

06 CHAPTER

SPECIFICATIONS FOR MECHANICAL WORKS (GENERAL)

Applicability

The following clauses specify general mechanical requirements and standards of workmanship for equipment and installation and must be read in conjunction with the particular requirements for Contract. These general specifications' clauses shall apply where appropriate, except where redefined in the particular sections of the technical specifications which shall be applicable.

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.

BS 5135	Specification for arc welding of carbon manganese steels
BS 5316 Part-2	Specification for acceptance test for centrifugal, mixed flow and axial pumps – Test for performance and efficiency
BS 6072	Method for magnetic particle flow detection
BS 6405	Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes: Class 1 & 2
BS 6443	Method for penetrate flow detection
ASTM A-36	Specification for Structural Steel
ASTM A-216	Specification for Steel Castings, Carbon suitable for fusion welding for high temperature service
ASTM A-276	Specification for stainless steel and heat resisting steel bars and shapes
ASTM A-351	Specification for castings, Austenitic – Ferric (Duplex) for Pressure containing parts
ASTM A-743	Specification for castings, Iron – Chromium, Iron – Chromium – Nickel and Nickel Base Corrosion Resistant for general Application
ASTM A-744	Specification for castings, Iron Chromium – Nickel, Corrosion – Resistant
IEC – 189 Part 1 & 2	Low frequency cables and wires with PVC insulation and PVC Sheath
AWWA C 501	Cast Iron Sluice Gates
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 switch gear and control gear
IS 3177	Code of practice of electric overhead traveling cranes and gantry cranes other than steel work cranes
IS 3624	Vacuum and Pressure gauges
IS 3815	Point hooks with shank for general engineering purposes

BS 2910	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 3017	Specification for mild steel forged ram shorn 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
BS 4871	Specification for approval the sting of welders working to approved welding procedures
BS 4942	Short chain link for lifting purposes
IS 1710	Specification for Pumps – Vertical Turbine Mixed and Axial Flow, for Clear, Cold Water
IS 5120	Technical requirements of roto dynamic special purpose pumps
IS 5600	Horizontal / vertical non clog type centrifugal pump for sludge handling
IS 6595	Horizontal Centrifugal Pumps for Clear, Cold Water
IS 7090	Guide lines for rapid mixing devices
IS 7208	Guide lines for flocculator devices
IS 10261	Requirements for clarifier equipment for waste water treatment
IS 8413	Requirements for biological treatment and equipment
Part-II	Activated sludge process and its modifications
IS 10037	Requirements for sludge dewatering equipment, sludge
Part-I	Drying beds, sand, gravel and under drains
IS 6280	Specification for Sewage Screens
IS 3938	Electric Wire rope hoists

Further, following codes and standards unless specified herein shall be referred to for pipe lines, pipe works and fittings.

IS 210	Specification for grey iron casting
IS 290	Specification for coal tar black paint
IS 456	Code of practice for plain and reinforced concrete
IS 458	Specification for pre cast concrete pipes (with and without reinforcement)
IS 516	Method of test for strength of concrete
IS 638	Specification for sheet rubber jointing and rubber insertion jointing
IS 783	Code of practice for laying of concrete pipes
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1367	Technical supply conditions for threaded steel fasteners
IS 1387	General requirements for the supply of metallurgical materials
IS 1500	Method for Brinell hardness test for metallic materials
IS 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS 1537	Specification for 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 1916	Specification for steel cylinder pipes with concrete lining and coating
IS 2078	Method for tensile testing of grey cast iron
IS 3589	Specification for MS Spirally Welded Pipes
IS 3597	Method of tests for concrete pipes

IS 3658	Code of practice for liquid penetrant flow detection
IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5504	Specification for spiral welded pipes
IS 6587	Specification for spun hemp yarn
IS 7322	Specification for specials for steel cylinder reinforced concrete pipes
IS 8329	Specification for DI pipes
IS 9523	Specifications for DI fittings
IS 4984	Specifications for HDPE pipeline
IS 14846	Specifications for valves
IS 783	Code of practice for laying of concrete pipes
IS 3114	Code of practice for laying of cast iron pipes
IS 3764	Excavation work - Code of Safety
IS 4127	Code of practice for laying of glazed stoneware pipes
IS 5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS 6530	Code of practice for laying of asbestos cement pressure pipes.

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.**

Design and Construction

- a. The plant design, workmanship and general finish shall be of sound quality in accordance with good engineering practice. Design shall be robust and rated for continuous service, at the specified duties, under the prevailing operational site conditions.
- b. The general design of mechanical and electrical plant particularly that of wearing parts, shall be governed by the need for long periods of service without frequent attention but shall afford ready access for any necessary maintenance.
- c. Similarly items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as the originals.
- d. No welding, filling or plugging of defective work will be permitted without the written permission of the Engineer. All welding spatter shall be removed.
- e. It shall be the responsibility of the contractor to ensure that all the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation.
- f. It shall be the responsibility of the contractor to ensure his equipment interfaces with any existing equipment correctly. Any interfaces must not affect the integrity of the equipment, or invalidate any warranties or guarantees.
- g. Each component or assembly shall have been proven in service in a similar application and under conditions no less than those specified therein.
- h. The equipment shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.
- i. All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.

j. Materials shall be selected to eradicate or reduce corrosion to a minimum.

Tropicalization

Equipment is to be designed for tropical climate suitable for Indian conditions and the city/location where it is to be installed and the following shall apply.

- i. Tropical grade materials should be used wherever possible. Some relaxation of these provisions may be permitted where equipment is hermetically sealed.
- ii. Iron and steel and in general to be painted or galvanized as appropriate in accordance with the specification. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electro-magnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc. which are built up of lamination or can not for any other reasons be anti rust treated, are to have all exposed parts thoroughly cleaned and heavily enameled, lacquered or compounded.
- iii. The use of iron and steel is to be avoided in instruments and electrical relays whenever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be corrosion resisting steel. Instruments screws, except those forming part of a magnetic circuit, are to be of brass or bronze. Springs are to be of brass, bronze or other non-rusting material. Pivots and other parts for which non-ferrous material is unsuitable are to be of an approved stainless steel.
- iv. Fabrics, cork, paper and similar materials, which are not subsequently to be treated by impregnation, are to be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed oil varnishes are not to be used.

Climate

- i. All part and materials used shall in all respects be suitable for the climatic conditions of the city/location where it is to be installed. The following maximum conditions shall be used for all design.

Maximum Ambient Temperature for Design Purpose	:	50 °C
Maximum Relative Humidity	:	95%

In damp situations and wherever exposed to the weather, precaution shall be taken against corrosion of metal work, cable armour conduit and the like.

De-Rating due to the Climatic Conditions

- i. All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 50 °C in accordance with the appropriate regulations unless otherwise specified.
- ii. All materials and equipment which are subject to certification by testing authorities etc. shall be certified as being tested at 50 °C ambient unless other higher temperature specified elsewhere for specific equipment/product.

Packing and Delivery

- a. All part and equipment as necessary shall be packed in first quality containers or packing; no second hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.
- b. Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.

- c. The 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 kg gross.
- d. Precaution is to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings impregnated with anti-rust composition or vapour phase inhibitors are to be used of sufficient strength 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.**
- e. Lids and internal cross battens of all **packing cases are to be fixed by screws and not nails.**

Hoop metal bindings of cases are to be sealed where ends meet and if not of rust less material are to be painted. 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 of which the batten may rest. Cases are to be up-ended 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 is to be strengthened by means of a pad.

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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 is to be strengthened by means of a pad.

All stencil marks on the outside of the casings are to be either of a water proof material or protected by Shellac or varnish to prevent obliteration in transit.

- f. Wood wool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.
- g. Where applicable, indoor items such as electric motors, winch and control gear, instruments and panels, machines components etc. are to be 'cocooned' or covered in polythene sheeting, selected at the joints and the enclosures provided internally with an approved desiccators.
- h. 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.
- i. Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forward 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.

- j. Structural steel work, pipes, valves, encased fittings and metal work shall be similarly marked. In addition, one in every ten repeated articles shall bear the dispatch marks in suitable paint or other

approved medium. When in the opinion of the Engineer, the dispatch marks can not be applied satisfactorily to any item, they shall be stamped on a petal label attached to the 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.

- k. The Engineer may require inspecting and approving the packing before the items are dispatched but the **contractor is to be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor for any loss or damage due to faulty packing.**

Finish

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.

Wrought Steels

Where not otherwise specified wrought steel shall be selected from the appropriate grade of IS: 1570 and be free from blemishes, short or hammer marks.

The Contractor shall submit for the approval of the Engineer-in-charge, the grade number selected for each component.

Castings

All casting shall have a homogenous structure and be free from blow holes, 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 pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

Steel Castings

Where not otherwise specified, steel castings shall be selected from the appropriate grade of BS 3100.

Grey Iron Castings

All grey iron castings supplied shall be to the appropriate grade of IS: 210. 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.

Spheroidal Graphite Iron Castings

All spheroidal graphite or modular graphite iron shall be to the appropriate grade of BS 2789.

Bronze

Where not otherwise specified, the bronze used shall be made of a strong and durable zinc free mixture to IS: 318.

Aluminum and Aluminum Alloys

Bars and extruded sections shall be to designation EN 8 or BS 1474. Aluminum and aluminum alloys shall not be utilized unless alternative materials are considered unacceptable. The use of aluminum requires the approval of the Engineer in all cases.

Aluminum and Aluminum alloy Castings

Castings shall be manufactured from LM5 to BS 1490 and subjected to a chill cast to increase tensile strength. Aluminum and aluminum alloys shall not be utilized unless no other materials is considered suitable. Immersed structures or structures that are periodically immersed shall not be constructed from aluminum or aluminum alloys.

Painting and Metal Protection

All bright metal parts shall be covered before shipment with an approved protective compound and adequately protected during shipment to site. **After erection these parts are to be cleaned.**

All exposed metal parts of the equipment including piping, structures, etc. wherever applicable, after installation unless otherwise surface protected shall be first painted with at least one coat of suitable Zinc rich epoxy primer which matches the shop primer paint used, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved by the Engineer for painting. After wards, the above parts shall be finished with two coats of epoxy/coal tar epoxy coating/paint. The quality of the finish paint shall be as per the standards of ISI or equivalent and to be of the colour as approved by the Engineer. The paint shall be suitable for use in industrial corrosive works atmosphere.

All bright metal parts shall be covered before shipment and transportation with approved protective compound and protected adequately during shipment and transportation to the site. After erection, these parts are to be cleaned.

All pipe services wherever applicable are to be painted in accordance with the Owner's standard colour code scheme, by the Contractor.

MS/GI Hand Rails shall be painted with synthetic enamel paint or as specified in Scope of Work/ process description/Process Design Criteria and detailed Specifications and of shade approved by engineer-in charge.

Chromium Plating

All chromium plating shall comply with IS: 1986.

Galvanizing

Where steel or wrought iron is to be galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with IS: 2629.

Attention shall be paid to the details of members in accordance with 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 galvanizing.

All surface defects in the steel including cracks, surface lamination, 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 complete before the structures are galvanized. The surface of the steel work to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulfuric 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 brushed, so that the whole of the metal shall be less than 610 grams per square meter of surface galvanized, except in the case of tubes to BS 1387 when it shall be 460 grams per square meter.

On removal from the galvanizing bath the resultant coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux ash or dross etc. and free from any defect that is detrimental to the stated end use of the coated article. Edges shall be clean and surfaces bright.

Bolts nuts and washers shall be hot dip galvanized and subsequently centrifuged in accordance with IS: 2669. Nuts shall be tapped up to 0.4mm oversize before galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of nuts.

During off-loading and erection, the use of nylon slings shall be used. Galvanized 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 galvanized coat damaged in any way shall be restored by following.

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

Where surfaces of galvanized steel work are to be in contact with aggressive solutions and/or atmospheres the galvanizing shall receive further protection by painting.

Fasteners

Bolts, nuts and studs and fasteners with nominal diameters up to and including 39 mm required to be made in carbon steel shall conform to BS 6104 and threaded in accordance with IS: 1363 and 1367. Bright steel washers 3.0mm in thickness shall conform to BS 4320 and shall be provided beneath bolt head and nut.

The above items required to be supplied in stainless steel shall conform to IS: 1570. These items together with holding down bolts and anchor plates required to be supplied in high tensile steel shall conform to BS 970 Ref. Symbol T.

Drilled anchor fixings fasteners for use on concrete structures shall be of an approved type by the Engineer's Representative. The Positions of all drilled anchors shall be approved by the Engineer's representative and a Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit. All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such, that when fitted and tightened down with a nut and washer, the threaded portion shall fill the nut and not protrude from the face thereof by more than a half diameter of the bolt. Rivets shall conform to BS 641 and tested in accordance with BS 1109.

Forgings

Carbon steel forgings shall be manufactured heat treated forgings and tested in accordance with BS 29.

Foundation and Settings of Machinery

The Contractor shall arrange for the provision of all foundation and plinths required for the plant and shall be responsible and setting for ensuring that all foundations and plinths are constructed and boxed out for Machinery holding down bolts in accordance with the approved drawings.

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

The Contractor shall visit the site during the course of construction and check the Civil Works to ensure that the foundation and/or plinths are at correct required location and height for the acceptance of the machinery. When the foundations and/or plinths have been complete and are in a satisfactory condition, the machinery shall be installed as directed by the Engineer's representative.

The machinery shall be mounted on flat steel packing of a thickness selected to take up variations in the level of the correct 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 alighted, 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. The Civil Works Team shall then carry out the grouting and building in of the machinery. However, the Contractor shall take responsibility for the satisfactory nature of this work, and shall have a representative present.

Built In Items

The Contractor shall include in the relevant Schedule of the Specifications, details of all the items of equipment to be "Built in" by the Civil Works Team, together items with details of the period in which these items could be delivered to site.

The Contractor shall provide to the Civil Works Team full details of the box outs and plant fixing and foundation requirements for incorporating in the Civil Work. The Contractor shall liaise closely with the Civil Work and shall obtain from him a program of the civil works, clearly showing the dates when box-out and plant foundation details will be required. The Contractor will be responsible for co-coordinating and program his work schedule with the Civil Work so as to ensure an optimum arrangement with the minimum of disturbance to the progress of the Works as a whole. The Contractor shall deliver all items of equipment that are required to be built in the civil works, as required by the construction program and shall arrange for a representative from the equipment supplier to be in attendance during the progress of such works. The Civil Works team shall grout up and make good when instructed by the Engineer's representative.

Location and Alignment

Where individual items of equipment and mechanically located and coupled, such as alignment motors, gear boxes and similar items depended upon correct alignment for satisfactory operation, each shall be mounted on a common bed plate and when alighted shall be located by means of dowels to ensure that correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

Coupling

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 of the all metal flexible type.

General Service coupling shall be of 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 half coupling face.

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 alignment shall be a tight fit on the shafts and secured the hand fitted keys and fully checked for alignment. All necessary equipment for checking alignment shall be supplied by the Contractor.

Where flexible coupling 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 torques 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 subject to the approval of the Engineer. In particular, the alignment procedures which involve rotating one half coupling only will not be accepted.

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 alignment of 1 degree maximum and 1mm 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.

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 BS 5512 Lubricators Part 1, 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 condition prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable.

All ball or roller bearings, except those supplied and "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 lubricator 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 platform 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 Bearings shall be entered in the Operation and Maintenance instructions.

Gear boxes

The gear boxes shall be totally enclosed dust, water and hose proof. Suitable lifting lugs shall be provided. They shall be robustly constructed and arduous duty.

The gear case 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 gear boxes 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 1.5** when applied to the rated motor power or higher as recommended by equipment manufacturer.

The gears shall be manufactured from steel to BS 970 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 hours L10 life.

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 hour 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 suitable preservative.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be coated with a suitable preservative.

The gear box 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.

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 provide and fix all the steel work, including stairways, ladders, hand railing, checkered plate and open mesh flooring frames and curbing as detailed in the specification and/or as shown on the contract drawings or as directed by Engineer.

All steel work shall be constructed in mild steel and shall be galvanized after manufacture or shall be provided with finish as specified in the specifications of specific equipment/work.

For all pre-fabricated metal work, including multiple duct covers, external ladders, open mesh flooring, checkered plating, hand railing, staircase, structural steel work and the like, the Contractor shall submit fabrication drawings for the approval of the Engineer prior to the manufacture of any of these items.

Hand Railing and Safety Chains

Hand Railing

Hand railing shall be of MS ERW Medium Class of circular hollow section and shall comply with the relevant requirements of BS 1387, BS 6323 Part I or BS 4360. Mild steel toe boards shall be provided, 100mm high by 3mm thick positioned above the platform level and fixed securely to the standards. All items shall be painted with epoxy paint & epoxy primer.

Standards shall not be less than 38mm external diameter and rails shall not be less than 32mm external diameter.

Horizontal handrails shall be 1000mm high with an intermediate rail at mid height. Handrail height shall be measured vertically from finished floor level to the hand rail centerline.

Handling and fixings 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 center lines of adjacent standards or 10mm 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 less than two bolts and line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5 m. centers. 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.

The Contractor shall ensure that unless specified hereinafter to the contrary, all hand railing shall be of uniform appearance and manufacture.

Safety Chain

Mild steel safety chain shall be 8mm nominal size grade (M 4) non calibrated chain Type 1, complying with BS 4942 Part 2. After manufacture, mild steel safety chains shall be hot dipped galvanized in accordance with BS 729.

Stainless steel safety chains shall be manufactured from grade 316S31 steel complying with ISO 570 Part 1. Chain links shall be welded and have an internal length not exceeding 45 mm and an internal width of between 12mm and 18mm. The fins caused by welding shall be removed and the weld shall be smoothly finished all round. When tested in accordance with clause 7.3 of BS 4972 Part 2, each chain shall withstand a breaking force of 30kN and a proof force of 15kN.

Open Mesh and Chequer Plate Flooring

Open mesh flooring and gratings shall generally comply with BS 4592 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slip and shall be mild steel galvanized.

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 3mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the approved drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be obtained systemically 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 galvanized and of the non-slip type, not less than 10mm 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/sq. meter and the deflection shall not exceed 1/200 of the span or 10mm whichever is the least.

All flooring shall be removable and set flush in mild steel galvanized 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 permits 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 includes ducts.

Lifting keys shall be supplied for each location and the type of key shall be such that inadvertent release is avoided.

Stairways

Stairways shall be detailed, fabricated and erected to the dimensions shown on the drawings and in accordance with BS : 449 Part 2 to carry a load of 750 kg/sq. meter. Treads shall be rectangular open mesh fixed to the stringers, not directly to concrete. Sloping hand railing shall be as specified for horizontal hand railing but with the top rail 850mm vertically above the line of pitch and standards vertical and spaced at not more than 1500mm., 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 galvanized 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 900mm above the pitch line.

Ladders

Ladders shall conform to BS 4211 except where the specified here after. They shall be in mild steel galvanized as specified in. The stringers shall be flat section not less than 65mm x 10mm spaced 380mm 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 600mm apart. Ladders over 3.0 m long shall have additional intermediate stays at not more than 2.5 m centers.

Rungs shall be 20mm diameter round bar at 250 mm c-c distance shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225mm 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 750mm. The hoops shall be at approximately 70mm centers and the first hoop shall be 2400mm. above ground or lower platform level.

Where the rise exceeds 6000mm, an intermediate landing shall be provided.

Multiple Duct Covers and Frames

Multiple duct covers and frames shall be of cast iron, water proof, 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 approved drawings.

A heavy grease seal is to be formed between the cover and frame to prevent ingress of grit.

General Requirements for Pipe work

The Contractor shall supply, deliver and erect all pipe work and fittings within the structures and externally to the limits indicated on the approved drawings and in accordance with each section of specification.

Pipe work and fittings shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of the pumping mains shall be the closed valve head of the pump plus the maximum suction static head. The maximum surge pressure shall be limited to 125% of the maximum working pressure. All pipe work and fittings 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 or higher as per process requirement.

There shall be a sufficient number of mechanical joints to enable mechanical plant and valves to be disconnected from built-in pipe work. Such joints shall be tied 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 limits depending on the nature of the fluid or substance to be conveyed.

All pipe work shall be adequately supported by purpose made fixings. Support shall not be provided by plant or equipment.

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

Where pipe work is connected to plant and equipment readily demountable fittings in the form of unions or flanged adapters shall be provided. The flanged adapter 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 gasket not less than 5mm in thickness and galvanized fastenings or fastening as specified shall be included.

Pump suction bell mouths shall be standard castings in either cast iron or ductile iron.

Unless otherwise specified, the 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 pipe work or associated fitting shall be clearly identified in paint with the plant item number indicated on the Contractor's arrangement drawing.

Puddle flanges shall be provided on all pipes where they pass through pumping station walls/water retaining structure 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 BS 4865 Part I. Gaskets shall be manufactured from material complying with BS 2494 for Type 1 rings.

Pump suction and delivery manifolds shall be provided with a drain valve where natural drainage does not occur.

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 erection particularly the removal of weld deposits. Initial capping of the ends for protection during transport and storage shall not be removed until erection takes place.

Grey Iron Pipe work and Fittings

Grey Iron flanged pipe work shall conform to BS 4622 – not less than Class 3 with flanges to BS 4504 Part 1 – table 16.

Spheroidal Graphite Cast Iron Pipe work and Fittings

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

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

ABS Pipe work shall be provided and installed for special purposes where hereinafter specified. The pipe work shall conform to BS 5391 and the fittings to BS 5392.

Fabrication of Carbon Steel Pipe Work and Fittings

The Contractor shall fabricate the pipeline by butt-welding without utilizing a backing ring in accordance with BS 2971 Class II metal arc welding of carbon steel pipe work. Branches shall be formed in accordance with BS 2971 (Class I or Class II, depending on operating conditions) and shall be welded before so that at any point along the bend, ovality will not reduce the bore by more than 21%. Radii of hot bends for all pipes shall not be less than five times the outside diameter. Gusseted "Cut and Shut" and wrinkle. All pipe flanges shall be of the wrought steel slip on type conforming to BS 4504 PN 16, welded on in accordance with BS 2971 (Class I or Class II, depending on operating conditions). No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or Victaulic coupling as necessary.

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. When instructed by the Engineer's representative, the Contractor shall arrange for the welder to produce test welds in accordance with the provisions of BS 2971.

Pipe Work Installation

All pipe work, pipe fittings, jointing materials etc. shall be of the best quality free from defects and obtained from a supplier approved by the Engineer. The installation of the pipe work shall be carried out using skilled personnel and pipe work shall be installed according to the drawing 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 have 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 for damage or deterioration.

Underground Pipes

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

Examining Pipes

Before being used, each pipe casting or fitting shall be properly examined and should 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.

Cutting Pipe Work

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 deburred.

Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items/equipment 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 BS 5378 parts 1, 2 and 3 and screw fixed rigid construction.

Designation labels shall be of 5mm trefoil with black lettering on white background. Embossed materials and techniques shall not be accepted.

The Contractor shall provide 2 nos. enameled iron plates worked "Men Working of Plant". The plates shall be 200mm x 75mm with red lettering on a white background.

N. B.: All identification and warning labels shall be in ("Hindi Language") and English.

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.

Suppression of Noise

All plant equipment offered shall be quiet in operation. The noise level within the building shall not be more than 85 dB (+5 percent on this over the audible frequency spectrum measured at mid-band), "A" scale when measured along a contour 3 meters from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 dB (+5 % on this over the audible frequency spectrum measured at mid-band), "A" scales when measured along a contour 3 meters from the external wall. Noise test measurement 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 which render it liable for rejection unless it is satisfactorily modified at the Contractors expense by the programmed commissioning date.

Trolley and Chain Pulley Block

- a. The chain pulley block shall be operated on the lower flange of the bridge girder.
- b. 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.
- c. The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet and shall be provided with roller type guarding to prevent snagging and fouling of the chain.
- d. All the gearing shall be totally encased. Proper lubricating arrangements 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.
- e. 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 antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.
- f. The traveling trolley frame shall be made of rolled steel conforming to IS: 2062. The side plate 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.
- g. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.
- h. The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depressed type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per BS 2903/IS: 3815.
- i. 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.
- j. If the weight of offered pump set/equipment is more than the craned capacity specified, the contractor shall offer the crane capacity 1.5 times higher than the weight of the pump set/equipment or as per latest IS.

Pipes and Fittings

- a. The cast iron pipes shall generally conform to class B IS: 1537/IS: 1536/IS: 7181 and pipe fittings shall conform to IS: 1538. Ductile Iron pipes shall conform to IS 8329/BS: 4772.
- b. The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr. FG 200.
- c. The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance as specified in IS standard.
- d. 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 order.
- e. The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centerline. The intersecting axes of the tees shall be perpendicular to each other.
- f. 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.
- g. The dismantling joints shall be of cast iron with EPDM seal ring.

Ventilation Systems

These specifications are common to all dry well/wet well effluent, sewage and water pumping stations and treatment plants. The scope of ventilation system includes following.

- a. Supply Air Fans
- b. Exhaust Fans
- c. Associated Ducting

Wherever the drawings provided for ventilation system, indicate proposed ventilation fans and the routing of ducting. It is the responsibility of the contractor to study and analyse the adequacy of the system and suggest any improvement at the same time taking into consideration all the requirements of the public authorities including safety orders and Fire Protection Rules & Regulations and IS Codes. The necessary permits shall be obtained by the contractor and all payments towards license inspections etc. paid before starting the work.

Supply Air Fans

Air fans shall be of centrifugal type and fan housing shall be hot-rolled steel of thickness 3/8". End flanged shall be fixed to the casing by continuously welding over the entire circumference. The flanges shall have bolt holes for bolting to inlet bell, companion flanges or ducts as the case may be. Housing shall be continuously welded and shall be expanded by suitable mechanical means to insure concentricity. Motor support shall not be less than 3/9" thick steel plate. Support ring shall be continuously welded to the support plate.

Fan rotor and blades shall be made from cast aluminum with suitable corrosion resistant coating. Belt driven fans shall have multi V belts on pulleys with suitable guards. V belts shall be 150% of rated HP duty.

The fan rotor shall be whirl-tested to 125% or operating speed and shall be statically and dynamically balanced on fan motor shaper to maximum tolerance in one (1) mil double amplitude at design operating speed.

The fans shall have inlet screen at inlet bell cone and carbon steel bolts for existing discharges cone with flanges on both ends attachment to fan and to discharge ducting.

Fan motor supports shall be of adequate strength, constructed from 1/4" carbon steel angles. All the external fasteners shall be stainless steel.

Motors

Motors selected for the fan shall be of adequate rating with a safety factor of 1.5 or greater. If the fans are belt-driven the motor shall be mounted on slide rails for belt tension and adjustment. The complete assembly shall be mounted on Neoprene Vibration Isolators. The motor shall conform to the relevant latest Indian Standards or British Standards. It shall have permanently lubricated ball bearings. The motor shall be suitable for 415 V, 3 Phase 50 Hz supply.

The bearing life shall not be less than 20,000 hours at design conditions and motor shall be of class 'F' insulation to allow for operation up to 95 °C rise over the ambient temperature of 45 °C. External copper grease leads for lubrication of motor bearings shall be provided by the manufacturer.

Fan motor shall be standard totally enclosed fan cooled (TEFC) foot mounted squirrel cage induction motor with single speed, single winding, continuous duty variable torques.

A conduit box shall be mounted on the exterior of fan casing and lead wires from the motor conduit box shall be protected from the air stream by being encased in a tight metal conduit pipe.

The belt drives shall have stainless steel wire cage guards.

Supply of air fans in dry well shall have air flow switches and pressure switches fitted in the ducting. The selection of these switches is left to the contractor to suit the fan units being supplied.

Exhaust Fans

Exhaust fans shall be of direct drive, impeller propeller type, having maximum speed of 1450 rpm.

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 screens, Plastic or light weight aluminum back draft compels and electrical disconnecting means 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 motor 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 before proceeding with the work.

Dampers

All dampers shall be of louver type, robust construction, and tightly fitted suitable for the location and service required.

Dampers shall have suitable links, levers and quadrants as required for the proper operations, control or setting in any desired position. Dampers and these operating devices shall be made robust, easily operable and accessible through access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all items.

Dampers shall be placed in ducts and every branch supply or return air duct connection whether or not indicated on the drawings for the proper volume control and balancing the system.

Grilles and Diffusers

All grilles shall have vertical and horizontal adjustable bars and controlled from the front of the grill.

Installation

The duct fabrication and installation shall generally conform to IS: 655 latest. It is the responsibility of the Contractor to provide and neatly erect all the sheet metal work as shown on the drawings or as required at site to the satisfaction of the Engineer.

All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the building, whether or not the same are shown on the drawings. All necessary modifications as required shall be carried out by the Contractor, however maintaining the same area.

All co-ordination with other agencies/contractor working simultaneously at the site to avoid repetition of work shall be the responsibility of the Contractor.

