The upper seal shall be oil lubricated with a carbon rotating component and fixed tungsten carbide component.
- The lower seal shall have both parts in tungsten carbide.
- A detector shall indicate when moisture is leaking past the first seal.

Bearings shall be fabricated as follows:

- Bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump
- The upper bearing(s) shall be of the grease lubricated sealed for life type; the lower bearing (s) shall be lubricated by the internal oil supply
- The bottom bearing(s) shall be of the angular contact ball bearing type in combinations with roller bearing(s)
- If required in the project specification, remote indication shall be provided for bearing high temperature using a thermistor at the lower bearing, to provide a signal at 95°C

Motors shall be fabricated as follows:

- Motors shall be 415 V, 3 phase, 50 Hz, with variations as given below.
 - a) $\pm 10\%$ Voltage variation
 - b) $\pm 5\%$ frequency variation
 - c) $\pm 10\%$ combined voltage and frequency variation
- Motors shall be squirrel cage, induction, air filled, totally sealed to IP 68, suitable for the maximum immersion depth to be encountered, rated for zone 2 use with group 1 gases, to BS: 5345
- Motor insulation shall be Class F, limited to a Class B temperature rise
- Motor temperature shall be monitored using a thermistor, in each phase of the winding, set to stop the motor when the monitored absolute temperature reaches 130 °C
- A watertight cable junction box sealed from the motor shall be provided for the motor power and signaling cables shall be EPR insulated, Niplas sheathed flexible 450/750 volts grade, oil and grease resistant, with tinned annealed copper conductors in accordance with BS: 6007. The cable shall be brought directly out of the submersible motor without joints, and shall be of sufficient length, minimum 20 m to be terminated in an IP67 junction box outside adjacent to the wet well. They shall be sized in accordance with the electricity utility regulations and BS: 7671
- Cables shall be supported using a proprietary 'sock' arrangement at the top.
- Where required in the Special Specification pumps shall be provided with proprietary monitoring and control units for inclusion in the motor controls. Analogue inputs shall include the following:
 - Winding temperature
 - Bearing temperature
 - Cooling oil temperature

Digital inputs shall include the following:

- High winding temperature
- High bearing temperature

- Loss of coolant oil/seal failure
- Over temperature
- Moisture ingress

Motors shall be capable of start up and operation in the event of a completely flooded wet well. Motors shall be selected to meet the maximum power required for the selected impeller at all operating conditions. Motor cooling shall either be oil cooled and fins shall be mounted on the external frame to dissipate heat to the surrounding service fluid (sewage). The use of external cooling water is not acceptable. Coatings and Protection shall be provided as follows:

- Cathodic protection with replaceable sacrificial zinc anodes shall be provided if required in the Special Specification.
- All parts of the pump and motor shall be 100% holiday free fusion bonded epoxy coated to a minimum thickness of 300 microns.

12.19.2.7 Accessories

The following accessories shall be provided for each pump:

- Pressure gauges. The discharge pipe work of each pump shall be provided with a 19 mm diameter tapped opening and stainless or brass isolating valves and diaphragm pressure gauges. In the case of dry-mounted submersibles a similar tapping valve and gauge shall also be provided on the suction pipe work of each pump
- Air bleed offs. In the case of submersible pumps automatic brass air bleed ball valves shall be provided on the reflux valves, venting via a 40 mm diameter stainless steel pipe to the wet well. In the case of dry mounted submersible pumps these valves shall be provided on the highest point of the volute casing
- Labels. Each pump shall have a stainless steel label permanently fixed to the pump and an identical label fixed to the pump starter compartment.

12.19.2.8 Factory Inspection and Testing

The Contractor shall secure from the pump manufacturer certification that the following inspections and tests have been conducted on each pump at the factory, and submit to the Engineer prior to shipment:

- The pump casing has been tested hydrostatically to 1.5 times the maximum closed valve pressure
- Impeller, motor rating and electrical connections checked for compliance with the specifications
- Motor and cable insulation tested for moisture content or insulation defects
- Prior to submergence, the pump has been run dry to establish correct rotation and mechanical integrity
- The pump has been run for 30 minutes submerged under a minimum of 2 m water after the operational test above, the insulation tests above has been performed again, and after the performance test below.

Each pump shall test at the factory for performance according to BS 5316 Part 1, including:

- Flow
- Inlet pressure
- Outlet pressure
- Motor power
- Torque
- Efficiency

The Contractor shall secure from the pump manufacturer the following certification and submit to the Engineer prior to shipment:

- Certified copies of the pump characteristic curves and reports generated by the tests described above and as required by BS: 5316 (Part 1)
- Foundry composition certificates for all major castings (pump case, impeller, motor housing) showing exact material composition and tests conducted to ensure compliance with the pump manufacturer's material specifications.

12.19.2.9 Witness Shop Test Requirements

Pursuant to approval of the shop drawing submittal, the Contractor shall arrange for a Witness Shop Test of the manufactured pumps at the manufacturer's test facility. Each pump shall be tested at the manufacturer's premises for the full operating range of the pump to BS: 5316 (Part 2) Test shall be carried out at rated speed with minimum NPSH available at site. Pump performance shall be within the tolerance limits specified in the above said BS. The contractor shall furnish the guaranteed values of discharge and efficiency for the total head at duty point for each pump.

The team witnessing the shop test shall comprise representative(s) from the Contractor, Client and Engineer. A detailed test plan along with schedule, test procedure, deliverable and timelines shall be submitted by the Contractor prior to arranging the shop test. The following tests shall be performed on the motor-pump combination unit:

- Motor
 - Hi-Pot Test
 - Bearing Temperature Test – The said motor shall be run dry for a period of six to eight hours and temperature measurements on the inner and outer raceway of the bearing (outboard and inboard) be made starting at the six hour mark and ending at the eight hour mark. Temperatures shall be recorded over 15 minute intervals and shall not exceed 120 deg. F (outer raceway) and 180 deg. F (inner raceway)
 - Insulation Breakdown Test
- Pump
 - Pump Performance Test
 - Vibration Test

If the said pump or pumps fails the witness shop test, a re-test shall be performed at NO additional cost to the Client. Required modifications to the equipment, revised schedule and work plan shall be provided in a new submittal by the Contractor for review.

Pursuant to successful completion of the shop test, the Contractor shall submit a shop drawing containing the test procedure, witness shop test results including system drawing, performance curve, detailed calculations and data collected (readings). System Efficiency calculated during the witness shop test shall meet or exceed the manufacturer's guaranteed efficiency for the said pump. Contract shall also certify that the efficiency guaranteed by the manufacturer shall be equal or greater than the efficiency guaranteed by other manufacturers (minimum 3 nos.) for commercially available pumps of the said configuration. System Efficiency shall be calculated by obtaining the BHP of the motor by use of a Torque Dynamometer or approval equivalent measuring instrument. Nominal efficiency of the motor shall not be used in calculation of motor output (pump input).

Characteristic and system curves for the pumps shall be supplied to a reasonably large scale, which shall show the capacity of the pumps under single and multi pump operation at the duty point.

When tested through their complete range of workable heads at the maker's works, all the pumps shall give results which conform to the curves submitted with the Tender. Curves showing pump efficiency and kW loading shall also be included.

12.19.2.10 Spare Parts and Tools

The Contractor shall ensure that the pump manufacturer provides all spares and special tools required during the commissioning and maintenance periods and as required below. In addition to the spare parts required in the Specification the following spare parts for each pump shall be furnished to the Client:

- Three sets of complete upper and lower bearings
- Three sets of wear rings
- Three sets of gaskets and three sets of 'o' rings complete
- Three sets of upper and lower mechanical seals
- Additional spare parts as recommended by pump manufacturer and/or recommended by the Engineer to cover two years of operation following the maintenance period

The cost of the above mentioned spare parts shall be included in the rate quoted for the pumps.

12.19.2.11 Site Inspection and Testing

Equipment delivered to the Site shall be examined by the Contractor to determine that it is in good condition and in conformance with the approved working drawings and certifications. All equipment shall be installed in strict conformance with the Specification and the manufacturer's instructions.

Contractor shall provide the services of the pump manufacturer's representative to supervise the installation, commissioning and start-up of the pumping equipment.