The ducting shall never be hung from the ceiling and only support of beams and columns shall be taken. The ducts shall be rigid and adequately supported and braced with beams or columns. All joints shall be made tight and all interior surfaces smooth bends shall be made with radius not less than one half the width of the duct. All the sheet metal connections, partitions and required to confine the flow of air and through the filters and fans shall be constructed from No. 18 galvanized iron thoroughly stiffened with 25mm x 25mm angle iron braces and fitted all necessary doors, to give access to all parts of the equipment. Doors shall be set conveniently where required. At the connection of ducting and inlet/outlet of fans, a double-fiber glass reinforced canvas sleeve shall be used.

All fans shall be protected and painted to avoid corrosion.

Lubrication

All blower bearings shall be provided with adequate facilities for lubrication. Exhaust fan unit bearings shall be sealed lubricated type. All oiling devices, grease fittings shall be readily accessible. All bearings shall be lubricated upon completion of the work using lubricants specified by the manufacturer.

Testing

The Contractor shall adjust, test and air balance the ventilating and exhaust systems and shall submit a report after final adjustments to 5% of designed air quantities.

Operating Instruction

Three (3) copies of an Instruction book giving complete service data on all equipment and system shall be furnished.

SPECIFICATIONS FOR MECHANICAL ITEMS / EQUIPMENT

See the "GENERAL REQUIREMENT FOR MECHANICAL ITEMS / EQUIPMENT" at end of equipment specifications for painting, min. documentation requirement for approval during execution & prior to manufacturing and inspection requirements.

NOTES / PROVISIONS

Bidder to take note of following provisions applicable for specifications for various mechanical equipment.

1. See the “GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENT” at end of equipment specifications for painting/coating, minimum documentation requirement for approval during execution and prior to manufacturing and inspection requirements.
2. For all imported equipment, the motors, gearbox, switchgear, PLC controls, etc. items and components as per manufacturers’ standards and makes shall be acceptable.
3. For items like mechanical screens, grinding screens, belt filter press, turbo/centrifugal blowers, centrifuge/decanter, SBR decanter, electric actuator, floating / slant mixers (anaerobic, anoxic, aerobic), etc. the motors, gearbox as per manufacturers’ standards and makes shall be acceptable.
4. For items like screw pumps, dosing pumps, valves, gates, EOT Cranes/Hoist/Material handling equipment etc. the gear box as per manufacturers’ standards and makes shall be acceptable.
5. Make of Crane Duty (S4) motor of small capacity ($\leq 5.5\text{kW}$) for EOT Crane/Electric Hoist as per manufacturers’ standards shall be acceptable.
6. The construction and general requirements for starter/control panel supplied by vendor along with equipment (applicable for equipment with max. motor rated $\leq 15\text{kW}$) can be accepted as under.
 - The control panel shall be generally be free standing, floor / wall mounting type, totally enclosed and dust, damp and vermin proof. Enclosure shall have IP-42/IP-52 or better degree of protection to be mounted indoor or under shed with suitable protection unless better protection class specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). Cubicle sheet steel shall be CRCA minimum 1.6mm for load bearing and non-load bearing members. Gland plate shall be CRCA sheet minimum 2.0mm thick unless higher thickness or better MOC (SS 304 or such better MOC enclosure) specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). For motors rated $\leq 15\text{ kW}$, the common equipment panel with multiple starters up to 6 numbers within single cubicle can be accepted. However for motor rated $>15\text{ kW}$, individual starter cubicle only shall be provided. For panel offered with multiple starters, the main incomer breaker shall be MCCB of suitable rating.
 - Starter shall be fuse less type. Incomer shall be with ammeter, voltmeter, indicating lamps etc. Start/Stop (Mushroom head stay put type with padlocking facility)/Overload Reset Push Button and Auto-Off-Manual, local-remote selector switches etc. shall be provided. Ammeter with Y-Phase CT shall be provided for all starters with motors rating **ranging from 7.5 kW to < 30 kW**, and ammeter with selector switches shall be provided for all starters with motors rating of $\geq 30\text{ kW}$. Control and power wiring shall be with minimum 1.5 sq. mm. FRLS Copper flexible. CTs, wherever provided shall be resin cast.

The breaker (MCCB/MCB) and other switchgear (MPCB, contactor etc.) shall be as per approved makes specified in tender/specifications for electrical works except for panels imported from outside the country for which makes as per manufacturer standard shall be accepted. However makes of rest all items like wires, selector switches, push buttons, CT/PT, etc. as per manufacturers’ standards are acceptable.

- For equipment starter required with/provided with VFD based starting or with Soft Starter based starting following to be noted:
 - ✓ VFD shall be selected such that the de-rated current of VFD/Soft Starter for 50°C continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor. Alternatively, VFD shall be provided of at least one rating higher than the motor rating.
 - ✓ The VFD for sewage/STP and industrial effluent or such application shall be with 3C3 conformal coating and for raw/drinking water or rest applications shall be with 3C2 conformal coating.
 - ✓ The Fast Acting (Semi-conductor) fuse for VFD/Soft Starter protection are not required for motors rated less than **75 kW**.
 - ✓ The series contractor in line of VFD/Soft Starter after breaker is not required for motors rated less than **75 kW**.

- ✓ VFD shall be with communication port (RS 485 Modbus or suitable) and shall be connected with plant PLC/SCADA for remote data, power monitoring and diagnostic data.
 - Shall be suitable for remote monitoring and control from PLC/SCADA system. Required potential free contacts shall be provided for On/Off, Trip and L/R selector switch status as a minimum. In case of PLC based control offered, the PLC shall be with communication port (Modbus protocol or suitable) to communicate with plant/main PLC/SCADA for remote monitoring and control.
 - For PLC based control provided in control panel supplied along with equipment by vendor, the PLC with specification and make as per manufacturers' standards are acceptable.
 - Bidder to refer the specifications for electrical works and instrumentation works for rest all requirements.
7. The detail specifications for various mechanical equipment provided below are general specifications/general requirements. Operation philosophy and construction methodology may vary for each manufacturer and for the type of equipment offered and can be accepted keeping the design philosophy/application requirement as specified in tender or as per process requirement and such minor variation in specifications can be accepted subject to review (if required with justification/supporting documents) and Client's approval.

DETAILED MECHANICAL SPECIFICATIONS FOR VARIOUS EQUIPMENTS

❖ SPECIFICATIONS FOR CLARIFLOCCULATOR MECHANISM (ROTATING BRIDGE TYPE)

Design and construction requirements:

Clariflocculator mechanism shall be suitable for installation in RCC tank (newly constructed or existing as applicable) as per following specifications. The tank **shall have a central area for coagulation and flocculation and outer area for clarification settling**. A partition wall in RCC construction separates the flocculation zone from the clarification zone.

General design criteria shall be as under:

A. Clariflocculator

Description	:	Parameters
Floor slope	:	1:12 or as per tender specifications
Inside dia. of clarifier	:	As per Design
Location of launder	:	As per Design
Weir loading	:	As per tender specifications
Outlet arrangement of the clarified water	:	90° 8 mm thk. FRP (or of MOC and thk as per tender specifications) adjustable V notch weir plate, min. 300mm Ht. and min. 100mm slot for weir height adjustment, to be fixed along the periphery of the clarifier tank as per hydraulic design calculations
Clarifier Bridge with wheel assembly	:	Min. 1200 mm clear width in to in
Peripheral speed of Scraper Arm	:	1 - 3 cm / sec
Thickness of scraper Blade	:	6 mm (Min.)
Thickness / Size of Rubber Squeezes	:	Min. 10 mm thk x 100mm or suitable Ht.
MOC of Bridge and Scraper	:	MS, IS 2062, epoxy painted. All hardware, nuts and Bolts (wetted / submerged and non-wetted) shall be of SS- 304 Material.
Painting	:	Epoxy paint as per specifications.
Telescopic Bleed valve	:	1 set for each clarifier as a standard. Inlet telescopic line to be provided with isolation valve (Sluice / knife gate valve).
Water flushing connection for each sludge withdrawal chamber / sludge withdrawal line	:	2 nos., 50mm dia. with isolation ball valve and flanged entry with blind flange, one on each side of sludge withdrawal valve of sludge withdrawal line, each on upstream and downstream side of sludge withdrawal valve.
Railing	:	MS pipe / structure railing with epoxy paint.

Description	:	Parameters
Sludge Drain Valve for each sludge withdrawal line / sludge withdrawal chamber	:	1 Nos. with extended spindle valve (shall be electric actuator operated if specified in tender specifications elsewhere or in BOQ/SOQ), minimum 300 mm diameter (or of size as specified in tender specifications elsewhere or in BOQ/SOQ) straight to drain chamber / sump. The actuator shall be above ground level connected with extended spindle.

B. Flocculator

Type.	:	Set of counter rotating flocculator blades
Flow	:	As per design
Qty. of Flocculation Paddles / Flocculators	:	4 Nos. / 2 Nos. can be accepted for clariflocculator (clarifier) diameter of up to 25m
GT Value	:	10,000 – 1,00,000
MOC of Flocculator / paddles	:	MSEP
Service factor for gear box	:	2.0 (Minimum).
Size	:	As per Design / For existing tank the size to be verified at site by vendor

Rotating Half Bridge

The bridge in welded steel construction shall span half the tank diameter and further beyond center in the direction of the walkway. The truss bridge shall be with clear 1.2 M width with walkway of MS grating suitable for load carrying capacity specified except for the portion of each drive and panel area where min. 5mm thk or higher size chequered plate shall be provided all around the drive area and at least 1m on either side from panel for panel area (alternately entire walkway shall be provided with chequered plate of min. 5mm thk or higher suitable for load carrying capacity specified). The bridge is pivoted at the center on a slewing ring bearing and is attached to a trolley with Cast Steel (CS) wheels moving over billet (steel rail) or steel plate / flats (as specified in BOQ / tender specifications elsewhere) mounted on the peripheral wall of the clarifier. A drive assembly located on the trolley and coupled to the trolley drive wheel through chain & sprocket arrangement rotates the bridge about the center of the clariflocculator.

It shall be provided with:

- Central platform for the installation of the stirrers (flocculation paddles) and their drives and for the local control panel;
- Paddle stirrers / agitators for slow mixing of the incoming raw water in the central unit;
- A radial scraper system with bottom scraper blades, suspended on the bridge.

The scraper and rotating bridge shall be of MS construction. Handrails shall be of 40 mm. dia. MS pipe size medium grade / suitable structure steel member size.

The rotating bridge structure shall incorporate a walkway having a minimum effective width of 1200 mm which shall be surfaced with M.S, chequered plates or gratings with chequered plates as specified above, painted black. The bridge shall be designed to take its own dead weight together with uniformly distributed loading of 250 kg/m² over the full span and width of the walkway bridge and a moving point load of 500 kg. Maximum deflection of the bridge under the specified loading shall not exceed 1/360th of the span. The **positive camber shall be kept** initially to compensate for the maximum deflection under dead weight and superimposed loads.

The bridge shall be so braced as to limit lateral deflection to less than 80 mm measured at mid span under a full load condition.

The central part of the bridge shall be large enough for the installation of the flocculator systems and the control panel.

The bridge shall have hand railing to both sides forming an enclosure at the centre in between. The finished height of the railing shall be min. 1.0 m above the walkway. Toe guards shall be provided and secured around the bridge walkway which shall not be less than 100 mm high and min. 3 mm thick.

Bridge Support and End Carriage

The bridge structure shall be supported at the center of the clariflocculator by means of cast iron bearing assembly of the slewing ring type and incorporating trunnion type mounting to accommodate vertical undulations of the traction wheels at the peripheral wall of the tank. The central bearing assembly shall be adequately lubricated and all grease points shall be extended to a battery plate mounted at the convenient point above the walkway. Oil fill and drain points, where applicable shall be extended to provide a convenient access for filling and draining the system. Catch drains shall be provided under all oil and grease point to prevent spillage from reaching the water surface.

The wheel carriage assembly shall be suitably proportioned to provide adequate stability to the rotating bridge structure, whilst providing the suitable base for the motors, gear box, driving and idling wheels, shafts and bearings. The wheels shall be such that a de-railing cannot occur due to some misalignment. The size and design of wheels and carriage shall be calculated to transmit optimum tractive effort relative to the proportions of the scrapper without producing wheel spin when the wheel path is subject to the climatic conditions.

Center Bearing Assembly

This shall essentially consist of a slewing ring bearing assembly that shall be located by an MS platform and center tube. The platform shall be supported on the RCC center pier.

Slip ring Assembly

The slip ring assembly shall be mounted above the top level of the tank walls. Sufficient rings (Min. 12 nos. slip rings) shall be provided for power cable and control cable for remote monitoring and control from **ICP / PLC / SCADA** and as specified in Process Design Criteria & Specifications or Scope of Work or Description of Project or elsewhere of tender specifications. However, if specified to provide only the power cable then min. 7 Nos. slip rings shall be provided. Slip ring assembly shall be provided at the center of the clariflocculator above the center bearing assembly for supplying power to a distribution board to supply power for four (4) nos. flocculator drives and one (1) no. bridge drive. A distribution board is provided on board the clariflocculator bridge for distributing power to the five (5) drives from one incomer. Common status of the units shall be provided to main control room and possible to start and stop from remote location / PLC & SCADA control if specified elsewhere in tender / BOQ / SOQ.

The slip rings for power portion shall cover the motor supply (R, Y, B, E and N generated in control panel or to be provided from outside as per requirement). For remote monitoring and control where specified the slip rings shall be provided to cover ancillary circuits with common status of drive and flocculators units like ON/OFF, Trip/Fault, A/M status for status monitoring and common start and stop command for remote operation / control.

For smaller diameter clari-flocculators as specified above for which 2 nos. floccualtors are considered, the slip ring quantity shall be reduced proportionately.

Drive Unit

This traction unit shall consist of a driving and idling wheel assembly.

The bridge drive shall comprise of either (a) motor with reduction gear, a chain sprocket or (b) a geared motor. The assembly shall be rigidly mounted and shall be adequately rated for continuous service in water treatment works environment.

Both the drive and idling unit shall be fitted with suitable diameter CS wheels and shall be carried on the respective shafts supported on anti-friction bearings.

The wheels shall travel on the clariflocculator wall over steel billets (steel rail) of size as recommended by vendor as a standard unless otherwise / other methodology specified in BOQ / tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). The steel billets shall be fitted / welded over insert plates of required size and thickness provided on top radially across walkway by a radial distance of about 1-1.5m inserted in concrete during civil works.

Insert plate (for either of steel billet / MS Flat options) shall be provided on top radially across walkway by a radial distance of about 1.5-2m inserted in concrete during civil works on which the peripheral wheel shall move.

If BOQ / tender specifications elsewhere specify for wheel moving directly over top of peripheral RCC wall, then in this case the CS wheels shall be with PU coating. The top of wall shall be finished such that top of wall is in proper level without any undulations for smooth movement of wheels over the wall.

The mechanism shall be driven by adequate HP motor mounted on the periphery of the bridge

All lubrication points, all necessary provisions shall be made for routine maintenance and for prevention of oil and grease spillage. A deflector shall be provided and fitted to the leading edge of the driving carriage. It shall be angled at 45° and arranged to be adjustable within 3 mm of the perimeter rail such that material coming in the way of free passage of the wheel shall be deflected.

Floor Scraper, Blades and Fixtures

Scraper shall be suspended from the bridge at various points across the bridge length covering half the diameter of the tank. The scraper blades shall be manufactured from MS fitted with renewable rubber squeegees and attached to steel arms suspended from the bridge.

Scrappers shall be suspended and arranged to give continuous and progressive scrapping of the entire floor of the clariflocculator and the swept area of the successive blades shall overlap. The configuration of blades shall be designed to carry sludge and deposited suspended solids from the periphery of the tank and deposit it efficiently in the withdrawal hopper / sludge pocket.

The number and length of individual blades shall be designed by the vendor, but the depth shall not be less than 300 mm and the thickness not less than 6 mm. Renewable fabric reinforced rubber wearing strips of cross section not less than 12 mm x 100 mm shall be fitted to each blade to provide a continuous contact surface which is adjustable for wear. The material shall have hardness not greater than 40 and be manufactured from well-proven compound.

Backing strips shall be fitted to give support to the fixing of the rubber wearing strips and the assembly shall be secured by means of stainless steel bolts. Appropriate washers shall be fitted beneath all bolts head and nuts.

Flocculation Zone

The flocculation compartment shall be of RCC construction concentric to RCC clariflocculator tank.

Four (4) nos. flocculation paddles shall be suspended from the bridge, one on each side of the center pier in the direction of bridge and one each in direction perpendicular to the bridge (2 Nos. in case of small diameter tanks as specified above, suspended from the bridge in opposite direction as per vendor design).

The area of paddles shall be 10 – 15% of the cross sectional area of the flocculation zone. These shall be supported from the rotating bridge. Shaft and impeller blades of flocculator shall be of MSEP material. The motor HP shall be as per design.

Overflow

The overflow from the clariflocculator shall be collected through adjustable 90Deg V-notch 8 mm thick FRP weir (or of MOC and thk as per tender specifications) to be provided along the peripheral wall of clariflocculator of min. 300mm Ht. and with 100mm Ht. slot for vertical weir adjustment. The weir plates shall be fixed with stainless steel anchors, nuts and washers.

Local Distribution Board, Motors, starters and control

The bridge drive and the flocculators shall be controlled from an **outdoor panel in SS-304 housing** (double door) suitable for outdoor installation installed in the central part of the bridge. The drive status indicating lamps and required on & off push buttons, Emergency Stop PB with padlock facility, A/M selector switch for remote monitoring and control requirement if applicable, etc. shall be provided on this control panel. Canopy for panel shall be provided if required.

A local distribution board (SS enclosure suitable for outdoor installation) shall be furnished along with the mechanism for distribution of power to the peripheral drive motor and motors for flocculation paddles.

The electrical supply to bridge or flocculator driving motors shall be taken through a multi ring and slip – ring collector unit mounted in a fully water proof enclosure. The unit shall be fitted at the centre of rotation of each bridge and shall be complete with all necessary support bracket, anti – rotation device. A suitable means of lubrication shall be provided.

Bridge drive and flocculator motors shall be of squirrel cage type, protected and shall be rated at least 30% above design duty and shall meet the specifications of motor mentioned under electrical section.

All cables shall be connected to a termination box at the wall of the clariflocculator. From there, cables are connected to the main control panel. Common status like drive status and trip signals shall also be fed to PLC for suitable alarm and tripping / stopping of the drives.

The electrical equipment shall comprise of:

- Incoming cable (4C/5C power cable and control cable as applicable as per tender specifications / BOQ) to be laid separately in 2 nos. heavy duty uPVC / GI pipe lines of min. 100mm dia. (with dual draw wires or suitable arrangement for pulling cables to top of centre column) with sufficient slip ring contacts (Min. 6 Nos. if only power cable to be provided and with min. 12 nos. slip rings if power cable and control cable for remote monitoring and control from ICP / PLC / SCADA required) for the on-board power supply and the supply of all motors & other remote control & monitoring requirements;
- On-board local control panel in SS housing suitable of outdoor installation;
- Drives for the flocculator stirrers;
- Drives for the bridges;
- Emergency mushroom type stop buttons with padlocking at the control panel and at LCS the outer side of the bridge;
- Lighting.

Refer the “Notes/Provisions” in under general specifications for mechanical works and electrical specifications for control panel and other general requirement/specifications and makes as applicable.

Telescopic Valve Arrangement

One no. Telescopic valve arrangement shall be provided to sample the sludge for quality check purpose from the sludge withdrawal pipe as a standard.

In case where two or more sludge withdrawal lines as specified in tender specifications / BOQ / SOQ telescopic valve arrangement shall be provided for each sludge withdrawal line separately.

The telescopic sludge withdrawal line to be tapped from sludge withdrawal line shall be provided with isolation valve (Sluice or knife gate valve). The return sludge line from telescopic valve sampling chamber to sludge withdrawal pipe line shall also be provided of min. 150mm dia.

Min. 50mm dia. Flushing line (MS Med. Duty) with blind flange or suitable end connection to connect with plant service water supply line. This flushing line shall be connected to sludge withdrawal line on both the upstream and downstream side of sludge withdrawal valve and each of this line shall be provided with isolation ball valve in SS-304 and with flanged end for pressurized flushing and chokage removal on either side.

NOTE: The above specification and MOC are minimum and higher or better MOC and specifications shall be provided if specified elsewhere in tender specifications (in Process Design Criteria & Specifications or Scope of Work or Description of Project or elsewhere of tender specifications) or in BOQ/SOQ/Price Bid.

❖ SPECIFICATIONS FOR TWIN LOBE AIR BLOWERS (ROOTS TYPE)

Air blower shall be designed to perform satisfactorily under specified start up condition, part and full load operation, maximum differential pressure operation and relief valve setting pressure and up to trip speed.

All the compressor casing shall be air cooled type for up to 5500mm WC discharge pressure and water cooled type or with after cooler for more than 5500mm WC discharge pressure unless specified otherwise elsewhere in tender.

The blower vendor shall provide performance curves of the offered blower including the following as a minimum.

- maximum, minimum and intermediate speed curves

The blower shall have bottom discharge. Front discharge blower may be permitted only for small capacity blowers up to and including 7.5KW rating.

Blower manufacturer shall also incorporate the mass flow at rated duty conditions when air used for process control (Aeration Tank or such application).

Vendor to provide data sheet which shall include minimum and maximum speed, minimum and maximum flow, turndown ratio of offered blower (flow reduction possible at rated pressure), BkW at rated and at turndown point etc.

Blower Design Parameters

The design parameters to be considered are as under.

a	Minimum/Maximum Air Inlet Temperature	5 °C/45 °C
b	Design RH	65%
c	Altitude	As per Site Location
d	Capacity (Nm ³ /Hr.) at Discharge	As per Design/Process Requirement, Nm ³ /Hr. (Defined at 0 °C, 1.013 bar & 0 % Rh)
e	Mass Flow (applicable for process air /	Vendor to provide Mass flow with actual air

	oxygen transfer application, not applicable for mixing, air scour or such applications)	flow condition.
f	Head/Discharge Pressure (Kg/cm ²)	As per Design
g	Speed of Blower	2000 RPM (Maximum)
h	Temperature Rise at Discharge	Vendor to provide.
i	BKW (Input Power to Blower) – Duty Point (Rated Condition)	Vendor to provide.
j	Motor Rating, KW (SF for motor selection to be considered as per Tender)	Vendor to provide.
K	Turndown Ratio available with offered blower (Min. 50% or higher i.e. up to 50% flow or lower flows) @Rated Pressure (applicable for process air / oxygen transfer application or blower with VFD operation)	Vendor to provide.
l	Motor RPM – Turndown Point (applicable for process air / oxygen transfer application or blower with VFD operation)	Vendor to provide.

NOTE: for blower offered with 4P pole, the blower rpm shall be max. 90% of the rated speed of blower (max. 1300 RPM).

Air Blower shall consist of the following accessories.

- Twin Lobe Compressor
- TEFC Squirrel Cage Induction Motor of IE 3 efficiency class. Bidder to refer electrical specifications for technical specifications & approved makes. The vendor to select appropriate rating of motor with provision of reserve power margin as specified. Motor for VFD operated blower shall be of VFD duty.
- Suction Filter
- Suction/Discharge Silencer
- V Belt & V Belt Guard
- Motor Pulley & Compressor Pulley
- Slide Rail
- Common Base Frame
- Safety Valve
- Anti-Vibration Pads
- Pressure Gauges: Bourdon type, 150mm dia., SS casing and glycerin filled with manifold valve, syphon and snubber etc. of make as per specifications for instrumentation work.
- The blower noise level shall be within 85 dB (A) at a distance of 1.86m. If noise level exceeds without hood then acoustic hood shall be provided to meet this requirement.
- Acoustic hood is to be fabricated as per manufacturers' design/standards by using appropriate MOC and glass wool of required density to restrict the blower noise level within limit as specified. Blower vendor to provide GA drawing for hood along with opening details, overall dimensions and MOC.
- Inter-Connecting piping comprising of discharge Butterfly Valve, Flap/Wafer type Non-Return Valve and Metallic Expansion Bellow. Bidder to refer specifications for mechanical works for technical specifications and make of valves and bellows. Additionally the MOC of bellows and valves/internals shall be suitable to withstand the temperature at discharge of blower considering the temperature rise at delivery of blower over design ambient of 50 °C.
- Any other required accessories and protections for satisfactory running of blowers.

Material of construction of various part of the air blower shall be as under.

Casing	:	CI, FG 260, IS: 210
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Lobes	:	SG Iron 500/7 IS: 1865
Shaft	:	EN8/EN 19/EN 24 BS: 970 Part-1
Gears	:	EN 353 case hardened and ground
Common Base Frame	:	MS Fabricated

❖ SPECIFICATION FOR CHLORINATION SYSTEM – VACUUM TYPE, FLOOR/WALL MOUNTED

Type	:	Vacuum Type Solution Feed, Floor/Wall Mounted
Turndown Ratio	:	Minimum 10:1 over full range of operation
Electric Power	:	415V \pm 10% 3 Phase 50 Hz.

General Description

The Chlorinators are required for the disinfection and treatment of municipal and industrial water and wastewater.

The Chlorinator equipment shall be designed to ensure maximum safety of operating personnel and equipment. The Chlorine gas control system shall operate under vacuum to prevent gas leakage

In general, the Chlorinator operates under a vacuum that is produced at the ejector and transmitted through the control unit to the vacuum regulating valve located at the gas supply. Gas enters the vacuum regulating valve and moves toward the flow control components under a vacuum. Gas next passes through the Rota-meter, where its flow rate is measured and the V- Notch orifice, where feed rate is controlled manually or by an automatic positioner. At the injector, the metered gas is dissolved in the water stream. The resultant Hypochlorus solution is discharged to the point of application. Feed rate of Chlorinator shall be controlled by either one or both of these methods: interrupting the injector water supply to shut off the Chlorinator's operating vacuum; changing v-notch-orifice area (by positioning the v-grooved plug in its ring) while holding vacuum differential across the orifice constant.

Chlorinator shall be Vacuum Type Solution Feed Floor/Wall Mounted Chlorination system consisting of a Floor/Wall mounted cabinet with in-built chlorine flow meter with chlorine rate control valve, interconnecting vacuum piping, with Remote vacuum regulator, Remote injector with primary check valve, vent and vacuum tubing, yoke clamp, etc. complete in all respects and with highest safety standards and meeting all latest regulatory requirements.

The Chlorinator of up to 10Kg/Hr. capacity shall be floor/wall mounted type whereas Chlorinators of more than 10Kg/Hr. capacity shall be floor mounted type only.

The system shall be designed to prevent freezing of the liquid chlorine at the maximum rate of withdrawal.

Chlorination system including all main parts, sub parts, bought out items shall be designed to conform to latest IS: 10553 Part B (1983) and other applicable national/international standards.

This scope of work covers the complete design & engineering, manufacturing, performance testing, delivery, installation and commissioning of Chlorination system. The complete chlorination system & plant shall comprise the union connecting to the cylinder/drum valve up to and including the final dosing point and including chlorine containers (toner/cylinder) as specified in tender and any other as required for making the chlorine plant working in all respect and whatever needed to make the plant operational shall be included, no extra claim for the same on later date will be considered.

DESIGN & OTHER REQUIREMENTS

All pressure gauges shall be provided with isolating valves.

The suction velocity for booster pump shall not exceed 1.5 m/sec and velocity in the pressure water lines shall not preferably below 2 m/sec. but not exceeding 2.5 m/sec in any case.

Gas filter shall be capable of holding all the solid particles with readily removable glass wool cartridges or equivalent materials.

Chlorine stop valve shall be as per IS: 3224 isolated from the gas and shall have needles and seats of easily replaceable type.

Gas flow meters shall be calibrated in metric units.

All components in contact with chlorine shall be of suitable material to withstand corrosion.

All spring shall be used in the vacuum regulator shall be tantalum alloy or hastelloy.

Each Chlorinator Set shall consist of following components as a minimum.

- Floor/Wall mounted Front operated Cabinet of suitable MOC,
- Vacuum Regulator (regulator shall incorporate a positive chlorine gas shut-off valve, a pressure relief valve, and an excess vacuum shut-off valve),
- Injector/Ejector Assembly with Check Valve,
- Chlorine Flow meter Flow Rate Indicator (Rota meter mounted on cabinet),
- Chlorine Rate Control Valve, manually operated for chlorine gas flow increase/decrease (mounted on cabinet) (in case of auto dosing specified in tender, this valve shall be kept fully open),
- Differential Pressure Regulator (mounted on cabinet),
- Secondary Check Valve (mounted in cabinet),
- Drain Valve (mounted on cabinet),
- Vacuum and vent tubing as per requirement and
- Vacuum Gauge (mounted on cabinet)

Each Chlorinator Set shall have following accessories as a minimum.