The commissioning tests shall be performance and reliability trials to ensure that the pumps have been correctly assembled and installed and that their performance matches that obtained during the manufacturer's factory and shop tests. In the event of an unwarranted change in the pump performance characteristics or power consumption, all necessary steps shall be taken as

soon as possible to establish the cause and remove the fault at no additional cost to the Client. Similar action shall be taken for an undue increase in bearing or gland temperature, increased gland leak rates, unsatisfactory vibration levels or any other fault or defect in the operation of the pumps. The site reliability trials shall include the following:

- A record of bearing and coupling clearance and alignments shall be tabulated to show the "as-built" condition of each pump
- A record of all overload, timing relay and oil pressure relays shall be tabulated to show the "as-built" condition of each motor starter
- All cables shall be 'megger' tested to confirm the integrity of the insulation. A tabulated record of results shall be made
- The control panel shall be statically tested with motors disconnected to confirm the correct sequence of operation
- Each pump shall be operated individually over the range from closed valve to maximum emergency top water level, on a recirculation basis, using unscreened sewage, and for a minimum of four hours continuously. During this test the following parameters will be recorded: -
 - Motor phase currents
 - Pump output
 - Ambient and test water temperatures
 - Power consumed
 - Power factor
 - Vibration
 - Functionality

The commissioning trials shall extend until each pump unit has run 'continuously' for at least 3 days under all operating conditions. The term 'continuously' shall include running at various speeds or on a start/stop basis as determined by the control system

The Contractor's supervisory staff, and the pump manufacturer's representative, if required by the Specification or the above, shall be present during the period of the tests and trials. The Contractor shall be responsible for any failure of the whole equipment or any part thereof, whether such failure shall be determined by the methods detailed herein or otherwise. If the Contractor interrupts the pump test or trial, or through negligence on the part of the Contractor's staff, it shall be completely repeated for the pump set concerned.

12.20 DOMESTIC WATER PUMPSETS

Centrifugal type, self priming monoblock pump set with capacity of 5 cu. m / hr and a total head of 12 m suitable for pumping clear water from underground tank to overhead tank shall be provided. Pumpsets connected to a common header of 25 NB size and 3 m long. 25 NB suction and discharge piping with necessary unions, bends and tees shall be provided. Piping shall be as per IS: 1239 heavy class.

12.21 PORTABLE SITE DRAINAGE PUMPS

12.21.1 Description of Site Drainage Pumps

Portable site drainage pumps shall be provided, complete with all necessary hoses, cables and support rope, suitable for transportation to and use at any location on the works.

The pumps shall be of submersible vertical shaft, centrifugal single stage and non-clog type suitable for operation on a 415 volt, three phase 50 Hz supply.

Each pump shall be capable of handling sludge and liquids containing grit and solids as found in pump suction, drainage, tank and general site drainage duties.

The sump pump shall be of heavy construction with impellers made of high grade abrasive resistant material having non-overloading characteristics.

The pumps shall run smooth without undue noise and vibration.

Suction and delivery pipes shall be as per IS: 1239 heavy class galvanised steel, with the required length of 50 mm diameter. Pipes and fittings to lead the pumped liquid to the wet well shall be provided

12.21.2 The pumps shall conform to the following:-

- i) The pump casings shall be of cast iron with a lower renewable wear ring and any other parts liable to wear shall also be renewable.
- ii) The impellers shall be generally in accordance with standards and shall be capable of passing a solid sphere of 10 mm. diameter without choking. They shall be designed to give non-overloading characteristics over the complete working range of the pump.
- iii) The design of the pump units shall be such that there will be no tendency to unlock any part due to a possible reversal of rotation. The pump speed shall not pass through or approach the critical speed.
- iv) The pumps shall be capable of working for long periods without cleaning or attention and special precautions shall be taken to avoid wear on the working surfaces due to grit.
- v) An oil chamber shall be incorporated between the pump and motor units to lubricate the seal rings.
- vi) The unit shall be supplied with an adequate length of suitably sheathed flexible cable, which shall pass through a watertight gland on entry into the motor body.
- vii) The pump shall be suitable for operation in liquids that have been subject to direct sun lighting and the rating shall be continuous when operated at any point on the characteristic curve between closed valve and zero head.
- viii) The pump delivery shall be suitable for the connection of flexible hoses utilising a quick-release type coupling. 5 numbers of 5 m lengths of 50 mm. diameter rubber, with fabric or cord reinforcement, discharge hoses shall be supplied along with each pump. Each length fitted with quick release type metal coupling to suit the pump.
- ix) Each pump shall be rated to deliver 5 to 7.5 lps against heads between 5 and 10 m.

- x) For the purpose of lifting the pump in and out of sumps etc., there shall be provided two Nos. 10 m lengths of 15 mm. diameter good quality rope for each pump. One end of each length shall be spliced with a galvanised mild steel (or corrosion resistant metal) protection oval. Four Nos. galvanised screwed shackles of not less than 60 mm. diameters shall be supplied to secure the rope to the pump lifting point.

12.21.3 Method of Control

Automatic

All controls, timers etc., necessary to achieve the sequence of events detailed hereunder shall be housed in the Control Panel detailed else where.

Manual

Manual control shall be provided for the portable pumps. The thermal protection of standard the Specification shall be included in the control circuit.

12.21.4 Motors

Submersible pump motors shall be provided generally in accordance with standard specification and shall be of the squirrel cage submersible type protected to IP.68 and shall be rated at 20 per cent above the calculated maximum power required on site.

The motor windings shall incorporate thermal switches as a safeguard against overheating. The thermal switches shall be connected into the control circuit of the starter and arranged for hand reset only, and arranged so that the starter circuit cannot be energised until all plugs and sockets are connected and the thermal switch is heating.

The motors shall be provided with adequate cooling facilities which shall be achieved either by the surrounding water in the sump or by providing a motor jacket cooling system supplied with water from the pump volute. The portable drainage pump motor starter shall be housed in a weather proof box fixed on the wall of inlet (screen) well.

Each portable pump shall be supplied with a 30 metre length of flexible six core cable (power/earth and thermal leads) for connection to the starter socket at the inlet well and terminating with a six pin plug with secure fixing (this plug shall not fit power point socket outlets). There shall also be provided for each type of pump 3 No. 20 metre lengths of six core motor cable length on portable drum with stand, cable ends terminated with matching six pin plug / socket or one 3 pin and earth socket phy. & 2 pin socket/phy both controlled by TP & SP MCB's respectively.

12.22 MANUALLY RAKED BASKET SCREEN (LIFTING TYPE)

The screen shall be L-shape and shall be capable of being lifted by means of a electrically operated mechanical lifting arrangement and raised above the operating platform, as and when necessary.

The vertical screen shall be fabricated out of stainless steel flats. The Frame, Guiding bars and fixing bolts shall be of stainless steel. The bottom of the screen shall be stainless steel plate with perforations to drain the screening.

The L - shaped screen shall comprise of SS flats, 10 mm thick and 50 mm wide in section. The clear spacing between the flats shall be 37.5 mm. The width and height of screens shall be as per the drawing enclosed.

The screen shall move vertically up or down in guide channels fixed to the side walls of the inlet chamber. Each screen shall have two lifting hooks, spaced sufficiently apart from the centre at the top of the screen frame.

Stainless steel rollers shall be provided on the screen frame, two on each side, to enable the screen to move smoothly in the guide channel. The cross braces and stiffeners of the screen shall be provided on the downstream side of the screens to ensure that the screen does not deform in use.

12.23 NOT USED

12.24 MATERIAL HANDLING CRANES

12.24.1 Manually Operated Traveling Crane

Manually Operated Traveling Crane shall be installed in the Suction Well cum Pump House to lift and handle the submersible raw water pumps and associated equipment. The crane-bridge shall consist of a single bridge girder supported at both ends of the columns of the Suction Well cum Pump House. Steel used shall be tested in conformance to IS: 2062. The girder and supports shall be rated at sufficient strength to carry the test load without causing any deformity under stress or deflection.

The runway rails of adequate strength and rigidity, rail clamps and other accessories for mounting the rails and suitable end stops for the bridge shall be supplied by the Contractor. The rail section shall be 15 kg/m. The operating floor elevation for lifting and transverse travel is the plinth level of the pump house, which is indicated in the Contract Drawings.

12.24.2 Trolley and Chain Pulley Block

The chain pulley block shall be operated on the lower flange of the bridge girder. The load chain shall be made of alloy steel as per IS: 3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.

The hand chains for the hoisting and traverse mechanism shall hang clear of the hook and both chains shall be on the same side. The hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guarding to prevent snagging and fouling of the chain. All gearing shall be totally encased. Proper lubricating arrangement shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat-treated alloy steel. Gears shall be as per BS: 436 / IS: 4460.