- CS Manifold suitable for required quantity of Chlorine Tonner/Cylinder connection and of minimum 18mm Sch. 80 CS pipe (high grade seamless carbon steel, SA 106 Gr. B SCH 80 pipe) or higher size to suit Chlorinator capacity - 1 Lot.

Pressure regulating valve shall be provided with each manifold if required.

The manifold design philosophy shall be as under.

- The manifold shall be designed to connect no. of cylinders/tonners to meet total capacity requirement considering maximum 1% drawl rate per cylinder/tonner capacity (i.e. 1 Kg/Hr. in case of 100Kg cylinder and 9 Kg/Hr. in case of 900 Kg tonners or maximum up to 10Kg/Hr. for 900Kg tonner if permitted by Chlorination Vendor ensuring satisfactory operation of Chlorination System) and accordingly considering no. of cylinders/tonners required for the rated/design capacity of Chlorinators e.g. For 15Kg/Hr. chlorinator connected to 900Kg tonner and considering drawl rate of 1% will require two tonners to be connected to manifold per chlorinator.
- One to one connection shall be provided between each manifold and its associated chlorinator with interconnection valves between each manifold header for diverting flow to adjacent system if required.

- The manifold design and provision shall be as specified above and the actual no. of tonners/cylinders to be connected shall be as specified elsewhere in tender/BOQ or as per client requirement.
- 2 Nos. isolation valves shall be provided for each toner/cylinder connection, one at manifold header side and other as auxiliary isolation valve for toner/cylinder side. The auxiliary valve on toner/cylinder side shall be installed on the chlorine tonner/cylinder valve to minimize operation of the chlorine container valve.
- Required copper tubing for each chlorine toner connection to its associated manifold and connected with auxiliary isolation valve on tonner side and header valve on manifold side. The flexible container connector shall be of 3/8" dia. cadmium plated, arsenic free annealed copper tubing with PVC sleeve or suitable protection. Minimum 2 nos. or higher numbers as required washers of lead with antimony shall be provided with each tubing.
- CS Gas filter (Moisture Trap), 1 No. for each gas manifold. In case of single manifold where permitted as above for up to 3Kg/Hr. chlorinator the gas filter shall be provided in 2 Nos. (1W + 1S) connected in parallel with inlet and outlet isolation valves for each filter. Filter shall have CS or suitable Body and filter element shall be removal cartridge type woven glass fiber and activated alumina or such suitable. Filter element holder shall be of finer material like Monel.
- Required No. of Isolation Valves for CS manifold as per IS: 3224 (tonner connection, manifold interconnection etc. as applicable).
- 2 Nos. Chlorine Pressure Gauge (Monel wetted part MOC only) on each manifold on inlet and outlet of gas filter (permits to check gas pressure as well as chokage of filter), Bourdon type with Monel wetted parts, SS 316 Body, IP 65 Protection Class, Dual scale calibration shall be provided on each manifold. Chlorine pressure gauge with diaphragm seal can also be accepted with wetted parts as specified.
- Pressure reducing valve shall be provided on each manifold if required as per chlorinator vendor design/requirement for satisfactory and safe operation of chlorinators.
- Water Pressure Gauge On Ejector Inlet.
- Isolation ball valves on Inlet & Outlet of each Ejector of suitable size - 1 set for each plant.
- Isolation valves on Suction & discharge side and NRV on discharge side of each booster pump of suitable size - 1 set for each plant.
- Y type strainer on suction side of each booster pump of suitable size.
- NRV on ejector outlet line of suitable size.

All isolation valves for chlorine application shall be as per IS: 3224.

Each set shall also comprise of all std. accessories, sub assembly that is required for smooth operation of chlorinator and to complete the system In addition to above following shall be supplied in quantity as specified as a minimum or higher as required to complete the system:

- Centrifugal Booster Pumps of adequate capacity/rating of suitable type and MOC, minimum 1 No. with each chlorinator or higher number as specified elsewhere in the tender. MOC of pump set must be of CI body and impeller or better MOC with latest standard and suitable for chlorine application. Sizing calculations for the flow and head of the pump shall be submitted by vendor which shall be suitable for satisfactory operation of chlorination system. GA Drawing, Technical Data Sheet & Performance Curves of the pumps shall also be submitted for approval.
- Required length of uPVC piping and pipe fittings, Valves, NRV, Strainers etc. for connecting suction and delivery piping, as applicable, including interconnecting pipe/valves at delivery side of booster pump to chlorinator and main piping to feed water to any chlorinator. One to one piping shall be provided between each booster pump and its associated chlorinator with required interconnecting pipe and valves at discharge manifold to interchangeability of pumps flow to adjoining chlorinator.
- Diffuser – as per design & requirement, 1 No. of higher as specified elsewhere in tender.

- Suitable size of uPVC pipes and fittings for chlorine solution in required length to connect all associated chlorinators with provided nos. diffusers along with all inter connecting valves at both ends – 1 Lot.
- MS Skid as required – 1 Lot.
- Necessary automatic safety devices like gas-off etc. in case of emergency like failure of power, water supply, should be incorporated. Further safety devices for backwater entry in chlorinator due to failure of NRV should also be incorporated, as applicable.
- Isolation valves at manifold header to interconnect all booster pumps
- The system shall be constructed of materials suitable for wet or dry chlorine gas service. All vacuum connections & raw (booster) water & chlorine solution lines shall be of **Schedule 80 uPVC as a minimum or better** with required specials as per application requirement.
- Chlorine Tonner lifting beam as per ASME B30.20 with crane weighing scale / lifting hook with suspended weighing scale to weigh tonner (not applicable for chlorine cylinder).
- Any other piping, valves, accessories and other components, etc. as required to complete the work and for satisfactory operation of complete chlorination system and to meet the operational requirements as specified in the tender.

In case of manual dosing, the dosing rate shall be manually set and each chlorinator shall be equipped with a 0 to 10mg/l scale and a manual dose setter over the complete range. In case of auto dosing if specified elsewhere in the tender specification, an electric/servo motor actuator operated control valve (flow proportionate valve) shall be provided at chlorine line/vacuum line of each chlorinator to operate in closed loop control based on 4-20mA of such signal from the free chlorine transmitter or such suitable feedback and shall have manual override facility to operate the system manually in case of automatic valve or dosing system malfunction/ failure.

In case of auto changeover of tonner/cylinder battery specified elsewhere in tender specifications/BOQ, the change to the standby tonner/cylinder battery shall be carried out automatically in the event of duty tonner/cylinder battery getting empty. When the pressure in the duty chlorine tonner falls to less than 1kg/cm² the automatic change over device with suitable type of actuator shall operate to isolate the empty tonner battery and to bring the full standby tonner battery on line. In this case two nos. manifold shall be provided in 1W + 1S configuration with each manifold capable of connecting the tonners/cylinders for total working capacity of chlorinators at specified drawl rate. This is general requirement and in case of very high capacity or high no. of chlorinators (more than 2W/more than three chlorinators including working & standby) the design can be finalized mutually between the Client and Vendor considering operational requirement and suitability for client and to achieve the objective of continuous chlorination without need to take shutdown in case of emptying of any one battery of toner/cylinder.

The chlorinator shall be generally as per IS: 10553 (Part 2) of 1983 and Chlorine Institute of USA and suitable to provide continuous and constant measured quantity of gas while in operation. Intermittent start or stop control or automatic shut off of chlorine shall be possible in case of leakage in the piping or interruption of water supply.

In the event of development of excessive gas pressure in the system due to any reason, it shall be safely vented. In order to vent off any excess vacuum, relief valve shall be included in the system, which will admit air to release any excessive vacuum, which may develop. The location of the vacuum relief valve shall be such that the air admitted in the system will not pass through flow meter. Therefore, flow meter will indicate only gas flow.

Safety devices as under shall be supplied as a minimum.

- Two sets of approved Breathing apparatus/gas mask with rechargeable respirators (self-contained breathing apparatus, each comprising an air set, carrying harness, face mask and valves and ancillary equipment. Each set shall be provided with one 1200 liter capacity, 140mm diameter air tonners).

- Ammonia torch for leak detection.
- Four sets of safety clothing in various sizes, each comprising PVC overalls, Wellington boots with steel toe caps, goggles, gloves and safety helmets.
- Each set of safety equipment shall be mounted in a glass-fronted, non-locking PVC coated steel cabinet in approved locations on the outside of the building.
- Vendor to furnish the list of additional safety accessories required as a minimum as per statutory requirement and shall supply the same.

Further following shall also be considered in scope of supply.

- Emergency safety shower and eye wash fountain
- Ton container repair kit
- Statutory warning notices relating to the storage and handling of chlorine shall be provided. The signs shall be pictorial and provided in Hindi/local vernacular language and in English.
- Residual Chlorine test kit of range 0.2 PPM to 5.0 PPM to color glass comparator type.
- Set of erection and maintenance tools including special tools and tackles.
- 900Kg capacity tonner confirming to BS 1500 Part 1 1958 for liquid chlorine sufficient for 15 days requirement or in minimum quantity as specified in Process Design Criteria elsewhere in this tender, whichever is higher or in quantities as specified in BOQ/SOQ of Price Bid.
The same shall be approved from explosive Dept. of Central Government, permission to fill the tonner with liquid chlorine should be furnished. The container should be complete with first filling of liquid chlorine.
- Set of Roller support for each chlorine tonner connected with each of working and standby chlorination system provided within tonner room.
- Minimum 3 nos. chlorine leak detectors or higher nos. as required to suit tonner room area shall be provided in the chlorination equipment room for high and high-high level alarms and suitable safety interlocks. Chlorine gas leak detectors shall be provided each, with a single detector cell. At least two sensors or higher nos. as required shall be located in the chlorine tonner storage room and at least one sensor in the chlorination room. The chlorine leak detectors in the tonner room shall be mounted at suitable location in the tonner room to cover the entire area of room to detect any leakage.

The chlorine leak detectors shall initiate a local audible and visual alarm and also provide potential free contact for remote alarm at control room. The chlorine leak detectors shall have two adjustable alarm levels sensitive to chlorine concentrations above 1 mg/m³. At high level the ventilation fans shall be interlocked to start at high level. At high-high level alarm interlock shall be provided to stop the tonner room and chlorination room exhaust fans. Required relay/PLC based control panel shall be provided for the same. Pilot lights and warning sound generators shall be installed in outdoors to notify gas detection.

Sr. No.	Description	Materials of Construction
1.	Chlorine Gas Detector	Detection of Chlorine Gas Chlorination System. Detectors shall have facility for replacement of sensors. Detector housing unit shall be with mounting assembly etc. Detector transmitter shall have provision for interface with configuration device
2	Model	Vendor to specify
3	Operating Principle	Electrochemical Cell
4	Range	0-10 ppm
5	Overall Accuracy	± 5% of FSD
6	Output Signal	4-20 mA, with option of source/sink of 0-10 ppm reading
7	Repeatability	± 5% of FSD or ± 5% of measured value or better

8	Response Time	80% response time of 60 seconds or less
9	Monitor	Microprocessor based with LCD/LED display. Four alarm LEDs, a 90dB audible alarm with alarm acknowledge and reset facility. One monitor with each detector
10	Power Supply	110V/230V, 50 Hz AC OR 24 V DC
11	Alarm	The two adjustable relays per sensor shall indicate high and high-high level alarm reading. The alarm relay shall be user selected as either latching or non-latching
12	Hazardous Area Classification	Class 1, Division 2, Group C, D
13	Type of Protection	Weather proof to IP 65/NEMA 4X
14	Transmitter Type	Provision of Local Display of PPM levels detected
15	Sensor Configurator	Bidder to offer 1 configurator complete with cables, adapters, power supply , operation & maintenance manual suitable for applicable hazardous area

- Neutralization pit suitable for two tonners/cylinders as applicable shall be provided if specified elsewhere in tender for water distribution station application. However for treatment plants (water/sewage/effluent) where chlorination systems are specified, neutralization pit shall be provided compulsory (even when chlorine scrubber is specified in which case neutralization pit will act as emergency standby). The pit shall be accessible by the overhead tonner handling system (crane/hoist as specified elsewhere in tender). The pit shall be surrounded with removable guard railing. The pit shall be kept full with a neutralizing solution of lime/20% Caustic soda solution. The pit shall be capable of holding side by side two chlorine toners. Provision shall be made to drain the pit.

Note: Above requirement shall be adhered to in all respects for EPC tender. However, in case of Item Rate/Percentage Rate Tender the scope/requirements specified as per financial bid/SOQ shall govern & shall supersede above details where in conflict.

➤ **SPECIFICATIONS FOR FAIL SAFE PNEUMATIC ISOLATION AUTO SHUT OFF SYSTEM FOR CHLORINE CONTAINER (TONNER/CYLINDER) ROOT VALVE**

The Emergency Shut off Valve/Device/System is intended to offer the highest level of safety when handling chlorine gas containers. Working in combination with a gas warning device (leak detector), the gas containers (tonner/cylinder as applicable) are closed within a few seconds (within 5 seconds of detecting leak trigger) as soon as a leak is detected reducing the total possible chlorine leakage time to offer the operating personnel a significant level of safety since the chlorine gas room does not have to be entered to close the gas containers. The purpose is to secure the environment and eliminating a possible leak prior to the trained operator entering the area to attend/manually re-open the chlorine gas valves. Vendor shall design/offer the system (device) generally meeting with The Chlorine Institute (CI) guidelines.

Equipment for the emergency cylinder valve closure system(s) specified herein shall be coordinated with associated equipment and devices as required to provide complete and fully compatible system.

The no. of valve/device shall be provided as per tender specifications/scope of work/process description /process data sheet/SOQ/price bid.

The auto shut-off device is intended to be installed directly on the chlorine gas valve of chlorine container (tonner/cylinder as applicable) and controlled from a control cabinet. The valve shall automatically close upon receipt of a closure signal. In case of more than one (multiple) auto shut off devices, all shall close

simultaneously in the event of trigger/closure signal. It shall also be possible to test the valve periodically for functionality checking through test button/emergency switch by triggering it manually on the control cabinet located outside the storage/tonner or through local PB station provided at safe distance/area from tonner/chlorine storage room.

The auto shut-off device is to be specifically designed to close the cylinder or container valve(s) by using a pneumatic operated actuator directly coupled to the cylinder or container valve. The pneumatic operated actuator shall utilize compressed air or nitrogen as a source of operating gas.

The system shall use a bracket assembly that attaches directly to the cylinder or container valve and shall not require any support except on the valve. The system shall also avoid contact with the yoke and yoke adapter system. The system shall be designed to allow an operator to use a standard cylinder wrench to open the valve without removing the system. The system shall be designed to simultaneously close up all cylinder valves provided with auto shut off device when activated. For location provided with more than one auto shut off devices, systems that cannot close multiple valves simultaneously shall not be acceptable i.e. offered system should be able to close all connected shut off valves simultaneously in case of trigger/leak signal.

The selected actuator shall be adjustable or shall be with suitable closing torque to ensure that the correct, secure closure is achieved and vendor shall select accordingly.

The system shall operate even in the event of power failure i.e. an air receiver system for pneumatically operated maintained at required pressure and suitable battery backup system/UPS (minimum 2 hours battery back-up time) integrated in the control cabinet shall be provided to ensure that the device/s functions after pre-set time in the event of prolonged power failure. If more than one shut off valve/ device then the backup system shall be adequate to close/carry out at least one operation simultaneously for each of the total no. of valves provided in case of power failure.

The air receiver for compressor shall be provided with low and high pressure switches for automatic operation of compressor so that compressor stops at set high pressure and starts at low pressure. The low pressure set shall be adequate to ensure one or more shut off devices as applicable to operate/close simultaneously in the event of leak (trigger) or power failure. Further in the event of low-low pressure in air receiver (sensed by low-low pressure switch, to check condition of air leakage or such), an alarm flashed locally (and potential free signal or such shall be made available to hook-up with remote system at control room/SCADA room for remote alarm)

The chlorine gas leak detector for triggering the shut off valve/device action shall be provided as specified in chlorination system (or as per chlorine leak absorption system/chlorine scrubber specifications where this system is applicable/included in scope). If not specified elsewhere then the scope shall also include to provide minimum 1 no. chlorine leak detector or more to have at least 1 no. leak detector between 3-4 tonners (tonners provided with shut-off valve system).

The pneumatically operated auto shut off chlorine cylinder/tonner root valve shall be with pneumatic actuator, airline filter (AFR), Solenoid Valve, Yoke clamp etc. of required capacity, size, rating. The pneumatically actuated system shall also include an air compressor with air receiver of required capacity and at required pressure (including low and high pressure switches for automatic operation of compressor, starting on low pressure in air receiver and stopping when air receiver pressure reaches high set level), required air piping (uPVC Sch. 80) and air tubing.

The system shall be provided with PLC based Control panel for required monitoring, alarm (including hooter for local alarm) and operation shall be provided. PLC shall be with communication port (Ethernet with Modbus or such protocol) for remote monitoring. The scope also includes all required power, control and signal cabling.

Since this system is not continuously being operated, it is essential to operate the entire system including power back-up system periodically for preventing a possible malfunction of moving parts or power/ battery backup system. In general, it is highly recommended to check out the system weekly or bi-weekly as recommended by manufacturer.

The performance of the offered system shall be demonstrated at site/manufacturer works with required simulation.

Closure System Construction

The emergency cylinder valve closure system(s) shall generally consist of the following components.

- Pneumatic operated actuator capable of producing no more than 35 ft-lb of stall torque at 90 psig of operating gas pressure. The operating gas pressure shall be adjustable to provide 70 - 120 psig pressure range. The air requirement for offered pneumatic actuator/air motor shall be provided by Vendor along with offered actuator data sheet/catalogue from actuator OEM.
- Spring-loaded or such suitable coupler assembly to couple pneumatic operated actuator to the cylinder valve stem. Travel length of coupler assembly shall allow for varying lengths of cylinder valve stem. Coupler assembly shall preferably be an integral part of the pneumatic actuator.
- Bracket assembly to hold pneumatic actuator in place during closing of the cylinder valve. Bracket assembly shall be such to allow quick disassembly and shall not rely for support on packing nut or yoke assembly, or any other external support. Mounting bracket shall be fabricated from cadmium plated lightweight aluminium or such suitable material.
- A supply hose 6-foot or suitable in length and 3/8" inside diameter or such suitable dia. to suit actuator requirement and quick connect fitting shall be supplied for easy attachment of the pneumatic actuators to the operating gas source.
- A pre-assembled air control unit (AFR or such) shall provide filtered air that shall remove debris larger than 5 microns from the operating gas supply. It consists of the following installed components:
 - ✓ Operating gas pre filter: This filter shall remove debris larger than 5 microns from the operating gas supply. This filter shall be located in the operating gas supply line upstream from the solenoid valve.
 - ✓ Pressure switch: This pressure switch shall be of normally open configuration. Loss of operating gas pressure shall cause this switch to open and activate a corresponding alarm. Operating range of the pressure switch shall be adjustable.
 - ✓ Air Safety Valve: This valve provides protection for the solenoid valve. This is normally set for 125 psig or as recommended by SOV vendor.
 - ✓ Solenoid Valve: This valve shall be of normally open configuration. De-energizing the solenoid valve shall open the valve, allowing it to supply gas to operate the pneumatic actuators. This unit shall have 1/2" or suitable connections to accommodate field installation.
- Control Panel shall generally be as under.
 - ✓ The valve closure system shall be furnished with a local control panel with an enclosure to house the required controls. The control panel shall be mounted in the chlorine room or external of the chlorine room.

- ✓ The control panel shall include the required switches and pilot lights, emergency stop, reset switch, alarm silence, supply power, gas pressure low, system ready and system activated, UPS battery low, UPS failure etc.
 - ✓ All control devices shall be mounted on the front of the control panel enclosure. Each control device shall have an engraved or etched nameplate describing its function.
 - ✓ The control panel shall have a terminal strip for connection of power and control circuits in the field. All terminals shall be numbered and terminal numbers shall be shown on the manufacturers wiring diagram.
 - ✓ Electrical connections of supply power, external alarm and control wiring shall be the owner's responsibility.
 - ✓ Online type Uninterruptible Power Supply (UPS) to be provided, wired and mounted preferably internal or external of the control panel. The UPS shall have a minimum 1kVA output power with no transfer time required. The UPS shall utilize "true" on-line double conversion technology.
 - ✓ Uninterruptible power supply shall prevent the valve closure system from activating in the event AC supply voltage is removed or fluctuates. In the event of a sustained power loss, the valve closure system will get activated after a significant power loss and close the container valves. The back-up capacity of UPS shall also be checked periodically to ascertain the health of batteries/UPS System and the batteries shall be replaced periodically till the end of O&M period as required.
- Operating Gas Supply
 - ✓ The system owner shall provide operating gas supply, either compressed air or nitrogen.
 - ✓ The operating gas supply piping shall be 1/2" NPT or higher suitable to accommodate system components.
 - ✓ If nitrogen is used as the operating gas, owner shall supply a cylinder regulator on the cylinder to adjust nitrogen pressure to maximum 125 psig or as recommended by System Vendor.

The scope shall include all required piping, fittings, tubing and accessories etc. as required to complete the work in all respects.

DATA SHEET FOR AUTO SHUT OFF DEVICE/SYSTEM

PURPOSE	TO CLOSE CHLORINE TONNER VALVE ON Cl ₂ LEAKAGE
LOCATION	CHLORINE TONNER ON ISOLATION VALVE
VALVE CLOSING TIME	5 SECONDS MAXIMUM
NO. OF DEVICE(S)	AS PER TENDER SPECIFICATIONS/SCOPE OF WORK/ PROCESS DESCRIPTION/PROCESS DATA SHEET/SOQ/ PRICE BID
OPERATION	PANEL BASED
BATTERY BACK UP	2 HRS.
TYPE	NON REVERSIBLE
OPERATING MEDIA	PNEUMATIC AIR
ENVIRONMENT	MOC SHOULD BE SUITABLE TO CHLORINE ENVIRONMENT
PANEL OPERATION	1) AUTO/MANUAL ON-OFF 2) GAS LEAK INDICATION/ALARM 3) EMERGENCY START FACILITY 4) VALVE OPEN/CLOSE INDICATION 5) AIR PRESSURE LOW 6) UPS POWER LOW

	7) UPS FAIL 8) UPS POWER HEALTH/STATUS MONITORING
ACCESSORIES	1) COMPRESSOR 2) PNEUMATIC ACTUATOR 3) SOLENOID VALVE, IP 65 4) FILTER REGULATOR COMBINATION - LUBRICATOR 5) CLAMP 6) INTER-CONNECTING PIPING/VALVE 7) HOOTER 8) PLC BASED LOCAL CONTROL PANEL WITH COMMUNICATION PORT FOR REMOTE DATA TRANSFER & MONITORING

Note: The above are general requirement and certain features may vary as per manufacturer design but shall meet the above stated objectives for emergency chlorine container valve closure in the event of gas leak.

❖ SPECIFICATIONS FOR AUTO CHLORINE LEAK ABSORPTION / NEUTRALIZATION SYSTEM (CHLORINE SCRUBBER)

System Description

The system should operate automatically in case of chlorine leak from container/tonner which should be covered by FRP hood with sensor. In case of chlorine leaking from the container/tonner, the system should automatically start i.e. blower and pump should start simultaneously. The pump should deliver NaOH from tank through the top of absorption tower and blower that should suck the leaked chlorine from FRP hood should push this sucked chlorine from bottom of absorption tower. Due to counter current flow of NaOH from top and Chlorine from bottom, chlorine is neutralized. After neutralizing chlorine, chlorine free air will be vented out in the atmosphere. Vendor has to guarantee that at the outlet of the system chlorine content will not exceed than 0.1PPM. Theoretically, on a weight basis, to neutralize one kg of chlorine with required 1.13kg of sodium hydroxide and will produce 1.05kg of sodium hypochlorite.

Scope of Work

The scope includes complete neutralizing system including all following main components but not limited to the same and other equipment necessary to make it fully functional as per the requirement and for safety purpose:

- Suitable FRP hoods/covers for Chlorine tonners with 900kgs of chlorine gas in each tonner (in case of chlorine cylinders, the hood shall be suitable for 100kg or applicable capacity cylinders as specified in tender specifications/scope of work/SOQ/price bid),
- Combined ducting with blower of suitable rating for evacuation of chlorine gas from any tonner,
- FRP scrubber unit, caustic solution circulation system with piping valves,
- Alkali circulation Pumps,
- Sensors/detectors for leakage of chlorine gas,
- Auto starting of the above system with manual override facility i.e. shall be able to operate automatically as well as manually with operator intervention and
- Electrical control panel

The spent scrubbing liquor shall be suitably disposed.

The scope of supply indicated above is a minimum quantity requirement. Any material quantity/service requirement for completing the job in totality will be in bidder's scope.

The broad requirement for major components shall be as under.

A. Split type FRP hoods for Chlorine tonners

- As per number of tonners/cylinders connected to system (in service & standby),
- Thickness 5mm(minimum),
- Suitable sizing nozzles, as per system design including connection to main header and
- Sliding Window for tube connection and operation.

B. Caustic Storage Tank

- Suitable for 20% w/w caustic solution and for operating temperature up to 80 degree C or higher as per process requirement as significant quantities of heat are released by the sodium hydroxide- chlorine reaction.
- PVC-lined FRP/FRP + PP or such suitable MOC and thickness as per system/manufacture design.
- Vertical cylindrical with flat bottom Type Design.
- Capacity of tank to be adequate for absorption of chlorine leaked for one no. of completely filled chlorine container in service + 20% margin with minimum 300mm Free Board. However for chlorine cylinders or such low capacity system the tanks shall be of minimum 1000litres capacity.

C. Scrubber Column

- a) Fluid handled capacity is 20%w/w (maximum) caustic solution and chlorine gas.
- b) MOC is FRP+PP or such suitable and thickness as per system/manufacture design.
- c) Vertical cylindrical packed column type.
- d) Capacity is Adequate for absorption of chlorine leaked from one no. of completely filled chlorine container (tonner or cylinder as applicable) in service in one hour (maximum).

D. Centrifugal Blower

- The design capacity should take the maximum probable gas flow into account considering to such air/gas from all connected tonners/cylinders to the hoods/scrubbing system.
- 2 Nos. (1W + 1S) suitable to handle entire chlorine gas as per capacity of tonner/cylinder from leaked container and capacity suitable to suck air/gas from no. of chlorine tonners/cylinders connected to the scrubbing system in one hour (maximum) or as per manufacturer design,
- Body and impeller MOC is FRP + PP/FRP with suitable lining or such non-corrosive/corrosion resistant material to suit chlorine application.
- Necessary Accessories like Common base frame, discharge damper, belt guard etc. as applicable.

E. Circulation Pump

- 2 Nos. (1W + 1S), suitable to handle 20% Caustic Solution and of capacity to neutralize chlorine gas leaked from completely filled chlorine container (tonner or cylinder as applicable) in service in one hour (maximum),
- Body and impeller MOC is PP or such non-corrosive/corrosion resistant material to suit chlorine application,
- Horizontal Centrifugal Type,
- Necessary Accessories like Common base frame, Valves, Coupling Guard etc.

F. Connection Piping & Valves,

- Duct Line MOC is uPVC (Sch. 40), size suitable to handle peak flow/design flow of blower,
- Caustic Line MOC is uPVC (Sch. 40) and
- Valve, Strainer, NRVs MOC is PP.

G. Instruments

All Necessary instruments to be considered by Bidders as mentioned below.

- Level Switches
- Level Indicators
- Temperature Indication

- Chlorine Leak Detectors. If leak detectors specified in chlorination system then the same in specified quantity shall be provided as a minimum and any additional as required/recommended shall be provided to cover the no. of tonners / area of tonners connected to scrubber system. Min. 2 nos. leak detectors or higher such that minimum one leak detector is available between every 4 tonners that are provided in tonner room/connected to scrubbing system.

H. Electrical Panel/Control Panel

- Required electrical panel with starters for all equipment meeting tender specifications (refer electrical specifications)
- PLC based Control panel for automatic operation of Blower, Circulation pumps etc. and for instruments monitoring, etc. with manual override facility. PLC shall be with communication port (Ethernet with Modbus or such protocol) for remote monitoring as well as control if required from remote location.
- AUTO/MANUAL Selection. The system shall be in auto mode in default to be able to operate automatically through leak detection trigger signal or if required to operate from control room remotely.
- Hooter with hooter reset PB to provide local alarm in event of chlorine leak.
- Necessary Push Button, Indication lamps etc. shall be provided.
- Suitable potential free contacts shall be provided in for remote monitoring and alarm for PLC/SCADA system (to be hooked up with PLC/SCADA system at central control room).
- The electrical & control panel shall be installed at safe distance/area away from tonner room and as recommended by chlorination/scrubber vendor to ensure operation of system manually in case of automatic operation failure for any reason.

The scope also includes:

First fill of caustic solution and any other consumables or items/chemicals required for satisfactory commissioning and operation of the system and also subsequent periodic fill based on shelf life or for condition specified below and as per requirement/recommendation of Chlorination/Chlorine leak dissolving system vendor or due to usage in case of leakage as applicable till the end of O and M period

The neutralization system is a safety device to be run when the chlorine gas is leaked. Since this system is not continuously being operated, it is essential to operate the system periodically for preventing a possible malfunction of rotating parts. In general, it is highly recommended to check out the system weekly or bi-weekly as recommended by manufacturer and including pH value testing of caustic solution. As Carbon dioxide (CO₂) will be absorbed by the caustic solution during such periodic testing of the system it is required that caustic solution of concentration and quantity as recommended by scrubber vendor considering 15 minutes testing time of scrubber system during periodic testing to be added into the caustic solution tank every year. Caustic solution of concentration and quantity as recommended by scrubber vendor also to be replenished if the caustic is depleted to low concentrations so that the pH drops below 12.

Chlorine sensors remain to be replaced once shelf life gets over. The cost of sensor replacement shall be considered in scope of Bidder till the end of O&M period.

❖ SPECIFICATIONS FOR AGITATORS / MIXERS (FOR ALUM, DWPE, ANY OTHER CHEMICAL OR SUCH MIXING OR SOLUTION PREPARATION APPLICATIONS)

The Agitator / Mechanical Mixing Device shall comprise of rapidly rotating blades mounted on a vertical shaft coupled to the gear box shaft through rigid coupling and driven through a suitably rated 1500 RPM (Max.) continuous duty electric motor TEFC with IP 55 protection operating through a suitable type of reduction gear box to ensure uniform dispersal of the chemical solution / keep the sludge in suspension.

The agitator impeller shall be designed to ensure that Reynold Number is for Turbulent Condition for Mixing (Re > 4000). Vendor to provide calculations.

General Specification

- Agitator component shall be designed to fit through agitator opening on tank manhole.
- Pressure containing part shall have minimum corrosion allowance of 3 mm.
- Gear unit
 - A worm or suitable type of reduction gear shall be provided with a minimum service factor of 1.5 on the driver rated KW.
 - V belt operation is not acceptable.
- Rigid coupling shall have tapered bores with key in nut arrangement and of suitable MOC as per application requirement. Alternately, flexible coupling can be accepted / selected with a minimum service factor of 2 and shall be capable of continuous operation at the max. anticipated misalignment if required as per vendor design.
- The shaft shall be suitable for transmitting full torque available for the rated driver. (Starting torque).
- Shaft shall be suitable for jamming conditions considering that rotor / impeller is jammed at 0.75 R from centre (R = Radius of impeller).
- Shaft assembly designed with critical speed at least 30% removed from any operating speed.
- Individual Impeller / Agitator blade shall be in one piece construction.
- Bearing housing shall be designed with a span suitable for the minimum radial cum thrust loading used for the design of the shaft.
- It is preferred that the design of the agitator does not incorporate the use of a steady bearing at the shaft end. However if the use of such bearing is imperative the design shall be such that the bearing is of self-aligning type and pre-lubricated.
- Mounting Stool and Support Steel Structure (epoxy painted) shall be provided for agitator and to suit tank size.
- For circular tanks, vendor shall provide baffle plates (min 3-4 baffles) in suitable MOC (to suit fluid) and size to prevent vortex formation.

Mechanical Data:

Agitator type	:	Axial pitched turbine / low speed
No. of Blades	:	As per design
Impeller dia., mm	:	As per design
Gear box	:	Worm Gearbox or other suitable type as per vendor design
Agitator RPM	:	60-100
Shaft suspension Length	:	Suitable to Dosing Tanks Size / Depth.

Material of construction as min. as under or higher as indicated in BOQ / process data sheet or tender specifications elsewhere / as per process application requirement:

Agitator	SS 304
Impeller / Blade	SS 304
Shaft (up to Gear Box	SS 304
All fasteners / hardware	SS 304 or better

❖ SPECIFICATIONS FOR THICKENER MECHANISM (CENTRAL DRIVEN FIXED BRIDGE TYPE)

The Thickener Mechanism shall be suitable for installation in RCC tank. The mechanism shall comprise of the following main components:

- Bridge Superstructure spanning half the tank diameter with central drive maintenance platform

- Drive assembly complete with drive head, chain & sprocket, geared motor/motor and gear box etc.
- Feed Well
- Center Shaft
- Cone scraper
- Rake arms
- Tie rods for rake arms
- Plow blades & squeegees
- Scum Blade & Skimmer assembly
- A-frame supports for the skimmer assembly
- Scum trough and ramp with support angle
- Scum baffle with supports
- Weir plate

Brief Technical Specifications:

Bridge Superstructure

The bridge shall span the half diameter of the tank. The width of the walkway shall be minimum 1m. The bridge shall rest on the outer wall at one end and drive at the centre. The bridge and central platform shall be of truss type welded steel construction with walkway of gratings / checkered plates walkway. The bridge shall be provided with a drive maintenance platform at the center

Drive Assembly with Drive Head

The central drive head shall rest on the RCC center pier and supports the bridge at the center. The drive head shall be coupled to a geared motor or motor and gear box through chain & sprocket and shall support the center cage at the bottom for rotating the rake arms. Drive head shall be provided with high and high-high torque switches with potential free contacts (1NO + 1NC as a min.) for alarm at high torque and tripping of drive when torque exceeds high-high set level.

Feed Well

A fixed feed well shall be hung from the bridge superstructure. The feed well shall project at least 200mm above the full supply level (FSL) of the unit and shall be of adequate height to sufficiently project below the water level.

The inlet feed pipe shall run under or over side supports of the bridge up to the feed well.

Center Cage

The center cage shall be of welded steel construction. The center cage shall be bolted to the drive head at the top and shall support the rake arms at the bottom.

Cone Scraper

A cone scraper shall be attached to the bottom of the center shaft and shall serve to stir the sludge in the bottom hopper.

Rake Arms & Tie Rods

Two sets of rake arms shall be attached to the center cage torque cage in diametrically opposite direction through a hinged connection. The rake arms shall be attached to the center cage through tie rods with provision for adjustment of inclination of the rake arms. Each rake arm shall be provided with plow blades at the bottom and adjustable renewable squeegees for scraping of sludge.

Skimmer Assembly & Scum Blade

One set of skimmer assembly with scum blade shall be attached to the rake arm and shall serve to skim the floating material. The scum blade shall span from outside of the feed well to scum baffle at the periphery of the clarifier.

Frame support for the skimmer assembly

The skimmer assembly shall be supported by frame supports attached to the rake arm.

Scum trough and ramp with support angle

One no. scum box comprising of scum trough with ramp shall be provided at one point along the periphery of the clarifier and shall serve to collect the scum discharged by the scum blade into the trough. The scum box shall be supported from the side wall by support angles. The scum box shall be provided with flange connection of specified size for connection of scum pipe connecting the scum box to the scum sump.

Scum baffle with supports

The scum baffle shall be provided along the periphery of the tank to prevent floating matter from escaping into the overflow. The scum baffle shall be supported by support brackets from tank wall.

Weir Plate

Adjustable V-notch weirs shall be provided along the periphery of thickener for uniform draw-off of the overflow. The weir plate shall be fixed to the tank wall by means of plate washers.

Telescopic Valve Arrangement

Telescopic valve arrangement, min. 150mm dia., shall be provided to sample the sludge for quality check purpose.

Control Panel

The starters shall be provided in plant MCC or alternative starter panel for each mechanism can be supplied and shall be mounted independently near to the equipment installation. The system shall provide for remote / plant PLC controlled automatic operation of the mechanism in addition to manual operation through panel mounted selector switches as per the choice of operator. The panel shall be in with double door, **SS-304 enclosure** and suitable for outdoor application. Panel to be provided with canopy cover if required. Refer the “Notes/Provisions” in under general specifications for mechanical works and electrical specifications for other general requirement/specifications and makes as applicable.

Material of Construction	
Tank	RCC
Feed Well	MSEP
Bridge	MSEP
Rake Arm	MSEP
Vertical shaft / Centre Cage	MSEP
Blades	MSEP
V-notch Weir	3 mm Thk SS-304, Adjustable, Min. 300mm Height
Squeeges	Neoprene
Walkway	MS Checkered Plate / Grating
Handrail	32 NB Medium MSEP
Scum skimmer	MSEP
Scum Box	MSEP
Scum Baffle	8 mm Thk FRP, Min. 500mm Ht. or higher as per mfr. design
Anchor Bolt	SS-304
Fasteners – Under Water	SS-304
Fasteners – Above Water	GI or better

NOTE: The above specification and MOC are minimum and higher or better MOC and specifications shall be provided if specified elsewhere in tender specifications (in Process Design Criteria & Specifications or Scope of Work or Description of Project or elsewhere of tender specifications) or in BOQ/SOQ/Price Bid.

❖ SPECIFICATIONS FOR DECANTER CENTRIFUGE FOR SLUDGE DEWATERING

The centrifuge shall be suitable for de-watering the sludge of sewage/waste water/water treatment plant. It

shall have capacity of de-watering the liquid sludge of capacity as specified/as per design and having operational duty of 24 hrs./day. Centrifuge shall be capable of handling sludge consisting of minimum 0.8% solids by weight or as specified in design/process description. The dewatered cake shall be based on minimum consistency of 20% by weight dry solids.

Centrifuge shall work on mechanical sedimentation principal. Centrifuge shall have two phases for liquid and solid separation and removal. Separated solid in the decanter bowl are continuously removed by means of screw conveyor.

Centrifuge bowl cylinder shall be made of stainless steel. The feed pipe and the opening in the casing shall be fitted with seals. The feed inlet should enter the feed compartment in the hollow axis of the conveyor body to handle most of liquid sludge without risk of choking. The tips and leading flanks of the flights are hard faced with Tungsten Carbide alloy. The solid outlet opening shall be lined with hard metal bushings/flanges sprayed with suitable Tungsten Carbide coating. Longitudinal strips shall be welded to the inside of bowl wall retain a thin layer of sediment that acts as an abrasive shield.

Screw conveyor shall be fine pitched and made of stainless steel. Screw conveyor edge shall be hard faced with Tungsten Carbide coating.

The centrifuge shall be solid bowl centrifuge of co-current or counter-current design & having suitable cone angle of as per manufacturers' design so as to achieve smooth transportation in the conical section of the bowl itself. The centrifuge shall have sufficient clarifying length so that separation of solids is effective. The centrifuge and its accessories shall be mounted on a common base frame so that entire assembly can be installed on an elevated structure.

Main bearings, conveyor bearings etc. shall be compact, grease/oil lubricated with proper sealing arrangements.

Suitable single motor drive system to be provided with V-belt arrangement along with overload protection. Centrifuge wetted parts should be in SS 304 and Solid, Treated Effluent collection hoppers in Mild Steel with suitable epoxy paint.

Differential speed and bowl speed should be adjusted by changing the pulleys; differential speed may be adjustable by use of epicyclical or cyclo gear as per manufacturers' standards. The centrifuge assembly shall be protected with flexible connections so that vibrations are not transmitted to other equipment. The base frame shall be in epoxy painted steel construction and provided with anti-vibration pads. All steps necessary to prevent transmission of structure borne noise shall be taken. The drive motor shall be of **1450/2900 rpm (4 pole/2 pole)** as per manufacturers' standards.

The noise level shall be as per ISO 3746 standards, measuring 85-88 dB-A measured at 1 meter distance under dry run. The vibration level shall be as per ISO 10816-3 standards, measured at ≤ 4.5 mm/sec at pillow blocks under dry run condition. Adequate sound proofing shall be carried out for the housing of the centrifuges to ensure that the noise level at 5 meter distance from the enclosure is less than 75 dB -A.

Bowl

The centrifuge bowl material shall be centrifugally cast or fabricated from AISI 304 grade casting/stainless steel plates. The inlet slurry shall be fed to the centrifuge from conical/cylindrical portion of the bowl (depending on Counter Current/Co-Current flow configuration) via stationary feed tube. To protect the wear due to cake discharge, the bowl shall be fitted with satellite wear bushes or suitably coated with Tungsten Carbide. The bowl shall be fitted with axial ribs/strips from inside. The bowl assembly shall be independently balanced before assembly as per standards.

Conveyor

The centrifuge inside conveyor material shall be stainless steel AISI 304 grade. The conveyor shall have suitable scroll pitch to allow easy transportation of solids and acceleration of liquid in the pond without turbulence. The conveyor flights shall be protected against wear, by means of flame sprayed Tungsten Carbide alloy powder having content of nickel-chromium for higher bonding strength.

Gearbox

The gearbox shall be of planetary or cyclo design for compact and high performance operation, to monitor and achieve differential speed of the Conveyor.

Drive System

Drive system should be single motor driven via V belt pulleys in combination with VFD/Turbo Coupling/Eddy current system. Manufacturer to ensure suitable overload protection is provided for safety of motor and gearbox. Control panel for operation of centrifuge can be VFD/Star Delta/DOL type with starting method of motor as per manufacturer recommendation.

Frame

The base frame should be fabricated from MS material and should have the following functions.

- Supporting structure for the parts rotating in the pillow block frames.
- Holding the housing.
- Stabilizing the complete machine.
- Counter-mass to the rotating unit.

The design ensures that the processed product does not come into contact with the base frame. The motor can be flange or foot mounted as per manufacturers' standards.

Vessel/Cover

The vessel or collection cover shall be fabricated from AISI 304 sheet steel and should ensure the following functions.

- Collecting liquids and cake discharged from the bowl.
- Forming a guard for the rotating parts.
- Offering the possibility of connecting chutes.

Upper casing must remain bolted at all times during operation or can be hinged with cover switch to indicate cover open alarm in the panel.

Drive Motor

The drive motor shall be of suitable capacity, continuously rated, 415V, 3 Phase, TEFC squirrel cage induction motor to take care of initial accelerating torque load of the centrifuge rotating assembly in Star-Delta/VFD/DOL starting. The starting method of motor for decanter/centrifuge shall be as recommended by equipment vendor. The main drive is to be coupled with V belt and pulleys for ease of maintenance. For electric drive with VFD operation shall be inverter duty type. The electric drive shall be as specified in electrical specifications and of approved make as per tender.

Control Panel

The centrifuge panel shall be VFD/Star-Delta/DOL type as per starting method suggested by equipment vendor. It should have suitable interlocks to ensure safety of the Centrifuge motor and protect the centrifuge against overload. Manufacturer may suggest additional interlocks if required for their equipment. The type of starter shall be as recommended by centrifuge vendor.

The construction and general requirements for starter/control panel supplied by vendor along with equipment in brief are as under.

- The control panel shall be generally floor mounting type, free standing, totally enclosed and dust, damp and vermin proof. Enclosure shall have IP 42/IP 52 or better degree of protection to be mounted indoor or under shed with suitable protection. Cubicle sheet steel shall be CRCA minimum 1.6mm for load bearing and non-load bearing members. Gland plate shall be CRCA sheet minimum 2.0mm thick. For motor rated 15kW and below, the common equipment panel with multiple starters up to 6 Nos. within single cubicle can be accepted. However for motor rated >15kW, individual starter cubicle shall only be provided.
- Starter shall be fuse less type, meeting Type-2 co-ordination. Incomer shall be with Ammeter, Voltmeter, Indicating lamps etc. START/STOP (Mushroom head stay put type with padlocking facility)/OVERLOAD Reset Push Button and Auto-Off-Manual, local-remote selector switches etc. shall be provided. Ammeter with Y-Phase CT shall be provided for all starters with motor rating 7.5kW and above and up to <30kW, and ammeter with selector switches shall be provided for all starters with motor rating of 30kW and above. Control and power wiring shall be with minimum 1.5 sq. mm. FRLS Copper flexible. CTs, wherever provided shall be resin cast.

The breaker (MCCB) and other switchgear (MPCB, contactor, etc.) shall be as per approved makes specified in tender/specifications for electrical works except for panels imported from outside the country for which makes as per manufacturer standard shall be accepted. However makes of rest all items like wires, selector switches, push buttons, CT/PT, etc. as per manufacturers' standards are acceptable.

- For equipment starter required with/provided with VFD based starting or with Soft Starter based starting following to be noted:
 - ✓ VFD shall be selected such that the de-rated current of VFD/Soft Starter for 50 °C continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor. Alternatively, VFD shall be provided of at least one rating higher than the motor rating.
 - ✓ The VFD for sewage/STP and industrial effluent or such application shall be with 3C3 conformal coating and for raw/drinking water or rest applications shall be with 3C2 conformal coating.
 - ✓ The Fast Acting (Semi-conductor) fuse for VFD/Soft Starter protection as per electrical specifications are not required for motors rated <75kW.
 - ✓ The series contractor in line of VFD/Soft Starter after breaker is not required.
 - ✓ VFD shall be with communication port (RS 485 Modbus or suitable) and shall be connected with plant PLC/SCADA for remote data, power monitoring and diagnostic data.
- Shall be suitable for remote monitoring and control from PLC/SCADA system. Required potential free contacts shall be provided for On/Off, Trip and L/R selector switch status as a minimum. In case of PLC based control offered, the PLC shall be with communication port (Modbus protocol or suitable) to communicate with plant/main PLC/SCADA for remote monitoring and control.

❖ SPECIFICATONS FOR CAST IRON OPEN CHANNEL GATES

General

The construction of cast iron open channel gate shall be strictly in accordance with the specifications mentioned hereunder. The open channel gate shall be capable of performing the isolation duties in water/waste water treatment plant for those applications where the height of water is at least 300mm less

than the height of opening/shutter. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

Design

The open channel gate shall comprise of frame suitable for mounting in the parallel side walls of the channel. The frame shall be self-contained type with a yoke on top for mounting of the operating arrangement. The shutter shall move within the frame guides and shall be provided with suitable connecting arrangement to enable connect it to the spindle.

Water sealing on sides and bottom shall be affected by means of non-corroding seating faces secured in grooves of frames and remaining in forced contact with corresponding sealing arrangement mounted on shutter. Bottom sealing arrangement shall be flush bottom type to ensure that invert level of channel on either side of gate remains flush with the invert of the gate.

The spindle shall be rising type and provided with stop nut to avoid over closing of gate. The rising spindle shall be provided with transparent scratch proof and UV resistant polycarbonate cover tube to protect the threaded portion from the effect of dust, dirt and rain. The operating arrangement shall be manual or electric as specified elsewhere in the tender specifications. In case of manual operation operating mechanism should be such that the effort required to open/close the gate does not exceed 18kgs with diameter of hand wheel / crank restricted to maximum 750mm. However for all gates of size above 1000mm x 1000mm or above 1 m² shutter area shall be gear operated type only.

Materials of Construction

The materials of construction for various components shall be as under.

Gate Frame, Shutter/Door	Cast Iron IS: 210 FG 200
Side Guides	Cast Iron IS: 210 FG 200
Seating faces	Stainless Steel ASTM A 240 Type 304
Rubber Seals	EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar	Stainless Steel ASTM A 240 Type 304
Assembly Bolts, Nuts and Fasteners	Stainless Steel ASTM A 276 Type 304
Stem and Connecting Pin	Stainless Steel ASTM A 276 Type 304
Yoke	Mild Steel to IS: 2062 grade A, epoxy painted
Headstock	Cast Iron IS: 210 FG 200
Spindle Cover Tube/Pipe Hood	Polycarbonate

Note: The shutter height of gate shall be at least 300mm above the upstream water level.

❖ SPECIFICATIONS FOR WALL THIMBLE MOUNTED CAST IRON SLUICE GATES

General

The construction of cast iron sluice gates shall be strictly in accordance with the specifications mentioned hereunder. The sluice gates shall be capable of performing the isolation duties in water/ waste water treatment plant and pumping stations for isolation of flow in and out of a closed conduit as well as in those applications where water head is more than the height of shutter/opening. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The Sluice gates shall be wall thimble mounted only except for shallow channels. For shallow channels of up to 3.5 meter depth with water head not exceeding 2.0meter and Gate/Shutter area not exceeding 1.5 m² wall mounted gates can be accepted instead of wall thimble.

The gate shall be designed for seating and unseating head of minimum 5m liquid depth or as per design requirement (except for shallow channels/units < 5m total height for which it shall be subject to top of channel/unit and accordingly head shall be as per actual full height).

Design and Construction

The sluice gates shall be manufactured generally as per IS: 13349 (1992). The constructional features and details of components of the required gates are to be as under:

Gate Frame

- The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall either be flat back type or flange back type to suit the designed head and site condition.
- Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the Cast iron wall thimble mounted on the wall. A rubber gasket will be provided between the wall thimble and the gate for ease in future dismounting of the gate for repairs/replacement and seal any leakage between the flange of frame and wall thimble.
- The gate frame of these sluice gates shall either be self contained type or non self contained type depending upon site requirement. In case of non self contained gates the frames shall have short length extension guides and shall be without yoke at their top. The length of extension guides in such cases shall be sufficient to engage at least half the overall vertical height of door when the gate is full open and shall be in accordance with the relevant provisions of IS: 13349. In case of self contained gates the frames shall have full length extension guides and shall be provided with a yoke at their top. The length of extension guides in such cases shall be sufficient to engage the overall vertical height of door when the gate is full open position.

Wall Thimble

- The wall thimble will be made from cast iron for placement in the concrete wall. Its front flange will be machined, drilled and tapped to match with the frame flange.
- The cross section of the thimble shall be F shaped and the depth of thimble shall be minimum 300mm long. Gates subjected to high unseating heads shall have thimble cross section shaped E.
- To permit entrapped air to escape as the thimble is being encased in concrete, cast holes of 40mm diameter shall be provided at the bottom of wall thimble in each entrapment zone.

Gate Slide/Shutter/Door

- The gate slide/shutter/door will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head.
- The gate slide/shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

Seating/Sealing Faces

- a. Materials: These should be of Stainless steel or Bronze or as specified.
- b. Fitment: The facings shall be attached to flat/rectangular/dovetailed machined faces of gate frame and door, depending upon the applicable water head, and be secured in place using taper screws. The taper screws adopted for facings shall be of same material as that of the seat facings.

- c. The front faces of integral extension guides which can come in contact with the sealing faces of door while opening, shall also be fitted with sealing faces of the same material as that of the sealing faces on door. This is required to offer non corroding smooth sliding surfaces to the sealing faces of door/shutter during its vertical travel for opening and enhance the effective life of gate.
- d. Finish: The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces, in gate closed position, does not exceed 0.1mm.

Wedging Devices

- The sluice gates shall be provided with individually adjustable wedging devices to ensure forced contact between frame and shutter seat facings, when the gate is in closed position.
- The gates meant for seating head shall be provided only with side wedging devices. Gates meant for unseating head of sizes larger than 600mm, shall be provided with side, top and bottom wedging devices or with side and top wedging devices and flush bottom closing arrangement as required.
- The wedging devices comprise of wedge brackets fitted on gate aperture frame and door. The wedge bracket on frame shall remain in fixed position and those on door shall be adjustable or vice versa. A sort of slot and tannen arrangement shall be provided on base of wedge brackets to prevent any tendency to shift. Provision shall be made to clamp the adjustable brackets firmly in adjusted position.
- The wedging devices shall be made of cast iron. If the wedges/wedge blocks of wedging devices are of cast iron, then these are to be lined with contacting faces of the same material as that of sealing faces attached to the gate frame and door.

Conventional OR Flush Bottom Closing

The sluice gates shall be provided with conventional or flush bottom closure arrangement as required.

Generally as a standard the **gates shall be provided with flush bottom closing only especially for gates mounted on bottom of channel** etc. Only the gates mounted above the floor level and having required clearance below for applications like inlet pipe isolation at elevated level, etc. shall be with conventional bottom closing.

The sluice gates provided with conventional bottom closing arrangement involve corrosion resistant metallic contacting sealing faces at the bottom sill of gate. In such cases, the invert of the gate is required to be kept above the floor of the channel/chamber by at least 150mm to 250mm depending upon the size and type of gate. The contractor should verify whether this clearance is available at the site of installation for fitting a conventional bottom closure gate.

In case of conventional closing gate, if the invert of the gate is kept at the same level as that of the channel/chamber floor, then there remains a slot or a groove at the invert of the gate. Debris, dirt etc. which may settle in this slot and may not allow the gate to close properly and this may give rise to heavy leakages while in operation. With a view to avoid this, in situations where the invert of the gate is to remain at the same level as that of the channel/floor, a flush bottom closing gate instead of conventional bottom closing gate should be provided.

Flush bottom closing shall involve a flexible rubber seal at the bottom of the gate, mounted either on the shutter or on the frame, ensuring that the sealing face remains flush with the floor. The cast iron bar fitted at the bottom of the frame is required to be embedded in the channel/chamber floor and for this a cut out/recess of ample dimensions is required to be provided beneath the waterway opening along the gate

invert, while constructing the floor. The dimensions of this cut out shall be provided depending upon the feasibility to do so as per actual site conditions.

This cut out/recess is to be later on filled up with removable asphalt or loose concrete mixed with sand dust or vermiculate after putting the gate in position so that it is possible to break open this second stage grout for removal of the gate in future.

The rubber seal employed shall be made of EPDM or Neoprene rubber and the rubber seal retainer bar as well as the fasteners for fitting the rubber seal and the retainer bar are of stainless steel.

Gate Operating Head Stock/Lift Mechanism

- The operating head stocks shall be designed in such a manner as to permit the gate operation by a single person under the specified maximum operating head with an effort of less than 18kgs on the crank or hand wheel with a radius not exceeding 375mm. Vendor shall provide torque calculations in support of same.
- The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.
- Geared headstock shall be supplied with easily removable crank handle or handwheel with a radius not exceeding 375mm.
- All the gears of geared headstock shall be kept completely encased in cast iron housing to protect them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease nipples shall be provided at proper places for lubricating with grease.
- Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

Lifting Spindle/Stem

The sluice gates shall be supplied with rising type lifting spindles/stems. The stem shall be provided with acme/square threading, length of threaded portion being about 400mm more than the height of waterway opening. This much extra length is required to allow for a minor variation of approximately 100mm on either side of the specified height of operating platform.

The design of stem will be done as per the provision in IS: 13349.

Stem Block/Connecting Block/Thrust Nut

The rising type stem shall be connected to the door through a stem block/thrust nut housed in a ribbed pocket cast integral with the door. The bottom end of stem shall thread into the stem block and is locked in place by a set screw to prevent the stem from unscrewing. The stem block shall be cast Bronze or Gunmetal.

Safety Stop Nut

The stem shall be provided with a safety stop nut to prevent the chances of over closing of gate which may otherwise damage either the stem or the lifting platform. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set

in such a way that its bottom remains about 1mm to 2mm away from the top of headstock, in gate closed position.

In case of stainless steel stem, the stop nut shall also be of stainless steel material of the same grade.

Stem/Spindle Couplings

For ease in transportation and handling, maximum length of one piece stem shall be restricted within 5 meter length. Where the stem are required to be furnished in more than one piece, threaded stem couplings shall be furnished to interconnect different sections of the stem. The couplings shall have provision for pinning after inserting in the threaded end of the stem.

In case of stainless-steel stem, the couplings shall also be of stainless steel material of the same grade.

Stem Guide Brackets

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be adjustable center type - wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offer minor adjustment in the direction parallel to the wall.

The stem guides shall have machine bored split journals to facilitate erection. The journal shall be lined with Brass/Gunmetal bush.

Pipe Hood for Stem

A pipe hood shall be provided on the top of headstock in case of rising spindle/stem gates to cover the spindle threads for protection against damage, dirt, dust, water etc. It shall be made of transparent fracture resistant polycarbonate material. The pipe hood shall have vent holes to prevent condensation.

Gate Opening Indicating Arrangement

Gate opening indicating arrangement shall be provided to indicate the position of the shutter. This shall comprise of scale mounted on the pipehood and an indicator nut mounted on the rising spindle to show the extent of the opening and closing. The minimum scale graduation shall be 25mm.

Materials of Construction

The materials of construction for various components shall be as under.

Gate Frame, Shutter, Thimble	Plain Cast Iron IS: 210 FG 200
Headstock, Wedges, Stem Guides	Plain Cast Iron IS: 210 FG 200 Stem Guide shall be with LTB-2 Lining
Seating/Sealing Faces and Wedge Lining	Stainless Steel ASTM A 240 Type 304
Rubber Seals (If Applicable)	EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar (If Applicable)	Plain Cast Iron IS: 210 FG 200/Stainless Steel ASTM A 240 Type 304
Stem, Stem Guide Brackets, Coupling and Stop Nut	Stainless Steel ASTM A 276 Type 304
Assembly Bolts, Nuts and Fasteners	Stainless Steel ASTM A 276 Type 304
Yoke (If Applicable)	Mild Steel to IS: 2062 Grade A, Epoxy Painted
Stem Block	Leaded Tin bronze to IS: 318 Type LTB2
Lift Nut for Manual Ungearred	Leaded Tin bronze to IS: 318 Type LTB2
Pipe Hood for Stem	Transparent Fracture Resistant Polycarbonate Material
Operation	
Lift Nut for Manual Geared/Actuator Operation	As per Gear Box/Actuator Manufacturers' Standards

❖ SPECIFICATIONS FOR SUBMERSIBLE NON-CLOG PUMP (SEWAGE/SLUDGE/WASTE WATER)

A. General

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

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

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

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

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

The pump shall be designed to start with delivery valve semi/fully open to the extent possible.