The trolley track wheel shall be rim toughened, heat-treated carbon steel or low alloy steel or CI and shall be single flanged and shall have anti-friction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.

The travelling trolley frame shall be made of rolled steel conforming to IS: 2062. The side plates of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction, single hook type provided with a standard depress type safety latch. The hook shall swivel and operate on antifriction bearings with hardened raceways. Locks to prevent hooks from swiveling out of position shall be provided. Hook shall be as per BS: 2903 / IS: 3815.

The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting. Contractor shall offer a crane of capacity minimum 1-1/2 times greater than the weight of the pump-motor units to be handled.

12.24.3 Electrically Operated Hoists

Electric hoists shall be complete with hoisting motors wire rope drum, wire rope, hook, necessary gearing, sheaves, electromagnetic brake for hoisting motor wire rope drum, wire rope, hook, necessary gearing sheaves, electromagnetic brake for hoisting motion, weather and dust-proof push button station, contractor panel, all wiring, limit switches, etc.

Electric hoists shall conform to IS: 3938 and shall be suitable for outdoor application. All the parts of the hoist shall be designed to withstand surrounding atmospheric conditions without any deterioration.

Rope drums shall be either cast or welded to sustain concentrated loads resulting from rope pull. Drums shall be machine grooved right and left with grooves of a proper shape for the rope used.

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

Hoist ropes shall be extra flexible, improved plough steel rope with a well lubricated hemp core and having six strands of 37 wires per strand with minimum ultimate tensile strength of 1.6×10^6 KN/sqm.

Hooks shall be solid, forged, heat treated alloy or carbon steel of rugged construction of the single hook type and provided with a standard depress type safety latch.

Hoisting motor shall be equipped with electrically released, spring set, friction shoe type brakes having torque capable of holding 125% of the full rated hook load. Brake shall apply when either the motor controller or the main power switch is in 'OFF' position or in the event of power failure.

Drive motors shall be designed for frequent reversal, braking and acceleration and shall be as per IS:325. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS:3938. Limit switches shall be provided for over-hoisting and over-lowering conditions. The girder carrying the electrical hoist and the support columns shall

have enough strength to carry the test load without causing any deformity under full load condition and stress.

12.24.4 Pipes and Fittings

Cast iron pipes shall generally conform to Class B IS: 1537 / IS: 1536 / IS: 7181 and pipe fittings shall conform to IS: 1538 and laying of pipes as per IS: 3114-1985

Ductile Iron pipes shall conform to IS: 8329/and pipe filling as per IS: 9523:1980. All pipes and fittings shall be flanged. Laying and jointing as per 12288 - 1987

The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr. FG 200.

The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance of ± 3 mm.

The flanges of the straight pipes shall be square to the axis of the pipe. The faces of the flanges shall be parallel. The bolt holes in one flange shall be located in line with those in other.

The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centre line. The intersecting axes of the tees shall be perpendicular to each other.

The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.

The dismantling joints shall be of cast iron with EPDM seal ring.

12.25 EXHAUST FANS

Exhaust fans (2 nos.) shall be wall mounted at a specified clearance from the underside of the roof of the Pump House. Fans shall be sized such that each unit is capable of discharging a minimum of three (3) air volume changes per hour. Adequate infiltration of fresh air shall be ensured either through the main entrance door or windows. Exhaust fans shall be of the direct drive, propeller type. All the exposed parts shall be of aluminum, with transparent anodic anti-salt spray coating. All external fasteners shall be of stainless steel. Hood shall be hinged for accessibility and servicing. Fans shall be complete with aluminum bird screen, plastic or lightweight aluminum back draft dampers and electrical disconnect beneath the hood and protective grid guard below fan motor.

Motors shall be of relevant Indian standards or British standards and shall have permanently lubricated ball bearings. The rating shall be adequate with service factor of 1.50 based on rated horsepower. All motors shall be TEFC and be suitable for continuous operation without exceeding a temperature rise of 50°C over ambient. The motor shall be of constant speed and squirrel cage type, operating on 415-V, 3 phase, 50-Hz supply. Roof mounted motors shall have electrical disconnects.

Contractor shall submit all catalogues showing the sizing and rating of fans with the size of openings to be provided for approval to the Engineer prior to ordering and installation of the exhaust fans