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

Pumps' rotating parts and assembly shall be statically and dynamically balanced as per ISO 10816/ latest IS standards and shall run smooth without undue noise and vibration.

The auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts or as per manufacturer's recommendation/approved size. Minimum height of RCC foundation height shall be "Pockets" Height (Depth) and additional 50 mm".

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

B. Features of Construction

PUMP

Pump shall be vertical submersible centrifugal, single stage, non-clog suitable for permanent installation in wet-pit/sump. The pump shall have bottom suction and side discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump having delivery size up to 100mm shall be designed to handle solids of minimum 35-40 mm (for 50mm delivery size), up to 80 mm size (for 100mm delivery size) such that the size of solids to be handled is one pipe size lower than offered pump delivery size. For pumps having delivery size above 100 mm shall be capable of handling solids of minimum 100mm size.

Casing

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

Casing shall have facility for removal of clogged material from impeller vanes without dismantling the whole pump.

Impeller

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

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

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

Suitable mechanisms should be provided to avoid accumulation of grit/silt for enhanced life of mechanical seal.

Impeller Nut

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

Shaft Seal/Mechanical Seals

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with an electrical monitoring system for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

Bearings

Pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hours of operation. Bearings shall be greased for life i.e. shall not require any re-greasing.

Auto Coupling/Guide Pipe/Lifting Chain

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket with rubber diaphragm to make leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge

flange and the delivery piping shall be made by merely lowering the pump into guide rails/wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI duck foot bend. It shall be provided with all necessary fixtures like guide wire/guide pipe for guiding the pumps during lifting/lowering.

Each pump shall be provided with stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual 'O' rings/shackles in SS 304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting

Each pump shall be provided with stainless steel guide pipe/wire rope of required length.

Lifting Hook

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

INDUCTION MOTOR (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	± 10%
Frequency variation	:	± 5%
Combined variation of Voltage and Frequency	:	± 10%

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS 12615 (2018) (Efficiency minimum IE2 of IS 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & star-delta starting. Motor shall be capable to start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS: 8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 Part VII (1970) for dry

type motors. The corresponding class of insulation shall be class F with temperature rise limited to class B. However, for motors to be operated on VFDs, only class H insulation with temperature rise limited to class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher..

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

If these pump's motors are to be used with Variable Speed Frequency Drives than:

- ❖ The motor insulation shall be vacuum varnish impregnated instead of dip varnishing or trickle varnishing with double insulation coating.
- ❖ The motor insulation is to be of class H only.
- ❖ Current insulated bearings (preferably NDE) required for motor ratings above 200kW.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid/moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

Protection

Protection against increase in stator winding temperature (15⁰ C) shall be provided. Minimum three number thermostats/bimetallic switches in series shall be provided to sense the stator winding temperature.

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

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

Manufacturer shall provide Pump Monitoring Unit (PMU) with each pump set.

Submersible Cable

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

Power as well as control cables shall be of dual sheathed EPRS/PVC, armoured type with required numbers. of Copper core, round type and of required size as per design requirement.

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

The control cable shall be PVC insulated PVC sheathed, flexible, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, bearing temperature sensor, level sensor (thermostats/bimetallic switches/RTD) of 1.5/2.5 sq. mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 number of spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site.

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

Motor Cooling

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet/scope of work or if specified in BOQ.

C. Materials of Construction

The specific requirement shall be considered as under:

Pump Casing	CI IS 210 Gr. FG 260
Casing Wear Ring/Wear Plate	CI IS 210 Gr. FG 260
Suction cover/Oil Chamber/Motor Casing	CI IS 210 Gr. FG 260
Shaft	AISI 410
Shaft Sleeve	AISI 316 (if applicable)
Impeller/Impeller Nut	CF8M
Auto Coupling Unit	CI/WCB
Hardware (Nuts, Bolts, Fasteners, etc.)	SS 304
Motor Jacket (if applicable)	SS 304
Guide Rail Pipe	Heavy Duty minimum 50 mm dia. of SS 304 of suitable length
Lifting Chain	SS 304, Minimum equivalent to sump depth + 3m, with dual 'O' rings/shackles at every about 1.5m center to center.
Bolts, Nuts, Fasteners etc.	SS 304 (All, Wetted and Non-wetted)
Cable length (each run)	As per BOQ or Minimum equivalent to sump depth + 10 m, whichever is higher
Maximum Permissible Solid Size	As specified above in pump specifications

The above MOC is minimum requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

NOTE (For installation in Existing Sump): For Pumps to be installed / mounted in existing sump / tank where in it is not possible to take shutdown and empty the sump or provide new foundation or such site condition, the pump shall be provided with pre-cast RCC foundation with duck foot, guide pipe mounting, etc. arrangement for installing direct in sump and having arrangement for lowering and lifting the pump.

❖ SPECIFICATIONS FOR SUBMERSIBLE CENTRIFUGAL PUMP (RAW WATER / TREATED SEWAGE / CLEAR WATER APPLICATION)

A. General

Pump shall be submersible, vertical shaft, centrifugal, single stage suitable for permanent installation in wet pit/sump/jack-well constructed on the river/dam etc. along with submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump-motor set shall be designed to pump raw/clear water/treated sewage and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing

capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

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

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

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

The pump shall be designed to start with delivery valve semi/fully open to the extent possible.

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

Pumps' rotating parts and assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 6.3 mm/second. Noise level shall be limited to 85dBA at a distance of 1.0 m as per relevant and applicable standards.

The sole plates/auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts of manufacturers' recommended/approved size.

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

B. Features of Construction

Pump

Pump shall be submersible centrifugal, vertical shaft, single stage suitable for permanent installation in clear water reservoir/sump or in wet pit/sump/jack-well constructed in the river/sump/dam etc. The pump shall have bottom suction and side discharge nozzle. The pump shall be designed to handle silt, clay, pebbles and vegetation those are normally associated with river/surface water.

The SS heavy duty strainer shall be provided at pump suction so as to restrict the entry of oversize solids/floating material in order to run pump set without clogging and interruption. The strainer shall have sufficient suction area and openings throughout its surface to let water in easily. The size of the holes on strainer shall not be more than maximum permissible solid handling size/capacity of pump or lower as per the permissible solid handling capacity of pump and as recommended by pump vendor. The strainer shall be supplied by pump vendor only as per the area of opening and opening requirement to suit the offered pump design (the strainer area of opening shall be minimum 4 times the area of opening of bell mouth/suction).

Casing

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

Impeller

Impeller shall be enclosed or suitable as per manufacturer's design, single suction type with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall be designed to handle silt, clay, pebbles & vegetation those are trapped with raw water of river. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials.

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

Impeller Nut

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

Shaft Seal/Mechanical Seals

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with an electrical monitoring system for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

Bearings

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

Auto Coupling/Guide Pipe/Lifting Chain

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

Each pump shall be provided with a stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual 'O' rings/shackles in SS-304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting

Each pump shall be provided with a stainless steel guide pipe/wire rope of required length.

Lifting Hook

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

Induction Motor (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of Voltage & Frequency	:	$\pm 10\%$

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current, etc. in line with IS: 12615 (2018) (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of safety factor provided for Squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & star-delta starting. Motor shall be capable of start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS: 8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 Part-VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to class B. However, however for motors to be operated on VFD, only class H insulation with temperature rise limited to class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher.

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

If these pump's motors are to be used with Variable Speed Frequency drives than,

- ❖ The motor insulation shall be vacuum varnish impregnated instead of dip varnishing or trickle varnishing with double insulation coating.
- ❖ The motor insulation is to be of class H only.
- ❖ Current insulated bearings (preferably NDE) required for motor ratings above 200kW.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid/moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain

washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

Protection

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

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

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

Manufacturer shall provide Pump Monitoring Unit (PMU) with each pump set.

Submersible Cable

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

Power as well as control cables shall be of dual sheathed EPRS/PVC armoured type with required numbers of Copper core, round type and of required size as per design requirement.

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

The control cable shall be PVC insulated PVC sheathed, flexible, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, bearing temperature sensor, level sensor (thermostats/bimetallic switches/RTD) of 1.5/2.5 sq.mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 number of spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site.

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

Motor Cooling

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet/scope of work or if specified in BOQ.

C. Materials of Construction

The specific requirement shall be considered as under.

Pump Casing	CI IS 210 Gr. FG 260
Casing Wear Ring	CF8M/Bronze, IS 318 Gr. LTB 2
Suction Cover/Oil Chamber/Motor Casing	CI IS 210 Gr. FG 260
Shaft	AISI 410

Shaft sleeve	AISI 316 (if applicable)
Impeller/Impeller Nut	CF8M/Bronze IS 318 Gr. LTB 2
Auto Coupling Unit	CI/WCB
Motor Jacket (if applicable)	SS 304
Guide rail pipe	Heavy duty minimum 50mm dia. of SS 304 of suitable length
Lifting Chain	SS 304, Minimum equivalent to sump depth + 3 m with dual 'O' rings/shackles at every about 1.5 m C-C.
Suction Strainer	SS 304
Bolts, Nuts, Fasteners etc.	SS 304 (All, Wetted & Non-wetted)
Cable length (each run)	Minimum equivalent to sump depth + 10 m

The above MOC is minimum requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

NOTE (For installation in Existing Sump): For Pumps to be installed / mounted in existing tank / reservoir (generally up to 5 to 6 mtr. Depth where sump can be emptied or can be accessed and pump delivery can be decoupled for lowering and lifting), auto coupling, CI duck foot bend, guide pipe and such items not required / applicable for horizontal installation will not be included and in such cases the pump shall be provided with M.S.E.P. Horizontal Stand shall be supplied by the pump vendor, M.S.E.P. Horizontal Stand shall be suitable to withstand vibrations by Pump set.

❖ SPECIFICATIONS FOR HORIZONTAL MONO SUBMERSIBLE PUMP SET

The single stage horizontal submersible pump suitable for handling clear cold water commonly erected in open wells/sumps/wet pits shall be sturdy in construction ensuring basic hydraulic, electrical and mechanical performance needs conforming to technical requirements as stipulated in governing standards. Pumps shall conform to latest editions (including amendments and revisions) of IS: 14220 (2018).

The duty point of the pump set shall be located at the optimum efficiency point of the pump rating curves and there should not be steep fall in efficiency in the operating range. The verification of the pump sets performance will be as per relevant latest IS at rated three phase voltage. The pump with lesser number of stages will be preferred. RPM of pump set shall be 2900. Motor shall be working on three phase 415 V + 10% to - 15% at $50 \pm 3\%$ Hz AC supply.

The pump shall have efficiency deviation/drop within (-) 5 digits/points from efficiency at duty point, in pump operating head range from +10% to -25%.

Minimum motor horse power rating, cable size, starting system, minimum overall efficiency and delivery size shall have to be submitted in data sheet.

Pump

The pump shall confirm to IS: 14220.

Casing should be free from blow holes, slag inclusion and other detrimental defects. Casing should be provided with renewable wearing rings except in radial flow pump set. Casing should be hydraulically tested up to 1.5 times shut off pressure.

The Shut-off Head of the pump shall be 120% of Duty Point.

Impeller

Impeller shall be of closed type ensuring required performance and free of cavitation.

Shaft

The common shaft of pump and motor below the impeller shaft assembly including shaft protection sleeve shall be provided.

Suction Casing with Strainer

The opening of suction casing should be of proper size and shape to minimize, eddy current. In order to check entry of foreign materials strainer/screen shall be of minimum thickness of 0.5 mm.

Entrance velocity of water in the pump should not be more than 3.6 m/sec.

Motor

The motor shall conform to IS: 9283 (2013). It should be designed for $415 \pm 10\%$ and -15% volts, 3 phase, 50 cycles/second AC power supply. It should be totally enclosed squirrel cage induction type water cooled and water lubricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearing should be of wet type water lubricated and designed to take all untoward load at most unfavorable running conditions. Front and Rear bearing housing and thrust bearing housing should preferably be fixed separate replaceable bolts/studs and (not threaded connections) to the starter to facilitate easy dismantling. Inspection agency will open the motor base and check the thrust bearing and tilting pad type.

Full proof sealing arrangement by sand guard shall be provided in the motor inlet body to prevent open well/sump water impurities like sand, silt from entering the motor bearing stator and rotor should be impregnated with a superior varnish Class B thermal insulation properties by vacuum pressure or epoxy paints on stator when cold rolled stamping used and rotor shall be painted with Polyurethane paint and baked for at least $\frac{1}{2}$ hour under controlled temperature condition and not by manual or gravity flow to remove air pocket so that these are thoroughly filled up by varnish. Motor rotor should be preferably lead-shot blasted. Subsequently, rotor body should be baked repeatedly under controlled conditions to ensure long life of paint and hard finish to the surface to avoid corrosion before powder coating. The rotor shaft shall be provided with sleeves in the bearing portion. The windings should be accessible to facilitate checking and locating any faults without disturbing all the coils and also to enable replacement of any defective coils. It should be possible to rewind the stator with readymade pre-tested coils. Kelvin bridge/digital resistance meter shall preferably be used for measurement of hot and cold resistance of winding for evaluated temperature rise. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump set. Earth leakage current should not be more than 50 milli ampere at rated voltage.

The HP rating of motor should be at least 115% of the maximum pump input over entire range.

The motor should not get overloaded in the range of $+10\%$ and (-25%) of the specified pump head. The meaning of overload will be as per IS: 14220.

The HP rating of motor shall be selected from the standards ratings.

Following points are to be ensured while design and construction of submersible motor.

All rotating parts should be individually balanced on machine for minimum 700 RPM (and vibrations of the assembly during the testing shall not exceed to 80 micron peak to peak).

Brass drain plug is to be provided.

Compensating device is to be provided.

Rotor shall be painted and baked under controlled conditions or powder coated.

Winding shall be easy to assemble.

Winding shall be subjected to 1.5 kV for 30 seconds after 24 hours.

It shall have matching grooves for stopping stamping from rotation and shifting.

The rotating component shall be dynamically balance on machine for minimum 700 RPM.

Stamping treated chemically to recover unwanted substance and impurities.

Rotor shall be lead/sand shot blasted.

Thrust plate lapping is to be done on machine and the limit is 0.3 Micron.

Stator end ring shall be of bronze metal or MS.

Stator shall be re-windable with readymade pretested coils in each type of motor offered.

Method of Starting

Starting method up to 7.5 HP motor shall be DOL Starter and from 8 to 30 HP shall be Star Delta or as specified in BOQ.

Cable

Motor shall be provided with three core flat PVC Copper water proof and flexible cable of 5 meter length in single piece of suitable size with ISI mark (IS: 694). The cross sectional areas should be sufficient so as not to cause voltage drop of more than 2.5% of nominal voltage i.e. 10 volts at 415 volts throughout the length of the cable.

Marking and Name Plate

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

- 1) Manufacturer's Brand Name and/or Trade Mark/Model Embossed/Engraved on pump and motor.
- 2) Year of manufacturing.
- 3) Any other important matter that the manufacturer deemed fit to be inscribed.
- 4) BEE Logo is preferable. Manufacturer can give BEE logo voluntarily.

Typical name plate shall be as under.

- 1 Name of Manufacturer
- 2 Model
- 3 Head @ Nominal Duty Point (Meter)
- 4 Discharge @ Nominal Duty Point (LPM)
- 5 Overall Efficiency (%)
- 6 Motor Rating (kW/HP)
- 7 Rated Speed (RPM)
- 8 Maximum Current (Ampere)
- 9 Rated Voltage with Variation (Volt)
- 10 Rated Frequency (Hz)
- 11 Connection
- 12 Type of Duty (Whether Continuous or Not)
- 13 Delivery Size (mm)
- 14 Head Range for Non-Overloading Requirement (meter)
- 15 Year of Manufacture

Testing

Pumps shall have to be performance tested as per IS: 14220/IS: 11346 and motor will be tested as per IS: 9283 at manufacturers works by the TPI. Routine inspection of pump set shall be carried out by the TPI. Pumps will be tested with NRV fitted.

The manufacturer has to maintain and produce proper record such as calibration of instrument etc. for verification by inspecting agency.

The leakage current of submersible pump set shall not exceed 50 mili amperes at rated voltage. The firm shall furnish their quality assurance plan to the inspecting agency to review the same to their satisfaction.

The manufacturer shall have to provide material test certificate for impeller/shaft for chemical properties carried out at NABL Accredited Laboratory for verification.

Strip Test

The inspecting agency shall dismantle the pump set precisely to carry out the strip test which shall also include thorough review of the materials used with reference to the relevant tests.

Type Test

The type test certificate for electrical performance of motor shall be as per IS: 9283 with latest amendment from NABL Accredited Laboratory for each HP range/frame size of submersible motor shall invariably be submitted for review and acceptance.

Packing

Pump and motor shall be packed in a suitable wooden/corrugated box acceptable to the Employer

Materials of Construction

Materials of construction shall be as under.

Impeller	:	Bronze Grade LTB 2 IS: 318/SS 410
Pump-Motor Shaft and Shaft Sleeves	:	SS Grade X 12 Cr 12 IS: 6603
Pump Casing, Motor Bearing Housing and Base	:	CI Grade FG 260 of IS: 210
Bearing Bush	:	Bronze Grade LTB 4 of IS: 318
Studs and Bowl supporting Clamps	:	SS AISI 410
Motor Stator	:	SS 304
Motor Stator and Rotor Lamination	:	Silicon Steel Cold Rolled M 45 (Not more than 0.5mm thick IS 648)
Thrust Plate	:	CI Base with Carbon Plate
Stator Winding Wires	:	PVC Insulated as per IS: 8783
Rotor Conductor Core	:	Electrolytic Grade Copper IS: 613
Strainer	:	SS304 (minimum thickness 0.5 mm)
Sand Guard and Drain Plug	:	Bronze Grade LTB 4 as per IS: 318
Breather Diaphragm (Pressure Sustaining Components)	:	Nitrile Rubber

NOTE: The material components should be as per relevant IS except that shown as above.

❖ SPECIFICATIONS FOR SUBMERSIBLE CENTRIFUGAL NON-CLOG PUMP SET (SERVICE/BOOSTER WATER APPLICATION)

General

The pump shall be horizontally/vertically mounted, single stage submersible centrifugal mono pump set with enclosed/semi open type impeller and close coupled to its fully submersible electric motor designed for performance range of the impeller with required reserve power margin.

The total head capacity characteristic of mono pump set shall be continuously rising towards the shut off with the highest at shut off. It shall be suitable for handling clear/chlorinated water.

The pump shall run smooth without undue noise and vibration.

Features of Construction

The pump casing shall be volute type and impeller shall be as described above cast in one piece. Pump with semi open impeller shall be with wear plate of matching profile. The suction nozzle shall preferably be provided with strainer.

The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor and fixed with the help of SS impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

Pump with wet type motor shall be duly filled with cooling media and plugged properly. Pump shall be designed for intermittent and frequent operations.

Each pump shall be provided with delivery reflux and isolating valves, required power cables (and control cable if applicable) and suitable lifting gear for lowering and lifting the pump from the sump in case of fix

installation. Power/Control cables shall be of dual sheathed EPRS/PVC type with required number of Copper core, round type and of required size as per design requirement.

Induction Motor (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of Voltage and Frequency	:	$\pm 10\%$

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS: 12615 (2018) (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage and star-delta starting. Motor shall be capable to start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS: 8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 Part VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to that of class B.

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

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

Materials of Construction

Casing/Casing Cover/Wear Plates/Oil Chamber/Motor Housing	CI IS 210 Gr. FG 260
Impeller	CI IS 210 Gr. FG 260

Shaft/Shaft Sleeve	AISI 410
Shaft Sealing	Double Mechanical Seal (as applicable)
Lifting Arrangement	SS 304 chain or wire rope with hook(s) and having minimum length equivalent to sump depth + 3 m.
Cable Length (each run)	Minimum equivalent to sump depth + 10m

The above MOC is minimum requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

❖ SUBMERSIBLE NON-CLOG DE-SILTING/DEWATERING PUMP SET (PORTABLE)

General

The pump shall be non-clog, vertically-mounted, single stage with semi open/open-impeller type and close coupled to its fully submersible electric motors designed for dewatering.

The total head capacity characteristic of pump shall be continuously rising towards the shutoff with the highest at shut off. It shall be suitable for handling turbid water containing stringy materials. The pump shall be designed to handle solids up to 25 mm dia. size.

The pump shall run smooth without undue noise and vibration.

The power rating of the pump motor shall be minimum 150% more than the power required from zero discharge to zero head.

Features of Construction

The pump casing shall be volute type and impeller shall be non-clog type, cast in one piece. Pump with semi open impeller shall be with wear plate of matching profile. Pump impellers shall be designed to pass solids and shall be capable of pumping solids of up to 25 mm diameter.

The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor and fixed with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

Pump shaft stuffing box shall be sealed with double mechanical seal, one between motor and oil chamber and second between oil chamber and pump unit, suitable for sewage/dirty water and shall have minimum 20000 hours life. Pump shall be designed for intermittent and frequent operations.

Pumps shall be supplied with all necessary pipe work to discharge to surface drainage. Pumps in general shall be without guide pipe and duck foot bend but with required CI/GI stool/support arrangement to place the pump in location in bottom of sump.

Portable De-silting pump shall be supplied along with starter comprising of MCCB as isolator and required thermal over load relay, contactor etc. (Vendor can also consider to provide MPCB) as per type 2 co-ordination. Starter panel shall be installed near the pump. Starter panel shall be suitable for manual operation through panel mounted on/off push buttons and provided with on, off and trip indications and with local panel mounted digital type ammeter and voltmeter. Vendor to refer specification for LT panel for other general requirement for panel and for make of switchgear as specified under electrical specifications/tender specifications. The pump shall be provided with built-in low level switch to trip the pump in case of inadequate water level and the same shall be interlocked with starter panel supplied with pump.

Induction Motor (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of Voltage & Frequency	:	$\pm 10\%$

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS: 12615 (2018) (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage and star-delta starting. Motor shall be capable to start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS: 8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 Part-VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to that of class B.

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

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

Materials of Construction

Casing/Casing Cover/Wear Plates/Oil Chamber/Motor Housing	CI IS 210 Gr. FG 260
Impeller	CI IS 210 Gr. FG 260
Shaft/Shaft Sleeve	AISI 410
Shaft Sealing	Double Mechanical Seal

Lifting Arrangement	SS 304 chain or wire rope with hook/s and having minimum length equivalent to sump depth + 3 m.
Cable length (each run)	Minimum equivalent to sump depth + 10m
Hose pipe	PVC or suitable with required clamps in SS, Minimum equivalent to sump depth + 25m length

❖ SUBMERSIBLE DRAIN/DEWATERING PUMPS (For Dry Well Installation and Such Applications)

General

The pump shall be non-clog, vertically-mounted, single stage with semi open/open impeller type and close coupled to its fully submersible electric motors designed for dewatering.

The total head capacity characteristic of pump shall be continuously rising towards the shutoff with the highest at shut off. It shall be suitable for handling turbid water containing stringy materials. The pump shall be designed to handle solids up to 25 mm dia. size.

The pump shall run smooth without undue noise and vibration.

The power rating of the pump motor shall be minimum 150% more than the power required from zero discharge to zero head.

Features of Construction

The pump casing shall be volute type and impeller shall be non-clog type, cast in one piece. Pump with semi open impeller shall be with wear plate of matching profile. Pump impellers shall be designed to pass solids and shall be capable of pumping solids of up to 25 mm diameter.

The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor and fixed with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

Pump shaft/stuffing box shall be sealed with double mechanical seal, one between motor and oil chamber and second between oil chamber and pump unit, suitable for sewage and shall have minimum 20000 hours life. Pump shall be designed for intermittent and frequent operations.

Pumps shall be supplied with all necessary pipe work to discharge to nearby surface drainage/sump as required. Each pump shall be provided with delivery reflux and isolating valves, and suitable lifting gear for lowering and lifting the pump from the sump in case of fixed installation/when installed in dry well.

Pumps in general shall be without guide pipe, and duck foot bend but with required CI/GI stool/ support arrangement to place the pump in location in dewatering pit of dry well or in bottom of sump as required.

Pump if required to be supplied with starter panel, the starter panel shall be comprising of MCCB as isolator and required thermal over load relay and contactor etc. (Vendor can also consider to provide MPCB) as per type 2 co-ordination. Starter panel shall be installed near the pump. Starter panel shall be provided with A/M and L/R selector switches as required such that when L/R selector switch placed in local mode it shall be possible for manual operation through panel mounted on/off push buttons when A/M selector switch placed in manual as well as in auto mode through in-built level switches or other applicable method when A/M selector switch placed in AUTO mode and shall be possible to operate from remote location through PLC/SCADA when L/R selector switch placed in Remote Mode. Potential control circuit shall be suitable for on/off operation from remote and shall also provide potential free contacts for remote monitoring of pump status viz. on/off status, A/M & L/R selector switch status, trip status etc. feedback signals to PLC and on/off command. Panel shall be provided with required on, off and trip indications and local panel

mounted digital type ammeter and voltmeter. Vendor to refer specification for LT panel for other general requirement for panel and for make of switchgear as specified under electrical specifications/tender specifications.

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

Induction Motor (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	$\pm 10\%$
Frequency variation	:	$\pm 5\%$
Combined variation of Voltage & Frequency	:	$\pm 10\%$

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS: 12615 (2018). (Efficiency minimum IE2 of IS: 12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage and star-delta starting. Motor shall be capable of starting and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS: 8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 Part-VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to that of class B.

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

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

Materials of Construction

Casing/Casing Cover/Wear Plates/Oil Chamber/Motor Housing	CI IS 210 Gr FG 260
Impeller	CI IS 210 Gr. FG 260
Shaft/Shaft Sleeve	AISI 410
Shaft Sealing	Double Mechanical Seal
Cable Length (each run)	Minimum 10m
Lifting Arrangement	SS 304 chain or wire rope with lifting hook, minimum 5m length if the pump weight exceed 40 Kg

Alternately bidder can also provide non clog, self-priming, horizontal mono block or direct coupled, single stage type pump suitable for dewatering instead of submersible type with majority features and MOC as above.

❖ SPECIFICATION FOR HORIZONTAL SPLIT CASE CENTRIFUGAL PUMP

A. General

The pump shall be centrifugal, horizontal shaft, horizontal (axially) split case type designed and manufactured for pumping liquid like raw/clear/treated water. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts and all other required accessories.

The HSCF pump shall comply with all currently applicable statutes, regulations and safety codes and performance shall conform to IS: 5120, IS: 6595 Part I, IS: 11346 and IS: 9137 or their latest revision/edition.

The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the entire performance range of pump. Pump with drooping curves are not acceptable. The shut off head of the pump shall be minimum 110% of the total rated head but not more than 125% of the total rated head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 10% of BEP flow on either side meeting NPSH requirement. Pump selected with duty point lying on right side of BEP beyond 15% limit shall not be accepted.

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

The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSHr) is always less than available NPSH (NPSHa) to ensure pump's operation without cavitation under the worst operating conditions. The required NPSH at duty point and throughout the range shall be at least 0.75m and 0.5m less than the available NPSH respectively at the lowest water level in the sump. However, the NPSHr of the offered pump model shall be as per the design requirement/as per the conditions indicated in tender drawings. However it shall not be more than 7.0m in (in case of flooded suction conditions).

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

The pump shall be designed to start with delivery valve semi/fully open to the extent possible.

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

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

The power rating of motor to drive pump shall be suitable to meet maximum requirement of power for the rated impeller throughout its performance range.

B. Features of Construction

Pump

Pump shall be horizontal centrifugal, single/double stage, horizontal split case type suitable for dry pit installation with wearing rings. The pump shall have side suction and side discharge nozzle located in lower part of delivery casing.

The SS heavy duty strainer shall be provided at pump suction so as to restrict the entry of oversized solids/floating material in order to run pump set without clogging and interruption. The strainer shall have sufficient suction area and openings throughout its surface to let the water in easily. The size of the holes on strainer shall not be more than maximum permissible solid handling size/capacity of pump or lower as per the permissible solid handling capacity of pump and as recommended by pump vendor. The strainer shall be supplied either by the pump vendor or by the contractor as per the drawings of strainer provided/as recommended by pump vendor as per the area of opening and opening requirement to suit the offered pump design (the strainer opening area shall not be less than 4 times the area of opening of bell mouth/suction).

Casing

Pump casing shall be single/double suction of robust construction. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings. Casing drain connection with collard plug shall be provided at lowest part of casing. Tapping shall be provided at side center of suction and discharge nozzles for pressure gauge connection. These tapping shall be plugged by collard plugs.

Impeller

It shall be enclosed, single or double suction type or as per manufacturer's design with smooth and large ways so as to allow free passage to the fluid being pumped. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Impeller shall preferably be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration.

Shaft Sleeve

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

Shaft Sealing Arrangement

1) Stuffing Box

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

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

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

Pumps with rated design/duty head less than and up to 45 meters (maximum), gland packed stuffing box type shaft sealing arrangement is acceptable unless otherwise specified in BOQ / Price Bid.

2) Mechanical Seal

Pumps required with mechanical seals shall be equipped with mechanical seal and sealing systems in accordance with API 682 (third edition 2004)/DIN 24960 standards and ISO 21049 including pump and seal interface dimensions. Seal face material shall be Silicon Carbide Vs Silicon Carbide. Mechanical seal shall be cartridge mounted and balanced type. The seal box size shall be sufficient to dissipate the heat generated. Pump seal boxes shall be sized to accommodate mechanical seal system.

Provisions shall be made to center the seal gland and/or chamber with either an inside or outside diameter register fit. The register fit surface shall be concentric to the shaft and shall have a total indicated runout of not more than 125µm (0.005 in). Using the seal gland bolts to center mechanical seal components is not acceptable.

Seal chamber face runout (TIR) shall not exceed 0.5µm/mm (0.0005 in/in) of seal chamber bore. Seal box vent and drain piping with isolation valves manifold to other pump vent/drain connections shall be provided. Provision shall be made to ensure complete venting of the seal chamber.

Mechanical seal shall be designed and selected for the specified application in order to perform the equipment trouble free and working life shall be minimum 15000 hours of operation. Seals shall be covered with SS 304 mechanical seal cover and shall be tightened with SS fasteners as per the specifications.

External fluid piping for cooling, flushing and lubrication of seal faces shall be designed to suit pressure and temperature of fluid handled as recommended by the seal manufacturer. Seal flush medium, pressure, temperature and flow rate shall be specified. In case of pumps for pumping raw, mechanical seals must be supplied with SS 316 cyclone separator arrangement. The flushing pipe shall be stainless steel (SS 316) and cooling water pipes and fittings shall be carbon steel.

Seal must be designed to handle pumping of raw/clear water as the case may be or as per requirements specified in data sheet. For cooling of mechanical seal same raw/clear water will be used. No clear water will be available for seal cooling. For flushing/quenching plan as per API 682 shall be followed. In addition, where pressure reducing valve is required it shall be provided.

Seal glands and seal chambers shall have provision for only those connections required by the seal flush plan.

Pump Manufacturer/Contractor is responsible for arrangement of cooling/flushing by clear water required for bearing pedestal cooling and seal cooling stating required flow and confirming available pressure.

Specified seal and pump connections shall be identified by symbols permanently marked into the component (such as stamped, cast or chemically etched). Symbols shall be in accordance with those specified in ISO 21049/DIN 24960 standards.

Pumps with rated design/duty head more than 45 meters, only mechanical seal type shaft sealing arrangement is acceptable unless otherwise specified in BOQ/Price Bid.

However mechanical seal type arrangement is acceptable for pumps with rated heads for ≤ 45 meters if the contractor chooses or shall be as specified otherwise in BOQ/Price Bid.

Bearings

Pump shall be provided with anti-friction grease lubricated bearings. The entire rotating assembly of pump shall rest between minimum two bearings for smooth operation. Bearings shall be easily accessible for inspection and maintenance.

Coupling

Pump shall be coupled with electric motor mounted on a common base plate using pin bush type coupling of standard / reputed make. Coupling shall be statically and dynamically balanced at rated speed.

Coupling Guard

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

Base Plate

The pumping unit shall be provided with a common drain rim type base plate with 25mm dia. drain pipe terminated to nearest drain pit/trench. The base plate shall be of sufficient size and rigid construction fabricated from standard steel section conforming to IS: 2062 sufficient to maintain the pump and motor in proper alignment and position.

The minimum height of section shall conform to following table.

Pump with drive rating up to	Minimum Section height
Up to 30 kW	100 mm
37 kW to 55 kW	125 mm
75 kW	150 mm
90 kW and Above	200 mm

Base plate shall invariably be supplied by the pump manufacturer only.

The base plate shall be grouted on the RCC foundation with the help of “J” type foundation bolts of manufacturer’s recommended/approved size.

C. Materials of Construction

The materials of construction shall be considered as under.

Pump Casing	: CI IS 210 Gr. FG 260
Casing/Impeller Wear Ring	: CF8M/Bronze IS 318 Gr. LTB 4/SS 304 L
Shaft	: AISI 410
Shaft Sleeve	: AISI 410H or better
Impeller	: CF8M/Bronze IS 318 Gr. LTB 2

Shaft Seal	: Gland Packed (For operating heads \leq 45 meters) Mechanical Seal (For operating heads > 45 meters)
Lantern Ring	: Bronze IS 318, Gr. LTB
Liquid Deflector	: Natural Rubber
Gland	: CI IS 210 Gr. FG 260
Base Plate (Drain Rim type)	: CI/MS Epoxy Coated
Suction Strainer	: SS 304
Bolts, Nuts, Fasteners etc.	: Wetted and Non-Wetted SS 304

The above MOC is for minimum requirement and if process requirement is higher as indicated in process data sheet, the stringent MOC is to be provided.

❖ TECHNICAL SPECIFICATION FOR HORIZONTAL SPLIT CASE PUMP

A. General

A. General

The pump shall be of **horizontal, centrifugal, single stage, double suction, axially split casing (horizontal split case) type**, specifically designed, manufactured, tested, and supplied for handling **raw water and/or potable water** applications in continuous duty conditions. The design of the pump shall ensure reliable and efficient performance under varying operating conditions, including fluctuations in system head, flow demand, and suction levels, without causing instability, vibration, or hydraulic disturbances. The pump shall be capable of operating smoothly over the entire range of its performance curve without any detrimental effects such as cavitation, surging, or excessive wear.

The pump unit shall be supplied as a complete package consisting of **horizontally split casing, double suction impeller, shaft, shaft sleeves, wear rings, bearing assemblies, bearing housings, stuffing box or mechanical seal arrangement, coupling, base frame/sole plate, foundation bolts, and all necessary fittings and accessories** required for safe installation, operation, and maintenance. The pump shall be **directly coupled to an electric motor** through a flexible coupling mounted on a common base frame ensuring proper alignment and rigidity.

The entire pump assembly shall be designed in such a way that **maintenance and inspection can be carried out easily**, particularly by allowing removal of the upper half of the casing without disturbing the suction and delivery pipe connections or the alignment of the pump and motor.

Standards and Codes

The design, manufacture, testing, and performance of the pump shall strictly conform to the latest applicable editions and revisions of relevant Indian Standards and international guidelines. The pump shall comply with **IS: 1520 for horizontal centrifugal pumps, IS: 9137 for acceptance tests**, and other relevant standards as applicable. In addition, the design philosophy and hydraulic performance shall be in line with the recommendations of the Hydraulic Institute Standards and other internationally recognized engineering practices. All statutory regulations, safety requirements, and quality control procedures applicable at the time of manufacture and supply shall be adhered to.

Operating Requirements

The pump shall be designed to operate continuously and satisfactorily under all specified operating conditions without producing excessive vibration, noise, hydraulic surges, or mechanical instability. The hydraulic performance of the pump shall be such that the **head-capacity curve exhibits a continuously rising characteristic towards shut-off**, ensuring stable operation throughout the working range.

The **shut-off head** of the pump shall be carefully controlled and shall not be less than **115% of the rated head** and shall not exceed **135% of the rated head**, thereby ensuring adequate safety margin without imposing excessive load on the motor or system components. The pump shall maintain stable and efficient performance across the entire operating range without any tendency for hunting or unstable flow behavior.

Pump Selection Criteria

The pump shall be selected in such a manner that the **duty point lies at or very close to the Best Efficiency Point (BEP)**, and in no case shall it be outside the range of **±15% of the BEP flow**. This is to ensure optimum efficiency, minimum wear, and long service life of the pump components.

The impeller shall be selected with an **intermediate (trimmed) diameter**, and the rated impeller diameter shall be at least **10 mm smaller than the maximum possible diameter** for the selected pump model. This provision ensures flexibility for future adjustments and avoids operation at extreme limits. Pumps selected with impeller diameters below the minimum allowable size for the model shall not be accepted.

NPSH Requirements

The manufacturer shall ensure that the **Net Positive Suction Head Required (NPSH_r)** by the pump is always less than the **Net Positive Suction Head Available (NPSH_a)** in the system under all operating conditions, particularly at the lowest suction level. A minimum margin of **1.0 meter at the duty point and 0.5 meter across the entire operating range** shall be maintained to prevent cavitation.

The pump shall be capable of operating without cavitation, noise, or vibration even under the most adverse suction conditions, thereby ensuring longevity of hydraulic components and consistent performance.

Parallel and Independent Operation

Each pump unit shall be capable of operating both **individually as well as in parallel with other pumps** in the system without the need for excessive throttling or control. The pump shall exhibit stable performance characteristics such that no hydraulic interference, reverse flow, or overloading occurs during parallel operation.

All pumps supplied under the same specification shall have **identical hydraulic performance curves**, ensuring uniform load sharing and operational reliability.

Starting and Reverse Rotation

The pump shall be designed to start safely with the **delivery valve in partially or fully open condition**, minimizing starting load and avoiding pressure surges. Additionally, the pump and its associated components shall be designed to withstand the **maximum reverse rotational speed** that may occur due to reverse flow conditions when power supply is interrupted and the discharge valve fails to close.

The mechanical integrity of all rotating and stationary components shall be ensured under such reverse rotation conditions without damage or excessive wear.

Vibration and Noise Limits

The pump shall operate smoothly with minimal vibration and noise levels. The **vibration velocity shall not exceed 4.5 mm/sec**, and the **noise level shall be limited to 85 dBA measured at a distance of 1.5 meters** from the pump surface or as per applicable standards. Proper balancing of rotating components and precision in manufacturing shall be ensured to meet these limits.

Motor Rating

The electric motor selected to drive the pump shall be adequately rated to meet the **maximum power requirement of the pump over its entire operating range**, including at the highest possible impeller diameter. The motor shall not be overloaded under any operating condition, ensuring reliable and continuous operation.

B. Features of Construction

Pump Casing

The pump casing shall be of **axially split (horizontal split) design**, manufactured from high-quality cast material, and shall be robust enough to withstand operating pressures and mechanical stresses without deformation. The casing shall be free from casting defects such as blow holes, cracks, or porosity.

The internal surfaces of the casing shall be smoothly finished to minimize hydraulic losses and improve efficiency. The casing shall be provided with **replaceable wear rings** to reduce internal leakage and

facilitate easy maintenance. The design shall allow removal of the top half of the casing without disturbing the piping connections or alignment, thereby simplifying inspection and maintenance.

Impeller

The impeller shall be of **double suction, enclosed type**, designed to achieve hydraulic balance and minimize axial thrust. It shall have smooth flow passages with no sharp edges or obstructions that could cause clogging or turbulence. The impeller shall be **statically and dynamically balanced** to ensure smooth operation.

The impeller shall be securely mounted on the shaft using keys, locknuts, or other reliable fastening methods. It shall be designed to handle the specified flow efficiently while maintaining structural integrity under all operating conditions.

Shaft

The pump shaft shall be manufactured from **high tensile alloy steel** and designed to transmit the required torque without excessive deflection or vibration. The shaft shall be precisely machined, with proper alignment and surface finish to ensure smooth rotation and long service life.

Shaft Sleeves

Replaceable shaft sleeves shall be provided at locations where the shaft passes through the stuffing box or mechanical seal. These sleeves shall protect the shaft from wear and corrosion and shall be securely fitted to prevent any relative movement during operation.

Wear Rings

Replaceable wear rings shall be provided on both the casing and impeller to minimize internal leakage and maintain pump efficiency. These rings shall be designed for easy replacement and shall be made of suitable material to resist wear and corrosion.

Bearings

The pump shall be equipped with **anti-friction bearings (ball or roller type)** designed for a minimum operational life of **20,000 hours** under rated conditions. Bearings shall be housed in robust bearing housings with proper sealing and lubrication arrangements. They shall be easily accessible for inspection, maintenance, and replacement.

Stuffing Box / Mechanical Seal

The pump shall be provided with a shaft sealing arrangement as specified in the BOQ. In case of **gland packed stuffing box**, the design shall allow easy repacking without dismantling major components. The stuffing box shall include a lantern ring, drain connections, and split gland arrangement with stainless steel fasteners.

Where **mechanical seals** are specified, they shall be of reliable design suitable for continuous operation and shall be easily replaceable.

Coupling

The pump shall be connected to the motor through a **flexible pin bush type coupling**, capable of accommodating minor misalignments and transmitting full load efficiently. The coupling shall be dynamically balanced and provided with a suitable guard for safety.

Base Frame

The pump and motor shall be mounted on a **rigid fabricated mild steel base frame**, designed to minimize vibration and ensure proper alignment. The base frame shall be suitable for grouting and shall have machined mounting surfaces.

C. Materials of Construction (MOC)

The materials used for various components shall be as follows (minimum requirement):

- Casing: CI IS 210 Gr. FG 260 with 1.5%–2% Ni
- Impeller: CF8M

- Shaft: AISI 410
- Shaft Sleeve: AISI 410-H
- Wear Rings: CF8M
- Shaft Coupling: SS 410
- Gland: CI IS 210 FG 260
- Gland Packing: Graphited Cotton
- Base Frame: MS Epoxy Coated
- Fasteners: SS 304

More stringent materials shall be provided if required by process conditions.

D. Balancing and Performance

All rotating parts shall be **statically and dynamically balanced** as per ISO standards to ensure smooth operation. The pump shall operate without undue vibration, noise, or mechanical instability throughout its service life.

E. Additional Requirements

The manufacturer shall ensure that the pump is designed, manufactured, and tested to deliver **guaranteed performance** under specified conditions. For large capacity pumps exceeding **3000 m³/hr**, Computational Fluid Dynamics (CFD) analysis shall be carried out to verify hydraulic performance and flow conditions. All accessories, fittings, and components required for complete installation and operation shall be included in the scope of supply.

F. General Notes

The materials and specifications mentioned herein represent the **minimum acceptable requirements**. In case of more stringent process requirements, higher-grade materials and enhanced design features shall be adopted without any additional cost implications unless otherwise specified.

The pump shall be designed for **long-term, trouble-free operation**, with emphasis on reliability, efficiency, and ease of maintenance.

❖ SPECIFICATIONS FOR DOSING PUMPS - RECIPROCATING TYPE

GENERAL

Dosing pumps shall be mounted in a bund separate from the storage tanks and shall be fully accessible for operating and maintenance purposes without personnel having to enter the bund itself. Where appropriate, the pump bund shall be interconnected with the tank bund at an intermediate level.

The pumps shall be of hydraulically flexed sandwich diaphragm type gland less pumps with hermetically sealed diaphragm allowing complete leak proof operation driven by electric motors. HD type pumps shall be for flow range **> 1100-1200 LPH** driven by electric motors. However, pumps for up to **1200 LPH flow and pressure up to 4 kg/cm²** of reciprocating mechanically actuated diaphragm type driven by electric motors can also be accepted.

The pump, motor and drive arrangement shall be mounted on a robust combination base plate. Unless otherwise specified, only one liquid end shall be driven by any motor.

All chemical dosing pumps shall be provided with pulsation dampeners in SS 304 MOC (except for FeCl₃ or such applications for which SS-304 grade is not suitable, the metallic/non-metallic MOC suitable for the duty conditions shall be provided with justification) Metering/Dosing pumps shall have bypass with valves and external or in-built pressure safety valves (PRV). Accessories like Calibration Pot, PRV, Y-Strainer etc. shall be supplied along with pump set as specified and of metallic/non-metallic MOC suitable for the duty conditions.

Pumps shall comply with API standard 675, Positive Displacement Pumps - Controlled volume.

The chemical dosing pumps shall be with suitable type of auto stroke adjustment facility for monitoring and controlling the dosing rate through PLC/SCADA system and closed loop control as applicable for optimizing chemical dosing and process control as specified elsewhere for each application. These pumps shall be part of an automatic coagulation control/other process control loop.

PUMP HEAD MATERIALS

Pump heads and diaphragms shall be manufactured from thermoplastic materials viz. PTFE or such suitable for the duty conditions (alternately metallic materials viz. SS 316L/Alloy 20/CF8M or such suitable for the duty conditions can be accepted in specifically asked for elsewhere in tender specifications or only if prove that PTFE MOC is not suitable for application).

PUMP STROKE ADJUSTMENT

Variable stroke mechanisms shall be incorporated in the drive arrangement to allow infinitely variable adjustment of pump output by means of a micrometer, hand wheel or similar mechanical device whilst the pump is running.

Where the pump is part of an automatic coagulation control or other process control loop, the stroke mechanism shall be fitted with a three phase bi-directional motor with torque limiter and automatic stops at both extremes of travel. A position feedback potentiometer shall be provided to facilitate control and remote indication of position. The operational range of stroke adjustment shall not be less than 5:1.

DRIVE ARRANGEMENT

The pump head shall be driven through a totally enclosed speed reduction gearbox with integral reciprocating drive or the adjustable crank or mechanical lost motion type. The gearbox and reciprocating drive shall be oil bath lubricated. The unit shall incorporate filling and drain plugs for oil and an oil level indicator.

DRIVE MOTOR

Drive motors shall be of the three phase cage induction type either for fixed speed or variable speed operation.

Where variable speed operation is specified, the speed turn-down ratio shall be not less than 5:1.

PUMP PERFORMANCE

HD Type Pumps

The performance characteristics of dosing pumps shall be adequate in terms of linearity, accuracy and reproducibility as designed in API standard 675 to achieve the stated plant performance guarantee. The deviation from flow linearity of the pump shall not exceed $\pm 3\%$ of the rated capacity. The steady state accuracy shall not exceed $\pm 1\%$ of the mean delivered flow under fixed system conditions over the entire turndown range. The flow rate repeatability expressed as percent of the rated capacity of the pump shall not exceed $\pm 3\%$ of the rated capacity.

Mechanical Type Pumps

The performance characteristics of dosing pumps shall be adequate in terms of accuracy and reproducibility to achieve the stated plant performance guarantee. The steady state accuracy shall not exceed $\pm 1\%$ of the mean delivered flow under fixed system conditions over the entire turndown range. The flow rate repeatability expressed as percent of the rated capacity of the pump shall not exceed $\pm 3\%$ of the rated capacity.

Note: For very small capacity dosing pumps (For flow range of ≤ 25 LPH and/or ≤ 0.55 kW motor rating) the Bidder can consider to provide skid mounted electronic dosing pumps (solenoid actuated diaphragm pumps) instead of above specified type and of MOC suitable to type of fluid to be handled.

❖ SPECIFICATIONS FOR PROGRESSIVE CAVITY PUMPS (SCREW PUMPS)

Pumps shall be of the type in which a pumping action is generated by a helical rotating eccentrically within a resilient stator in the form of a double internal helix. The eccentric motion of the rotor shall maintain a constant seal across the stator as it travels through the pump to give a uniform positive displacement.

Pumps shall be arranged generally with a single shaft seal at the suction end. Mechanical seals shall be used in case of clear solution or else gland packing shall be used for sludge/abrasive fluids. If a flexible shaft is used to accommodate the eccentric motion, a corrosion-resistant shroud shall be fitted to prevent fiber build-up on the shaft. Enlarged inspection access holes shall be fitted to the suction chambers of all pumps for periodic removal of accumulated debris.

The shaft bearings shall be positively isolated from the fluid being pumped.

The rotor material shall be selected for corrosion and abrasion resistance for the fluid being pumped and for prolonged service life. Hard chrome or other approved coatings shall be of 75-100 micron thickness and shall be diffused in to the base material. The rotor shall generally be single-stage and shall incorporate not less than 360° of twist, but for high-head applications, it may be necessary to use more than a single-stage.

The stator shall be of a resilient material selected for chemical and abrasion resistance for the fluid being pumped.

Pump speed shall suit the application. The pump shall operate at an optimum rubbing speed depending on the abrasive and viscous characteristics of medium to be handled. For sewage and sludge handling maximum rubbing speed shall be as follows.

Sewage Sludge	≤ 1.5 m/sec
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Where variable delivery output is needed, the pump shall be provided with a variable-speed drive. The size and speed range of the pump shall ensure that the highest expected duty point shall lie within the available speed range. Variable drive and VFD operated motor shall be as per electrical specifications.

Pumps shall normally be driven by a fixed-speed electric motor through reduction gearing and the combined drive shall be continuously rated. Pump and motor shall preferably be mounted in-line on a common base plate. Alternatively, the drive motor may be top-mounted above the pump to minimize floor area, and shall be connected by external V-belts and pulleys. V-belt drives shall have full guards of the type that allow the belts to be observed without removal of the guard. Facilities shall be provided for ready adjustment of belt tension.

Coupling guards shall be provided, which shall be rigid, securely fixed, and designed so that removal is not necessary during normal operation, routine maintenance and routine inspections.

All motor enclosures shall be provided with ingress protection to IP 55. Motor anti-condensation heaters shall be provided and shall be suitable for use on a 220 V, single phase, 50 Hz supply if required based on drive rating as per electrical specifications.

Pumps shall be fitted with individual dry-running protection through suitable temperature sensing device imbedded in casing/stator to initiate pump trip.

Materials of Construction

Pump Housing	CI IS: 210 Gr. FG 260
Rotor	SS AISI 410 Hard Chrome Plated
Shaft	SS AISI 410 Hard Chrome Plated
Stator	Nitrile Black
Type of Drive	Gear Box
Base Plate	MS Epoxy Painted
Seal Type	Gland Packing

SPECIFICATIONS FOR SUBMERSIBLE PUMP SET FOR TUBE/BORE WELLS

The single/multi stage submersible pump suitable for erection in tube wells/bore wells shall be sturdy in construction ensuring basic hydraulic, electrical and mechanical performance needs as stipulated in governing standards. It shall have fast wearing parts of replaceable feature and easy rewind-ability of electric motors. Pumps shall confirm to latest editions (including amendments and revisions) of IS: 8034 and motors shall confirm to IS: 9283.

The duty point of the pump set shall be located at the optimum efficiency point of the pump rating curves and there should not be steep fall in efficiency in the operating range. The verification of the pump sets performance will be as per relevant latest IS at rated three phase voltage. The pump with lesser number of stages will be preferred. RPM of pump set shall be 2900. Motor shall be working on three phase 415 V + 10% to - 15% at $50 \pm 3\%$ Hz AC supply.

The pump shall have efficiency deviation/drop within (-) 5 digits/points from efficiency at duty point, in pump operating head range from +10% to -25%.

Minimum motor horse power rating, cable size, starting system, minimum overall efficiency and delivery size shall have to be submitted in data sheet.

PUMP

The pump shall confirm to IS: 8034.

Bowls should be free from blow holes, slag inclusion and other detrimental defects. Bowls shall be provided with renewable wearing rings except in radial flow pump set. Bowls provided with wearing rings should be suitable for lubricating by water and shall be of superior quality. The fitment of wearing rings with interface for locking compounds is to be done.

Impeller

Impeller shall be of closed type (not fabricated), ensuring required performance and free of cavitation.

Shaft

The pump shaft will be guided by bush bearings provided in bowl wherever required. Below the impeller shaft assembly. Shaft protection sleeve shall be provided. It shall have surface finishing of 0.75 microns.

Suction Casing with Strainer

The opening of suction casing should be of proper size and shape to minimize, eddy current. In order to check entry of foreign materials strainer/screen shall be of minimum thickness of 0.5 mm.

Entrance velocity of water in the pump should not be more than 3.6 m/sec.

Bearing Sleeve

The bearing sleeves are to be provided.

Non Return Valve

Non return valve will be provided with the pump discharge casing. NRV design shall be for the instant closure. No back pressure should develop which may adversely affect the pump set. It should have K-factor within the limits of IS: 10805.

MOTOR

The motor shall confirm to IS: 9283. It should be designed for $415 + 10\%$ and $- 15\%$ volts, 3 phase, 50 cycles/second AC power supply. It should be totally enclosed squirrel cage induction type water cooled and water lubricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearings should be of wet type water lubricated and provided with metal tilting thrust pads, designed to take all untoward load at most unfavorable running conditions. Winding wires shall be as per latest IS: 9283.

The ball used in the thrust assembly should be as required. Upper and lower bearing housings and thrust bearing housing should preferably be fixed separate replaceable bolts/studs and (not threaded connections) to the stator to facilitate easy dismantling.

Full proof sealing arrangement by sand guard shall be provided in the motor inlet body to prevent bore/tube well water impurities like sand, silt from entering the motor bearing stator and rotor should be impregnated with a superior varnish Class B thermal insulation properties by vacuum pressure or epoxy paints on stator when cold rolled stamping used. The rotor shaft shall be provided with sleeves in the bearing portion. The windings should be accessible to facilitate checking and locating any faults without disturbing all the coils and also to enable replacement of any defective coils. It should be possible to rewind the stator with readymade pre-tested coils. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump set.

The minimum power rating for motors to drive polder pump should be selected as per table below to meet the power demanded over its duty point of operation.

Required BkW of Polder pump	Minimum multiplying factor to arrive at motor rating
Below 7.5 kW	1.3
7.5 kW and above but below 15 kW	1.2
15 kW and above but below 75 kW	1.15
75 kW and above	1.10

The motor should not get overloaded in the range of $+ 10\%$ and $(-) 25\%$ of the specified pump head. The meaning of overload will be as per IS: 8034.

Following points are to be ensured while design and construction of submersible motor.

All rotating parts should be individually balanced on machine for minimum 700 RPM (and vibrations of the assembly during the testing shall not exceed to 80 micron peak to peak).

Brass drain plug is to be provided.

Rotor shall be painted and baked under controlled conditions or powder coated.
Winding shall be easy to assemble.
It shall have matching grooves for stopping stamping from rotation and shifting.
Stator end ring shall be of bronze metal or MS.
Stator shall be re-windable with readymade pretested coils in each type of motor offered.

The maximum outside diameter of pump and motor with cable and glands shall be 280 mm, 190/192 mm and 140/142 mm respectively for 300 mm, 200 mm and 150 mm tube/bore wells whereas the minimum outside diameter of pump and motor shall be suitable to the respective diameter of tube/bore well so that the same can be easily lowered into/or removed from the tube/bore wells. Also diameter of pump and motor shall be the same and mismatching of the same is not allowed.

Starting method: As specified in tender drawings/BOQ/tender specifications

Cable

Motor shall be provided with three core flat PVC Copper water proof and flexible cable of 5 meter length in single piece of suitable size with ISI mark (IS: 694). The cross sectional areas should be sufficient so as not to cause voltage drop of more than 2.5% of nominal voltage i.e. 10 volts at 415 volts throughout the length of the cable.

Materials of Construction

Materials of construction shall be as under:

Impeller	:	SS 410
Casing Wearing Ring/Neck Ring	:	Bronze Grade LTB 4 of IS: 318
Bowl	:	CI Grade FG 260 of IS: 210
Shaft	:	Stainless Steel AISI 410
Suction Casing/Discharge Casing/Last Stage Bowl	:	CI Grade FG 260 of IS: 210
Bush	:	Bronze Grade LTB 4 of IS: 318
Non Return Valve	:	CI Grade FG 260 of IS: 210
Studs and Bowl supporting Clamps	:	SS AISI 410
Motor Stator	:	SS 304
Thrust Bearing Housing	:	CI Grade FG 260 of IS: 210
Thrust Plate	:	CI Base with Carbon Plate
Segments	:	SS 410
Ball Retainer (If provided)	:	SS 410
Steel Ball (If provided)	:	SS Chrome Steel AISI 410
Bearing Bush	:	Resin Bonded Carbon Metal IS: 318 LTB4 and One Rubber Bush Above and Below
Motor Shaft with Rotating Sleeve	:	SS 410
Conductor of Winding Wire	:	Electrolytic Grade Copper IS: 613
Strainer	:	SS304 (minimum thickness 0.5 mm)
Sand Guard	:	Gun Metal (GM)
Coupling Sleeve	:	Stainless Chrome Steel AISI 410
Bearing Sleeve	:	AISI 410
Breather Diaphragm (Pressure Sustaining Components)	:	Nitrile Rubber

❖ SPECIFICATIONS FOR MATERIAL HANDLING SYSTEMS (CRANE / HOIST / CHAIN PULLEY BLOCKS)

General

Appropriate and suitable material handling arrangements shall be provided for all equipment included in Contractor's scope to transfer the equipment to maintenance area within the building and/or to transfer the equipment outside the building up to ground level for further transportation by the Employer. For this

purpose contactor shall provide monorails and hoist blocks with cross travel facility or cranes with 3D movement (vertical i.e. hoisting motion, longitudinal i.e. long travel motion LT, Cross travel motion CT) where specified.

Codes and Standards

The design, manufacture, inspection and testing of monorails and hoists shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The monorails and hoists shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, are also acceptable. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Employer shall be final and binding.

IS: 807	:	Design, Erection and Testing of Cranes and Hoists
IS: 3177	:	Electric Overhead Travelling Cranes
IS: 3938	:	Specification for Electric Wire Rope Hoists
IS: 3832	:	Chain Pulley Blocks
IS 2429	:	Round Steel Short Link Hand Chain
IS: 6216	:	Short Link Load Chain Grade 80 Alloy Steel
IS: 2266	:	Steel Wire Ropes
IS: 15560	:	Points Hooks with Shank and Safety Latch
IS: 210	:	Cast Iron Castings

Design Requirements

If not specified elsewhere in specific requirement of tender specifications/BOQ, then generally for the hoists with more than 1.0 metric ton lifting capacity or more than 06 meters lift, motor operated hoist blocks for both long travel and lift shall be provided where rest other hoist blocks shall be of manually operated type for both, longitudinal travel and lift. Minimum 1.5 to 3 meter length of cantilever from edge of building/cladding shall be provided in monorails coming out of the building to lower the equipment to ground level clearing the building sidewalls/cladding and any other facilities beneath the floor up to ground level.

The exact lift/travel and capacity of the hoisting mechanisms and the mode of lifting equipment shall be as per approved GA drawings of building/concerned civil unit.

Clear height shall be maintained when handling one equipment over other, in such case dismantling of any equipment shall not be permitted. The center line of monorail shall not deviate by more than 500 mm from the center of gravity of any equipment that is to be lifted.

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

➤ ELECTRIC OVERHEAD TRAVELLING (EOT) CRANES

The crane shall be electrically operated, box/standard “I” beam type single/double girder complete with all accessories including down shop conductor, crane rails and fixtures, starter panel, cable up to starter and shall conform to IS: 3177, IS: 807, IS: 3938 and other relevant approved standards. Crane having 10 MT or higher capacity shall be double girder type only and shall be provided as per the relevant IS and other applicable standards.

The crane bridge shall consist of single bridge girders on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access walkway with safe hand railing as required along the full span length of the bridge girder shall be provided for double girder crane and for

single girder crane a center platform and two platforms at drive end shall be provided for ease of maintenance/access to crane drive. Steel shall be tested for quality conforming to IS: 2062, plates more than 20mm thick shall conform to IS: 2062/BS 4360 or relevant internationally approved standards.

The bridge shall be designed to carry safely the loads specified in IS: 807/BS 2573 or relevant internationally approved standards. All anti-friction bearings for bridge and trolley track wheels, gear boxes and bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective grease nipples.

Wheel base and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevent skew ness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads confirming to relevant standards.

The crane rails/square bars shall be of MS polish as per IS: 2062 or better grade of material. Mountings of the wheels shall be designed to facilitate easy removal for maintenance.

Walkways shall be of at least 500 mm clear inside width with 6mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

All exposed couplings, shafts, gear, wheels, pinions and chain drives etc. shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 10,000 hours. Electro-magnetic or hydraulic thruster brake shall be provided for the main hoist. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions.

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

Rope drums shall be grooved and shall be made of seamless pipe as per ASTM 106 Gr. A or B, cast iron of minimum Grade 25 or cast steel, rolled steel of welded construction and in case of welded drum this should be stress relieved and conforming to IS: 3177/BS 466 or relevant internationally approved standards. Rope sheaves are to be made from CI running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.

Hoist rope shall be extra flexible, improved plough galvanised/FMC plough steel rope with well lubricated hemp core and having six strands of 36 wires per strand with minimum ultimate tensile strength of $1.6/1.75 \times 106 \text{ kN/m}^2$ of right hand ordinary (RHO) lay construction. The ropes shall have a 6:1 safety factor on the specified safe working load, and shall conform to IS: 2266.

Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball thrust bearings with hardened races. The lifting hooks shall comply with the requirements of IS: 15560 or relevant internationally approved standards and shall have a safety latch to prevent rope coming off the hook.

Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to BS 436/IS: 4460 or BS 721 or relevant internationally approved standards.

A SWL plate not less than 150mm in height showing year of manufacture and rated capacity of hoist in figures shall be placed on each side of the crane girder.

The maximum deflection under full load shall not exceed $1/900$ of the span.

All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, braking resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits etc. necessary for the safe and satisfactory operation of the crane shall be provided.

Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper, GI shrouded type. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces. Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicating lamps.

- 'Start' and 'Stop'
- Long Travel - 'Right' and 'Left'
- Cross Travel - 'To' and 'Fro'
- Hook - 'Hoist' and 'Lower' and micro hoist and lower
- Red indicating lamp for supply 'ON' indication

Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent over travel for each of the following:

- For 'UP' and 'Down' motions of the hook
- Long travel motion
- Cross travel motion

Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

Drive motors shall be suitable for crane duty (S4) application and generally conforming to latest IS: 12615/IEC 600342-1 standards as applicable. Motor shall be designed for frequent reversal, braking, inching and acceleration. Pullout torque shall be 2.15 times the rated torque. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS: 3938/IS: 3177. Limit switches shall be provided for over hoisting and over-lowering and of two extreme ends of trolley travel i.e. cross as well as long travels. Make of Crane Duty (S4) Motors for EOT Crane / electric hoist as per manufacturer standards shall be acceptable.

Drive for hoist drive (up and down motion) shall be provided with VFD. VFD shall be as per vendor selection to suit the application and reliable operation. For this application being intermittent operation, derating as specified in tender / electrical specifications, conformal coating, and other specific requirements like provision FA fuse, etc. not required.

Tests and Test Certificates

Overload tests at 125% of the rated load shall be carried out and test certificates shall be furnished for hook, wire rope, brake and complete crane.

Following accessories shall be provided with crane.

- a) Mechanical stoppers for long travel and cross travel shall be provided.
- b) Pendant push button station shall be located at maximum 1.0meter from operating floor elevation.
- c) Earthing terminals shall be provided.
- d) Limit switches for over hoist, over lower, over cross travel and over long travel shall be provided.
- e) Flexible trailing cable system shall be provided with sufficient number of loops for specified cross travel.
- f) The control panel shall be provided. Panel shall be with isolation breaker/switch to receive the power from electrical panel.

g) MS ladder shall be provided by the contractor for maintenance.

Painting

Refer painting requirement / specifications provided separately below.

➤ HAND OPERATED OVERHEAD CRANES

Cranes shall be designed and manufactured in accordance with BS 2573/IS: 3177/IS: 3832 and shall comply with the requirements of BS 466/IS: 3177/IS: 3832 class II medium duty.

The crane details and ancillary equipment provided shall conform with applicable parts of the general requirements specified above for electrically operated over-head cranes, except that the crane shall be manually operated in all motions by conveniently mounted endless chains, arranged for operation by one man.

➤ ELECTRIC CHAIN HOIST AND TRAVELLING TROLLEY

The design, manufacture, inspection and testing of monorail, electric chain hoist and electrically operated traveling trolley shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. Electrically operated chain hoist shall conform to IS: 6547 (1972) and shall be designed for duty service Class II. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, are also acceptable.

IS: 6547 (1972)	:	Electric Chain Hoist
IS: 2429	:	Round Steel Short Hand Link Chain
IS: 6216	:	Short Link Load Chain Grade 80, Alloy Steel
IS: 15560	:	Points Hooks with Shank and Safety Latch
IS: 808	:	Indian Standard Medium Weight Beam
IS: 210	:	Cast Iron Castings

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

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

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

Chain hoist shall be suitable to fix with supporting/monorail girder at fixed location at the top/bottom flange of beam (for fixed installation) and bottom hook shall be so designed that it shall be free to swivel in the loaded conditions without twisting the load chain. Hook shall be forged as per IS: 15560 or its latest amendment.

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

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

Drive motors shall be suitable for crane duty (S4) application and generally conforming to latest IS: 12615/IEC 60034-1 standards as applicable. Make of Crane Duty (S4) Motors for EOT Crane / electric hoist as per manufacturer standards shall be acceptable.

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

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

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

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

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

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

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

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

Monorail 'I' beam shall be medium weight beams (ISMB) as per IS: 808 (1989) (Reaffirmed 1999) for steel beam in case of providing the same.

Clear height of the monorail shall be maintained to handle one equipment over other.

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

➤ **MANUALLY OPERATED CHAIN PULLEY BLOCK AND PUSH-PULL GEARED TROLLEY**

General

Hoist shall be designed, manufactured including overload testing with all accessories and shall be as per IS: 3832 and other relevant standards.

Complete unit shall be comprising mainly i) geared trolley with hand chain, ii) hand operated hoist block with hand chain and load chain, iii) gears, load brake and cover parts, iv) load blocks complete with sheaves and lifting hook and v) ratchet and pawl type load brakes.

All chain pulley blocks shall be designed for class II service as per IS: 3832. Materials of construction shall be as per IS: 3832.

Proof load testing must be carried out at 1.5 times the rated load as per relevant IS.

All hoists/chain pulley blocks shall be selected to have minimum headroom and shall be selected to lift heaviest piece of equipment. Further, it shall be possible to handle any equipment without disturbing other equipment.

All gears and bearings shall be lubricated by grease. All lubricating points shall be grouped together in easily accessible position. All parts requiring replacement/inspection/lubrication shall be accessible without need for dismantling of other parts/structures.

All components of hoist of identical capacity and duty shall be interchangeable.

Hoist shall have permanent inscription in English on each side readily recognizable from floor level stating safe working load.

Trolley

Trolley may be push pull geared type and of specified capacity as mentioned in BOQ or as per specific requirements.

It shall be designed to move the load along the “I” beam axis. It shall be rigid and robust in construction with side plates but shall also facilitate easy assembly / disassembly. The material of construction of trolley shall be as per IS 2062.

The steel plates shall extend beyond the trolley wheels on either side so as to act as bumper, protecting the wheels from damage by collision.

Trolley wheels shall be of single flange type in the taper/straight treads and accurately machined and shall be easily removable for repairs/replacement. They shall be compatible with and mounted on roller bearings to minimize frictional load, and parallel to the flanges of the “I” beam. Load shall be evenly distributed on all wheels. Wheel bearings shall be conforming to IS: 2513 or equivalent and shall be of standard make.

Hoist Blocks

The hoist frame shall be made of steel as per IS: 2062 and gear train shall be enclosed in housing. The hoist mechanism shall consist of a grooved rope drum operated through gears. Each end of the rope shall be anchored to the drum in such a way as the anchorage is readily available for maintenance. Each rope shall have two full turns of the drum when the hook is at its lowest position and one spare groove when the hook is at its highest position.

The leading rope taken by the drum should not slope sideways when slack and it should not caught between the gear wheel.

Rope drum, gear box, block etc. should be fabricated out of weld-able quality steel and as per IS: 3177/IS: 4460/IS: 3938.

All gears shall be of high grade heat treated alloy steel conforming to AGMA standards. Gears shall be forged and accurately machined and shall not be of split type.

All pulley blocks shall be provided with automatic mechanical load brakes which will prevent self-lowering of the load and sustain rated load in all working positions. Brakes shall be ratchet and pawl type/shoe and friction disc type and self-actuating at any load position.

The chain pulley block shall be fixed with the trolley with removable type pin(s)/ bolt(s) directly without having upper hook.

Load Chain

The material of construction shall be case hardened alloy steel as per grade 80 of IS: 6216. It shall be of size 8mm to 12mm or higher as required to suit load requirement.

The hand chain wheels shall be of cast steel/SG cast iron/sheet metal, the wheels shall be with flanges and designed to ensure effective operation of hand chain. Further, suitable local brake shall be provided as per IS: 3832 to arrest and sustain loads in all working positions.

Hand Chain

The hand chain shall be of grade 30 of IS: 2429. It shall be properly pitched and polished.

Bottom Block and Load Hook

The bottom block shall be of enclosed type and shall have guard against rope jamming in normal use. It shall have standard forged swivel shank hook fitted on antifriction thrust bearing. It also shall have lock to prevent hook from rotation and locking arrangement to prevent accidental unlocking. Pulley of the bottom block shall be provided with antifriction bearings.

The load hook shall be swiveling type forged circular shank section and shall confirm to IS: 15560. It shall be proof load tested at twice its rated load and with antifriction bearing.

❖ SPECIFICATIONS FOR VARIOUS VALVES & ELECTRIC ACTUATOR

General

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

Valves shall be double flanged type (unless the end connection is permitted otherwise as specified in specifications for each valve below/in process data sheet) and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Generally, valves shall be rated for nominal pressure of PN 1.0 as a minimum or PN 1.6 if required as per process application or as specified in tender specifications/SOQ/BOQ. Further, higher pressure rating valves shall be offered if required as per process application and in MOC as specified in specifications elsewhere for such applications or suitable for such pressure ratings if not specified explicitly. The CI/DI MOC specified are generally for water/sewage/sewage sludge applications. However for industrial effluent and certain chemical applications the valve MOC shall be offered to suit to the process fluid.

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

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. For all type of valves/gates (including open channel, thimble mounted, etc.) gear mechanism design and makes shall be as per manufacturer standard

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

Valves shall be free from sharp projections.

For valves with extended spindle/shaft following shall be considered/provided.

- Extended spindle MOC and size to be confirmed by valve manufacturer.
- Head stock/bracket supply shall be in valve vendor scope only. Valve manufacturer also to provide details and MOC of the same in GAD.
- For extended spindle the coupling and guide bracket details shall be provided by manufacturer. Generally it is desired to have two numbers universal couplings (one on top/ below headstock and one in bottom above gear box/valve body). In case of long spindle lengths muff couplings at about every 3m distance. Shaft guide bracket/support shall be provided if extension spindle is more than 3m long.

A SLUICE/GATE VALVES

Design Requirements and construction Features

Sluice valve shall be non-rising spindle type resilient seated (Manually operated) confirming to IS: 14846/BS 5163 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

Sluice valve shall be rising/non-rising spindle type when operated through electric actuators confirming to IS: 14846/ BS 5163 having PN 1.0/PN 1.6 rating.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

Body of the valve shall be designed for 1.5 times the rating of the valve.

Valve flange face shall be parallel to each other and flange face should be at right angle to the valve centerline.

Back side of valve flange shall be machined or spot faced for proper seating of bolt head and nut.

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

Valve shall close with clockwise rotation of the hand wheel. The direction of closing shall be marked on the hand wheel.

Valve shall be non-rising or rising spindle type and rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Stem sealing shall be done with NBR wiper ring in case of resilient seated and bonnet gasket shall be of EPDM. Valve shall be powder coated electrostatically internally as well as externally by RAL blue colour.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with repacking arrangement as per IS: 14846.
2. The valves 600mm and above size shall have channel and shoe arrangement as per IS: 14846.
3. The valves 350mm size and above shall have spur/bevel gear arrangement as per IS: 14846.
4. All valves shall have valve's OPEN/CLOSE indicator arrangement as per IS: 14846.

Materials of Construction

a) Body and Bonnet	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Wedge	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7 and core fully Encapsulated with EPDM rubber with integral wedge nut (For non-rising resilient seated valves)
c) Spindle Nut	:	Bronze IS: 318 Gr. LTB2
d) Spindle	:	SS BS 970 Gr. 304 S16
e) Seat Rings	:	SS BS 970 Gr. 304 S16
f) Back Seat Bush	:	Bronze IS: 318 Gr. LTB2
g) Shoe and Channel Linings	:	SS to BS 970 Gr. 304 S16

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

However, valves 15mm to 40mm size shall be generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended.

B1 SWING CHECK TYPE REFLUX VALVES (NON RETURN VALVES)

Design Requirements and Construction Features

Non return valve i.e. reflux valve swing check type confirming to IS: 5312 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type. The valve shall be suitable for mounting on horizontal pipe line.

The internal parts shall be easily accessible for inspection through inspection hole.

Hydraulic passages and doors shall be designed to avoid cavitation.

Valve body shall be designed for 1.5 times the rated pressure.

Valve shall be of swing type or ball type. Ball type valve must house a freely moving ball in such a way that return flow is effectively prevented.

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

Flow direction shall be clearly embossed on the valve body.

Valve flange face shall be parallel to each other and shall be at right angles to valve centerline. Flange back shall be machined or spot faced for proper seating of bolt head and nut.

Valve shall be rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with by-pass arrangement as per process requirement as per IS: 5312.
2. Valves 300mm and above size shall be provided with drain plugs as per IS: 5312.
3. Valves 450mm size and above shall have support foot as per IS: 5312.

Materials of Construction

a) Body, Cover, Doors and Hinge	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Body Ring	:	SS BS 970 Gr. 304 S16
c) Disc Ring	:	SS BS 970 Gr. 304 S16
d) Bearing Bushes	:	Bronze IS: 318 Gr. LTB2/SS BS 970 Gr. 304 S16
e) Gasket	:	Grafoil Filler SS 304 Spiral Wound
f) Ball (if applicable)	:	To Be with EPDM Rubber

However, valves 15mm to 40mm size shall generally as per API 6D/API 602 and having carbon steel body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended.

Note: For non-return valves with a diameter exceeding 600 mm, a dual plate check valve shall be provided.

B2 DUAL PLATE CHECK VALVES

General

All double flanged dual plate check valves shall conform to API 594 (1997) and API 598 or its latest amendment for pressure rating PN1.0/PN 1.6/Class 300 as specified in technical data sheet/BOQ. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials.

The internal dimensions and shape of the body, plates etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve as per manufacturing standard.

The designs of the plates, hinge pin, stop pins etc. shall ensure free swinging of the plates. The spring action shall optimize the equal closing rates of each plate. The dual plates face shall have close face contact with the body seat ring in close position. Valves shall be designed for horizontal and vertical mounting position. The plates shall not vibrate under full or partial flow condition.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of plates, springs and hydraulic passages.

B. Features of Construction

Body

Valve body shall be double flanged. The minimum thickness of metal for body shall be as per directives given in the API 594 and shall be maintained throughout any section uniform. The flange to flange dimensions shall be in accordance with manufacturing standard (Tables 2A and 2B).

Body of the valve shall be fitted with removable seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each check valve shall carry an embossed ARROW to indicate the direction of flow.

Flanges

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The finish on facing shall comply with MSS SP-6/ASME B 16.5. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS: 1538, Table IV and VI.

Plates and Hinges

Plates and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Plates shall be securely positioned on body seat face with the assistance of required nos. of spring or other devices. Plate seating face shall be renewable or uniformly deposited weld metal machined and lapped using good manufacturing process so as to provide leak less seating on body face ring.

The spring action shall optimize the equal closing rates of each plate. The plates shall be totally vibration free under full or partial flow condition.

Internal Wetted Parts

Internal wetted parts shall be suitable for the specified service conditions. The term shall include but not be limited to hinges, pins, bolts, bearings and any other part in contact with the fluid medium other than the body, plates, trim, springs and pipe plugs.

Optional Items

1. Valves 150mm and above size shall have lifting eyebolts.
2. Valves 600mm and above size shall have support foot.
3. Valves 600mm and above size shall have bypass arrangement as per process requirement.

Materials of Construction

a) Body	:	CI to IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Disc (Closure Plate)	:	Cast Steel (ASTM A216 Gr. WCB)
b) Seat	:	Nitrile
c) Spring	:	Spring Steel
d) Stop/Hinge Pin and Space Washers	:	SS 304

C KNIFE GATE VALVES

General

Knife edge gate valve shall be manufactured and tested as per MSS SP 81 standards.

Knife gate valves shall be suitable for use in waste water and sewage water containing solids and fibrous wastes etc. These shall be suitable for use at suction and delivery side of pumps as well as in branch lines in a sludge handling application of treatment plant or a pumping station.

The valve should be provided with gate made of stainless steel and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off/closure in sewage environment.

Design

The valve should preferably be bonneted up to 300mm size and bonnet-less for higher sizes. Valves shall be of wafer lug type construction up to 150mm size and full flanged construction for higher sizes. The valve shall be provided with flange drilling to suit ANSI 16.5B 150# with raised face or DIN PN 10 or IS: 1538 (1993) flange connections in between pipelines.

Valve shall be rated for nominal pressure of PN 1.0 as per SOQ/BOQ or as specified in tender specification or as per application requirement. It should be suitable for unidirectional application and should be able to withstand small bi-directional pressure.

The valve body should be cast and provided with replaceable type flexible sealing seals to offer drop tight shut off. The seals should be made of PTFE or EPDM rubber and should be held in place by an easily removable type seal retainer ring.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished and buffed.

Bonneted type valves shall be provided with O-rings based arrangement to seal the rear opening and reduce the operating torque. Bonnet-less valves shall be provided with sufficient ply of stuffing seals in the inbuilt stuffing box to seal the rear opening. The seals should be of non-asbestos PTFE to reduce the friction and offer higher life. Provision shall be made to enable tighten the stuffing seals. Replacement of stuffing seals should be possible to be carried out in installed condition of the valve but without there being line pressure.

The spindle should be double start threaded and non-rising type for compact and safe operation. Gate opening indicating arrangement should be provided to find out the extent of gate opening/closing.

Materials of Construction

The following materials of construction shall be offered for the knife gate valves.

Body	: Bonnet less CI FG 260 IS: 210 OR DI IS: 1865 Gr. 500/7
Knife Gate	: AISI 304 Gr. ASTM A240
Retainer Ring	: Ductile Iron/Steel Hard Chromed/Stainless Steel Gr. CF 8
Inlet Seal	: PTFE/EPDM
Spindle	: Stainless Steel Gr. ASTM A276 Type 410/303
Spindle Nut	: Bronze IS: 318 GR LT B2
Stuffing Plate	: Cast Steel ASTM A216 Gr. WCB
Stuffing Seal	: Synthetic Fiber (Yarn) impregnated with PTFE
Support Plate/Channel	: Carbon Steel Epoxy Painted/ SS 304

D BUTTERFLY VALVE

Butterfly valve shall be as per IS: 13095/BS 5155. Valve shall be suitable for mounting in any position. Valve shall be rated for nominal pressure as specified above in general requirements.

For valve size 150mm and above end connection shall be flanged and for sizes up to and including 125mm shall be flanged/full lug wafer type.

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

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

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

Valve of diameter 200mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

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

Butterfly valve where specified shall be electrically operated.

Materials of Construction

Sr. No.	Component	Material
(a)	Body	Cast Iron IS: 210 FG 260 OR Ductile Iron IS: 1865 Gr. 500/7
(b)	Body Ring	Stainless Steel BS 970 Gr. 431 S29
(c)	Disc	Ductile Iron IS: 1865 Gr. 500/7
(d)	Shaft	Stainless Steel BS 970 Gr. 431 S29
(e)	Disc Ring	EPDM Rubber

(f) Bearing Teflon

E BALL VALVES

General

Ball valve shall be manufactured as per BS EN ISO 17292 and Inspection and testing standard shall be BS EN 12266-1. Valve shall be rated for nominal pressure as specified above in general requirements.

Ball valve shall be supplied with a lever/wrench unless it is gear or electric actuator operated.

Soft-seated ball shall be with antistatic devices.

Soft-sealed BW/SW end ball valves shall have a 100mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats/seats.

The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ANSI class up to 200mm NB size. Valves 200mm NB onwards shall be in class 150 where the face-to-face dimensions shall be as per API 6D long pattern.

The ball of ball valve shall not protrude outside the end flanges of valve and shall provide 100% through passage to the flow of liquid.

Ball valve shall be of floating ball/trunnion mounted type as per following.

Class 150	200mm and below	Floating Ball
Class 150	250 mm and above	Trunnion Mounted

Unless otherwise specified, bore of all reduced bore ball valve shall be limited to one size lower than the nominal bore.

Valve Design	:	3 Piece Ball Valve
Type of Bore	:	Full Bore

Materials of Construction

Body and End Caps	:	ASTMA-351 Gr. CF8M
Ball/Stem	:	AISI- 316
Seat	:	PTFE
End Connection	:	Less than 50mm – Socket Weld End (SW)/Threaded (Screwed End) 50mm and above - Flanged end, 150#
Operation of Valve	:	By Lever/Gear/ Electric Actuator as per SOQ/BOQ

F AIR VALVE WITH ISOLATION SLUICE VALVE

DI temper proof flanged air valve with isolation sluice valve as per IS: 14845 PN 1.6 and IS: 14846 PN 1.6 respectively with SS 304 float, gun metal nozzle, complete hardware, bolts, nuts and washers, gaskets etc. Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

KINETIC AIR VALVE

General

The double acting kinetic air valve shall be manufactured as per IS: 14845 (2000) or its latest amendment suitable for the specified pressure rating. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from blow hole, flaw burr or other defects and sharp projections which are likely to get clogged with stringy materials.

The valve shall be capable of releasing air from pipe automatically when the pipe is being filled by liquid without generating high air pressure in pipe and shall remain closed once the pipe is filled to prevent spillage and loss of liquid and maintain rising main's pressure. Similarly, the valve shall be capable to admit air automatically to prevent development of vacuum while the pipe is being emptied.

Features of Construction

Body

Body of the air valve shall be flanged type and shall have high pressure and low pressure chambers to accommodate high pressure and low pressure float respectively. The chambers shall be designed and have proper guide for small orifice float and guide ribs with minimum clearance to large orifice float so as to allow wobble free upward and downward movement of floats in the chamber when required for releasing or admitting air without any obstruction.

Body shall be designed to avoid prematurely closing of the valve by the air whilst being discharged.

The cone angle of the low pressure chamber shall be such that even at critical velocity of air escaping at 344 m/sec the total impact force on the float is less than the suction force on the annular area between the float and cone. Cone angle and the minimum body thickness shall be as specified in IS: 14845 (2000). The low pressure cover shall be designed to withstand full operating thrust in working Conditions.

The seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

High Pressure Orifice

The high pressure orifice shall be so designed that the orifice is effectively sealed in working condition. The orifice shall be of size not less than 2.5mm and tapering to 10mm suitable to release accumulated air within the pipe. The edge of orifice shall be carefully profiled to avoid damage to the float surface. The orifice shall be protected by a Suitable plug of stainless steel.

Flanges

All valve flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat and drilled in accordance with IS: 1538, Table 4 and 6. Flange bolt shall be drilled off center.

Floats

The float size shall be as per individual design subject to minimum as specified in IS: 14845 (2000).

The buoyancy of the floats shall ensure effective sealing of large orifice even at low pressure. The float shall be made of seasoned wood or any other material having bearing strength and equivalent specific gravity. The floats shall be externally coated with vulcanite or rubber having required shore hardness as per IS. The floats shall be non-clogging and self-sealing type for trouble free operation.

Low Pressure Seat Ring

Low pressure seat ring shall be of natural or synthetic rubber having required shore hardness. The central orifice shall be profiled for maximum discharge in any given condition of pressure differential between the chamber and atmosphere. The float shall make contact with inner profile of the seat ring and seat ring shall withstand the bearing load under working condition without any deterioration in the quality.

Joint Supporting Ring

Low pressure seat ring shall be held securely in place under low pressure cover by a joint support ring to prevent it from sagging when the float is not sealing the orifice.

Cowl

A cowl shall be temper proof and designed to provide protection to low pressure, large orifice chamber, seat ring and float. It shall be designed to prevent direct ingress of foreign matter inside. There shall be

sufficient clearance between the orifice and the cowl to ensure easy passage of air under a given pressure differential.

Materials of Construction

Body and Cover	:	DI IS: 1865 Gr. 500/7
Floats	:	Stainless Steel 304
Gasket	:	EPDM or Nitrile Rubber ASTM D 1418
Cover Bolts and Nuts	:	Carbon Steel

Accessories

1. Isolating DI DF sluice valves manufactured as per IS: 14846 of identical size and rating.

Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

G ELECTRIC ACTUATOR (APPLICABLE FOR VALVES/GATES)

All local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gear box shall be oil or grease filled and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The valve actuator shall be suitable for ON-OFF type of service and duty shall be S-2 minimum 15 minutes of continuous operation. It should be capable of producing not less than 1½ times the required valve torque i.e. selected actuator rating in Kgm (Nm) shall always be 1.5 times the maximum valve torque in Kgm (Nm).

The operating speed shall be such as to give valve closing and opening within 120 seconds maximum up to 400 mm dia./height of SV/KGV/sluice gates. However for SV/KGV/SG exceeding 400 mm dia. /height shall be maximum within 300 seconds or as per manufacturers' standards subject to fulfilment of actuator torque rating be 1.5 times that of maximum valve torque. Moreover number of turns for valve close to valve open shall be less be preferably less than 200 for sizes up to 400 mm dia. Only in higher sizes the same may be permitted beyond 200 or as per manufacturers' design & standards. The operating speed shown here are for ready reference only. Care must be taken by the valve manufacturer to choose such model of actuator so as to keep the opening & closing time to as low as possible.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weather proof housing of IP 68. The motor starter shall be capable of starting the motor under the most severe conditions.

The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single-phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts etc. shall be carried out over an infrared interface (minimum two numbers shall be provided) or with outside push button arrangement or any such suitable arrangement without the removal of any actuator covers.

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

Each starter shall be equipped as follows as a minimum.

- a) AC electric motor.
- b) Reduction gear unit (with thrust bearing if required).
- c) Torque switch mechanism complete with set of torque switches for “Open” and “Close” position.
- d) Limit switch mechanism complete with set of limit switches for “Open” and “Close” position.
- e) 2 numbers of auxiliary limit switches to be provided for each direction in the switch mechanism in addition to the torque/limit switch for travel termination (if specified for any application in scope of work/process description & specifications).
- f) Hand wheel for manual operation.
- g) Hand-auto changeover lever with suitable locking arrangement.
- h) Local control switch/push buttons.
- i) Forward/Reverse integral starter.
- l) 1 Set “Open”, “close” and “Stop” buttons as applicable.
- m) 1 number Local – Off –Remote switch with padlocking facilities as applicable.
- n) Space heater, 220V rated.
- o) Position indicator.
- p) Position transmitter with 4-20 mA analogue output for valve open/close position if requirement specified elsewhere in tender as per application.

The following relays/potential free contact shall be provided.

- Full open
- Full close
- Torque switch open
- Torque switch closed
- Thermo-switch/thermal overload relay tripped
- Selector switch position local-remote-off
- Single phasing power supply failure.
- Remote position feedback in the form of 4-20 mA (if required/specified).

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification.

AC Electric Motor

Each motor shall be fully tropicalized and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variations of electric supply specified.

The motors shall be of appropriate rating for 3 phase, 50 Hz AC electric supply of required speed (RPM) of minimum class ‘F’ insulated with temperature limited to that of class B, high torque low inertia motors of 15 minutes rating, squirrel cage induction type with ‘O’ ring seal to provide complete environmental protection during long period of inactivity. The winding shall be impregnated to render them non-hygroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour. Make of electric motor shall be as per latest governing standards and manufacturers’ standards.

Motor Protection

Following motor protection shall be provided.

- a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- b) Motor temperature shall be sensed by a thermostat to protect against overheating.
- c) Single phasing protection.

Motor Controls

The reversing contactor starter and local controls shall be integral for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a 220V control

transformer (120V AC for energization of contactors and 24V DC rectifier supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.

Local control shall comprise push buttons for open close and stop operations, and a local/remote selector switch lockable in the three positions as below.

Local control only,
Remote control plus local stop only,
Stop locked off - No electrical operation.

Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

Integral Starter with Microprocessor Based Programmable Controls

The starter unit shall be with micro controller based control logic. Entire unit along with basic actuator should confirm to IP 68 standard of enclosure.

The actuator shall be field configurable having inbuilt pushbutton and LCD display to configure the features like inching or non-inching (hold on) mode etc. Also LCD display of actuator shall be able to show the operational status and fault information in text format. LCD display shall have minimum 32 characters.

Isolated 24V DC output shall be available for customer's use and for internal use of actuator.

Torque and Turns Limitation

Torque and turns limitation to be adjustable as follows.

- Position setting range – multi-turn: 2.5 to 100,000 turns, with resolution to 15 degree of actuator output.
- Position setting range – direct drive part turn actuators: $90^{\circ} \pm 10^{\circ}$, with resolution to 0.1 degree of actuator output.
- Torque setting: 40% to 100% rated torque.

Measurement of torque shall be from direct measurement of force at the output of the actuator. Methods of determining torque using data derived from the motor such as motor speed, current, flux etc. are not acceptable.

A means for automatic “torque switch bypass” to inhibit torque off during valve unseating and “latching” to prevent torque switch hammer under maintained or repeated control signals shall be provided.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

Local Position Indication

The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipe work to ensure that valve status is clearly interpreted. With main power on the display shall be backlit to enhance contrast at low light levels and shall be legible from a distance of at least 6 feet (2 m).

Red, green, and yellow lights corresponding to open, close and intermediate valve positions shall be included on the actuator display when power is switched on. The digital display shall be maintained and updated during hand wheel operation when all power to the actuator is isolated.

In addition, the actuator display shall include a separate text display element with a minimum of 32 characters to display operational, alarm and configuration status. The text display shall be selectable in English. Provision shall be made to upload a different language without removal of any covers or using specialized tools not provided as standard with the actuator.

Monitoring Facilities

Facilities shall be provided for monitoring actuator operation and availability as follows.

Monitor (availability) relay having one change-over contact. The relay being energized from the control transformer will de-energize under any one or more the following conditions.

- Loss of main or customer 24V DC power supply
- Actuator control selected to local or stop
- Motor thermostat tripped
- Actuator internal fault

Where specified, provision shall be made for contacts to provide discreet indication of one or more of the following.

- Remote selected
- Thermostat trip
- Actuator fault

Actuator text display indication of the following status/alarms.

- Closed limit, open limit, moving open, moving closed, stopped.
- Torque trip closing, torque trip opening, stalled.
- ESD active, interlock active.
- Thermostat trip, phase lost, 24V supply lost, Local control failure.
- Configuration error, Position sensor failure, Torque sensor failure.
- Battery low, power loss inhibit.

Integral data logger to record and store the following operational data.

- Opening last/average torque against position
- Closing last/average torque against position
- Opening motor starts against position
- Closing motor starts against position
- Total open/closed operations
- Maximum recorded opening and closing torque values
- Event recorder logging operational conditions (valve, control and actuator)

The data logger shall record relevant time and date information for stored data.

Data logger data is to be accessed via non-intrusive IrDA communication. Sufficient standard intrinsically safe tools shall be provided for downloading data logger and actuator configuration files from the actuators and subsequent uploading to a PC. The actuator manufacturer shall supply PC software to enable data logger files to be viewed and analyzed.

COMMUNICATION CAPABILITY:

The actuator shall be suitable for at least any one of the following control facilities.

- Modbus
- Profibus
- Foundation Fieldbus
- Device Net
- Pakscan

Wiring and Terminals

Internal wiring shall be of grade PVC insulated stranded cable of 650V and of minimum 1.5 mm² copper for control circuits and of minimum 4 mm² for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

Enclosure

Actuators shall be O-ring sealed IP 68. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site for cabling, the terminal compartment having the same ingress protection rating as the actuator with the terminal cover removed.

Enclosure must allow for temporary site storage without the need for electrical supply connection.

Position transmitter shall be provided if required to be provided as per process requirement.

Reduction Gear Unit

Reduction gear unit shall be of the totally enclosed oil bath/grease lubricated type. The gear box shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at a speed sufficient to cover the full extent of travel.

The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.

The gearbox shall have suitable stops to prevent movement of shaft beyond fully open/close position. The gearbox shall also be designed for 15% more torque than maximum sluice gate/valve torque.

❖ SPECIFICATIONS FOR METALLIC EXPANSION BELLOWS

Expansion bellow shall be fabricated in accordance with the EJMA/ASME standard.

The bellows shall be metallic corrugated design of MOC as specified and shall have flanged ends on both sides with liner/internal sleeve. The fatigue life expectancy considered for EB shall be minimum 3000 cycles. The drilling standard of EB flange shall be matched on piping side to ensure proper alignment and bellows is not subjected to torsional forces due to misalignment. It shall be single bellow design and suitable for axial movement of up to total 30mm (20mm axial compression and 10mm axial extension). Further it shall be suitable accommodate angular misalignment of piping for up to minimum 5mm/3 degrees for installation. The overall length of expansion joint for up to 300mm dia. size shall be 250mm, for above 300mm and up to 1000mm it shall be 300mm and for above 1000mm the same shall be 350mm. The austenitic stainless steel shall be welded using the TIG welding method. The shipping bracket of bellows shall be removed only after installation of the bellows at site.

To achieve maximum flexibility coupled with required resistance to pressure, bellows shall be formed with single or multiple walls using a number of concentric cylinders (multi-ply construction) of specified MOC, each longitudinally welded. However for the blower application the bellows shall be of multi-ply construction only.

Generally the expansion joint is provided of single bellow design as a dismantling/disassembly joint in piping near valve or pump or flow meter or such device or equipment for ease of removal and jointing. Tie rods/threaded draw bars attached to expansion joint assembly shall be provided for this application.

In case of bellows used for air piping application/in air blower discharge piping or such application witnessing vibration and temperature variations the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement. In case of bellows used for diaphragm type dosing pump or such pulsating service the expansion joint shall

be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

The weld end pipe shall be suitable for design pressure (Minimum PN 10 or higher as per design) and for CS/MS weld end pipe shall be with minimum corrosion allowance of 3mm for water/waste water application. However for blower application the bellows shall be designed for a working pressure of minimum 1 Bar or higher as per design and for a temperature of minimum 115⁰C or higher as per design and for velocity of minimum 25 m/sec or higher as per design and the liner thickness shall be suitable for the same.

During installation the bellows as a practice shall always to be placed between two fixed points. Thrust block or saddle welded to pipe to make it fixed must be provided on both sides of EB.

The shipping bracket of bellows shall be removed only after installation of the bellows at site.

For blower application generally after the bellow the first support (saddle or suitable) shall be provided at 4D distance and second support 14D distance from bellows to dampen the vibrations.

Materials of Construction

Component Description	Water / Sewage / Sec. Treated Indl. Effluent / Air Application	Indl. Effluent / Bio-Gas / Chemicals or Corrosive Application
Bellows	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Internal Sleeves / Liners	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Weld End Pipe	CS / MS	SS 316L
Flanges	IS:2062 with drilling as per IS:1538, PN10	IS:2062 with drilling as per IS:1538, PN10 with SS lining (all wetted portion with SS lining)
Tie / Limit Rods	Carbon Steel (CS) as per IS 1367	SS 316
Nut, Bolt , Hardware	CS as per IS 1367	SS 316

Note: For Chemical (Alum, polyelectrolyte, etc.) or Corrosive application the above specified MOC are minimum and higher / better / suitable MOC shall be provided as per the nature of chemical / fluid.

❖ ELECTRONIC WEIGHING SCALES

Two numbers of electronic weighing scales shall be supplied, one of them having a weighing capacity of 2,500/3000 kg. and another having 500kg capacity, which forms part of the job / scope of supply of this tender.

Design and construction requirements:

- The weighing scale shall be of platform type, consisting of compound levers, platform goods, and coupled to a dial type indicator.
- The design manufacture, testing erection and commissioning of the weighing scale shall conform to the latest revision of the relevant IS code.
- The platform shall be capable of accepting concentrated loads
- The 500 Kg weighing scale shall be used for weighing PAC / Alum blocks and other such chemicals which may be used for the water treatment process from time to time and the 2500/300Kg weighing scale shall be used for weighing chlorine tonners and the scale shall be adequately designed for this.

❖ SAFETY EQUIPMENT / TOOLS: 1 LOT

Supply of the following items which forms part of the job / scope of supply of this tender:

- (a) 1 Set : Digital Auto Multimeter

Digital Clip on (Clamp) meter (0- 600 volts, 0-1000 Amp)
Manually operated Megger (1000 volt) or as directed by Engineer in charge.

Make :- Meco / AE / Philips / Yokogawa/equi Reputed

(b) 1 Set Tools & Tackles

1. Box spanner set. Size 6 to 34 mm : 1 set
2. Ring spanner set : size 6 to 32 mm : 1 set
3. Fix spanner : size 6 to 32 mm : 1 set
4. Adjustable screw spanner set : (A) size of 9": 1 No. (B) Size 12":1 No.
5. Chiesel
(A) No. 105 N : 2 No
6. Screw Driver with insulated sleeve
(A) No. 936: 1 No.
(B) No. 937: 1 No.
(C) No. 938: 1 No.
(D) No. 832: 1 No.
7. Steel Scale
(A) 6" : 1 No
(B) 24" : 1 No
8. Centre punch
Size / Product No. 1985 : 1 No.
9. Hexo Frame
(A) 12" : 1 No.
10. Hex wrench set (Elen key)
Size : standard : 1 No
11. Tool box
Size : standard : 1 No
12. File with handle
(A) Round Smooth 12" : 1 No.
(B) Half Round Smooth 12" : 1 No.
(C) Halt Round Rough 12" : 1 No.
(D) Flat Smooth 12" : 1 No.
(E) Flat Rough 12" : 1 No.
(F) Triangle Smooth 8" : 1 No.
(G) Triangle Rough 8" : 1 No.
13. Bench vice
(a) 6" (No.5) : 1 No.
14. Insulated Plier
(A) size : 8" 2 Nos.
15. Mechanical Screw Jack with Tomy
(A) 3 Ton : 1 set.
16. Drill Machine wolf make (3 ph)
6 mm to 20 mm drilling capacity : 2No. Portable and Fix type
17. Bench Grinder - 1 No.
18. Bearing Puller – 3 Jaw – 12" – 1 No.
19. Cealing rope with hook at both end of minimum 4 mt. length of 3 Tonne capacity – 6 Nos
20. Hot and cold air blower – 1 No.
21. Aluminum sprit level – 12 Inch - 1 No.
22. Monkey Wrench
 - a. 12" – 1 No.
 - b. 18" – 1 No.
 - c. 24" – 1 No.
23. Pipe (Chain) wrench

- a. Pipe Size – 4”
- 24. Tap Set – 1 Set
- 25. Hammer – 3 Nos.

❖ PAINTING/COATING OF MECHANICAL ITEMS/EQUIPMENT

MS/CI/DI BODY OR PARTS OR STRUCTURE (GENERAL FOR PIPING AND PUMP/ BLOWER/ PROCESS OR SUH OTHER EQUIPMENT IF NOT PROVIDED AS SPECIFIC)

Painting shall be carried out with one coat of ~~red oxide~~/epoxy primer followed by two coats of epoxy paint after proper surface preparation as recommended by paint manufacturer/shot blasting prior to dispatch, to a total DFT of minimum 150 microns inclusive of priming (for equipment/gate/valves, etc. at manufacturer works before delivery).

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting as applicable. The mix of zinc rich epoxy primer shall be prepared at work site not earlier than 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40-45 micron and DFT 30-35 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employer's representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection, any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hours of mixing or as recommended by manufacturer and fresh mixing shall be done for every new application. Every successive coat of paint shall be applied only after 48 hours of previous coat. Before applying the next coat, the surface should be properly cleaned by duster.

CED Coating i.e. Cathode electro deposition coating which is the latest technology for corrosion resistance with uniform coating is also permissible and preferable over conventional painting.

OPEN CHANNEL GATES/SLUICE GATES (THIMBLE MOUNTED GATES)

Following painting procedure shall be adopted for the gates (CI/DI/MS MOC):

Surface Preparation	: Blast clean to near white metal finish using shot blasting.
Priming	: One coat of red oxide primer.
Finish Painting	: Black bituminous paint for gate assembly. Minimum DFT 200 microns inclusive of priming. Yoke and Headstock to be provided with red oxide / epoxy primer and epoxy grey or such suitable shade of paint having minimum DFT 150 microns inclusive of priming.

For Stainless steel gates, SS gate assembly shall be shot/grit blasted, pickled and passivated before delivery.

EOT CRANE

Painting shall be carried out as specified above for MS/CI/DI parts or structure before delivery. However, the final coat shall be golden yellow color with black zebra marking wherever applicable.

SS BODY OR PARTS OR STRUCTURE OR ENCLOSURE OR PIPING

Shall be shot/grit blasted, pickled and passivated before delivery / before erection at site (as applicable).

NOTE:

1. For equipment (including valves, gates, etc.) if paint surface is observed to be damaged/ deteriorated during storage or erection of such at site, an additional coat/touch up of paint shall be provided at site as directed by engineer-in-charge prior to commissioning/acceptance of site by client.
2. The paint shade as per manufacturers' standards' can be accepted.

❖ DOCUMENTS SUBMISISON OF MECHANICAL ITEMS/EQUIPMENT

In general, the minimum document submission for various equipment/items shall be as described below or additional as required for review to be submitted by manufacturers'/vendors' (duly stamped by manufacturers'/vendors') for review and approval during detailed engineering/execution and prior to manufacturing.

Manufacturing shall be carried out as per approved drawings and documents only and after complying comments as applicable.

PUMP AND PUMP-MOTOR SET (CENTRIFUGAL/POSITIVE DISPLACEMENT/ PROGRESSIVE CAVITY (SCREW)/RECIPROCATING (DOSING), ETC.)

1. Product technical data sheet.
2. Preliminary outline dimensional drawing (GA Drawing) showing the details of pump and motor, suction, discharge connections and foundation details.
3. Performance curves showing capacity v/s total head, efficiency, NPSH required and power requirements ranging from run out to pump shut off for minimum, maximum and rated impeller diameter of the offered pump.
4. ISO efficiency curve (as applicable).
5. Typical cross sectional drawing showing internal features of pump, parts and their materials.
6. Torque – Speed curve of the pump (as applicable).
7. Quality Assurance Plan.

VALVES (SV/NRV/DPCV/BFV/KGV/BALL/AIR VALVE, ETC.), SLUICE GATES, OPEN CHANNEL GATES

1. Product technical data sheet (valve torque shall be provided for electric/pneumatic actuator operated valve)
2. General outline dimensional drawings.
3. Cross sectional drawing showing constructional details with part list with their quantity and MOC confirming to relevant standards.
4. QAP of the product.

Additional Documents for ELECTRIC ACTUATOR OPERATED VALVES

1. Actuator data sheet (shall include opening & closing time and actuator torque selection with required safety factor over valve torque).
2. GA and wiring drawing of electric actuator.
3. Valve torque calculations.
4. Product catalogue.

EXPANSION BELLOWS

1. Product technical data sheet.
2. GA Drawings.
3. QAP of the product.

PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.)

1. Bill of materials.
2. QAP of the product.

MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL

1. Product technical data sheet.
2. Preliminary outline dimensional drawings.

3. Requirement of Girders/ISMB including minimum required size with all calculations.
4. Wiring diagram of panel.
5. QAP of the product.

MANUAL TYPE COARSE SCREENS

1. Product technical data sheet.
2. GA drawing.
3. Hydraulic calculation for head drop across screen for design/peak flow @ 50% clogging.
4. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
5. Recommended cable schedule (as applicable).
6. QAP of the product.

CHLORINATION SYSTEM, CHLORINE SCRUBBER / LEAK MITIGATION SYSTEM

1. P and ID of chlorination system.
2. Bill of materials.
3. Product technical data sheet and dimensional drawing of various components of system.
4. Lay out drawing of installation.
5. GAD/Recommended installation drawing of chlorination system.
6. GAD of chlorine tonner.
7. GAD/Recommended installation drawing of chlorine scrubber (as applicable).
8. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
9. QAP of the product.

PROCESS EQUIPMENT-GRAVITY SETTLING TANKS

(GRIT/DETRITOR MECHANISM, PRIMARY CLARIFIER, SECONDARY CLARIFIER, CLARI-FLOCCULATOR, REACTOR CLARIFIER, SLUDGE THICKENER etc.)

1. Product technical data sheet.
2. GA drawing.
3. Recommended Civil GA drawing.
4. QAP of the product.

AIR/GAS BLOWERS (ANY TYPE) and COMPRESSORS

1. Product technical data sheet.
2. GA and cross section drawing.
3. Performance curves.
4. Acoustic hood details (if applicable).
5. Actual flow calculation at design ambient, relative humidity and site altitude.
6. GAD, wiring and schematic diagram with BOM for control panel (if forming part of blower supply/part of blower skid).
7. Soft starter/VFD sizing ~~and selection after de-rating~~ (if forming part of blower supply/part of blower skid).
8. QAP of the product.

AGITATOR/MIXER

1. Product technical data sheet.
2. GA drawing.
3. Installation/Layout drawing (as applicable).
4. QAP of the product.

SLUDGE DEWATERING EQUIPMENT (CENTRIFUGE/BELT FILTER PRESS)

1. Product technical data sheet.
2. GA drawing.
3. Recommended Civil GA drawing.
4. Recommended P and ID of dewatering system.
5. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
6. QAP of the product.

Note: The data sheet and GAD as specified for equipment/item shall also be considered to include coupled items like electrical drives/motor including its performance curves, electric actuators including its wiring diagram, pneumatic actuators etc. as applicable.

❖ INSPECTION AND TESTING

Inspection of offered equipment/items at manufacturers' works' shall be done by the Client/PMC/TPI representatives as specified here in / as per approved inspection plan. Inspection shall be carried out as per relevant and applicable inspection and testing standards viz IS/BS/API etc. and as per approved quality assurance plans, technical data sheets, documents and drawings.

Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:

The Manufacturers'/OEM/Vendors' shall provide all instrument and equipment required to carry out applicable tests. The instruments shall be calibrated and certified by an approved independent testing authority preferably NABL accredited with valid calibration certificates as on date of inspection.

The inspection category and brief description of tests to be carried out for various equipment is as follows.

➤ PUMP AND PUMP-MOTOR SET (CENTRIFUGAL/POSITIVE DISPLACEMENT/ PROGRESSIVE CAVITY (SCREW)/RECIPROCATING (DOSING), ETC.)

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.
- Unless otherwise stated in data sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MECHANICAL BALANCING

- Major rotating components of the pumps like impellers, shaft, shaft sleeve etc. shall be individually statically as well as dynamically balanced preferably at rated speed.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various pumps components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

VISUAL INSPECTION

- Entire lot as per tender/BOQ shall be offered for visual inspection. The pumps shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

Pump shall be tested for its full operating flow and head range.

Test shall be carried out for rated discharge and maximum discharge. Each pump shall be tested at its rated speed with preferably with **JOB** or shop motor of required rating and speed for its entire working range.

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

PERFORMANCE WITNESS

1. CENTRIFUGAL PUMPS – ANY TYPE (HSCF/VT /SCF/ HNC-VNC / SUBMERSIBLE/ POLDER/ MONO BLOCK/MONO SUBMERSIBLE ETC.)

Pump (Based On Drive Motor Rating)	Pump Performance Test to be Witnessed/Reviewed for each duty and type preferably with JOB MOTOR (Also see notes below)
Up to 30kW motors	Visual/Performance test witnessing not required. Vendor to submit internal test certificates for review, approval and dispatch clearance as per note given below prior to dispatch.
> 30kW up to 160 kW motors	25% quantity or minimum 1 No. whichever is higher per duty/type.
> 160kW	50% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Notes: (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender. Hydrostatic test certificate, dimensional check certificates etc. as per approved QAPs and data sheet, of each pump for review, record and dispatch clearance prior to dispatch of pumps.</p> <p>(2) Vendor shall provide certified parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance test witnessing.</p> <p>(3) HSCF/VT/HNC-VNC Pumps with drive motor ratings > 45kW to < 160 kW, ONE JOB motor of each type and rating, out of the project (tender) lot, shall be sent to the pump manufacturers' works for performance testing of pump-motor assembly set. In case of testing of pump(s) with job motor(s), witnessing of inspection test of motors @ motor manufacturers' works shall stand waived and if pump(s) are to be performance tested with shop motor(s), inspection tests of motors shall be witnessed by the Client/PMC/TPI @ manufacturers' works as specified in technical specifications of electrical works.</p>	

2. SCREW PUMPS

Pump (Based On Drive Motor Rating)	Pump Performance Test to be Witnessed/Reviewed for each duty and type (Also see Note below)
Up to 5.5kW motors	Visual/Performance test witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given below prior to dispatch.
> 5.5 kW motors	25% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Notes: (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender, hydrostatic test certificate and dimensional check certificates etc. as per approved QAP and data sheet of each pump for review, record and dispatch clearance prior to dispatch of material.</p> <p>(2) Vendor shall provide parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance test witnessing.</p>	

3. DOSING PUMPS

Pump (Based On Drive Motor Rating)	Pump Performance Test to be Witnessed/Reviewed for each duty and type (Also see notes below)
Up to 5.5kW motors	Visual/Performance test witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given below prior to dispatch.
> 5.5 kW motors	25% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Notes: (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender, hydrostatic</p>	

test certificate and dimensional check certificates etc. as per approved QAP and data sheet of each pump for review, record and dispatch clearance prior to dispatch of material.

(2) Vendor shall provide parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance testing witnessing.

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

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on the body and seat (with water) of valves at required test pressure depending on PN ratings/design pressure rating(s) of valves for minimum duration of 2 minutes or as specified in applicable testing standards.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components of valves shall be furnished for PMC/Client's review and approval as stated in the data sheets.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The valves shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

- Valves shall be tested for operation as per applicable standards.
- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

PERFORMANCE WITNESS

Size of Valves	Performance Test to be Witnessed/Reviewed for each size/ rating and type (Also see note below)
Up to 300mm diameter	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> 300mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
Note: Manufacturer shall test all the valves internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of valve type for review, record and dispatch clearance prior to dispatch of materials.	

➤ OPEN CHANNEL GATE

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components viz. frame, side guides, shutter, rubber seals and spindle etc. shall be furnished for PMC/Client's review and approval as stated in the data sheets.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

OTHER TESTS

- **Movement Test**
Movement test shall be conducted in assembled condition using stems and headstock. The gate should be operated once from full close to full open and back to full close condition with a maximum force of 135 Newton-meter on the crank or hand wheel.
- **Seat Clearance Check**
With the gate in closed condition, 0.1mm thick feeler gauge should not pass through the sealing faces.
- **PMI Test**
Positive Material Identification (PMI) test to be conducted for seating/sealing faces, rubber seal retainer bar and stem/spindle during inspection.
- **DFT Measurement**
DFT of paint is to be measured with paint thickness measurement gauge during the inspection.
- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

PERFORMANCE WITNESS

Size/Area of Open Channel Gate (Shutter)	Performance Test to be Witnessed/Reviewed for each size, type and class of Sluice Gate (Also see note below)
Up to 1m ² area	Visual/Performance witnessing is not required. Vendor to submit internal test certificates for review/approval and dispatch clearance as per note given below prior to dispatch.
> 1 m ² area	10% quantity or minimum 1 number whichever is higher per size of gate/shutter.
Note: Manufacturer shall test all the gates internally and shall provide their internal test records as specified above along with material test certificates for all major parts as per tender, clearance check test, leakage test, movement test, dimensional check certificates, actuator internal test records for gates etc. as per approved QAP and data sheets of open channel gate for review, record and dispatch clearance prior to dispatch of materials.	

➤ SLUICE GATE

MATERIAL TEST CERTIFICATES

- Material test certificates for all important components of gates such as thimble, frame, shutter, seat facings, spindle and rubber seals etc. to be furnished at the time of inspection.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

OTHER TESTS

- **Movement Test**
Movement test shall be conducted in horizontal/vertical assembled condition using stems and headstock. The gate should be operated once from full close to full open and back to full close condition with a maximum force of 135 Newton-meter on the crank or hand wheel.
- **Shop Leakage Test**
Shop leakage test by applying unseating hydraulic pressure will be conducted with gate mounted vertically on a test bench. A hydrostatic pressure equal to maximum seating/ unseating head shall be applied to gate at centerline of gate opening from the back, i.e. unseating face of the gate in closed position, through pump. A suitable scaled calibrated pressure gauge put on the unseating face of the

gate shall indicate reading equal to unseating pressure head. Water leakage through the gate under above condition shall be collected in a collection pan and measured.

The leakage so measured should not exceed the limit of 2.5, 3.5 and 4.5 LPM per meter sealing perimeter for class I, class II and class III sluice gates as stated in the IS: 13349 (1992).

No alternate testing arrangement will be permitted in place of above method. Gates can be applied with a coat of primer to prevent rusting due to water exposure during testing.

- **Hydrostatic Body Test**

After the leakage test, hydrostatic body test will be conducted by applying hydrostatic pressure equal to 1.5 times the maximum operating head on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.

- **Torque Testing at Operating Head**

Torque test at operating head would be conducted at applicable head at manufacturer's shop for gates up to 2000mm x 2000mm size.

- **Seat Clearance Check**

With the gate in closed condition, 0.1mm thick feeler gauge should not pass through between seat facings.

- **PMI Test**

Positive Material Identification (PMI) test to be conducted for sealing/seating faces, rubber seal retainer bar (if applicable) and stem/spindle during the inspection.

- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

PERFORMANCE WITNESS

Size, Class and Type of Sluice Gate	Performance Test to be Witnessed/Reviewed for each size, type and class of Sluice Gate (Also see Note below)
Up to 1000mm dia./square (up to 1 m ² area)	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given Below prior to dispatch.
> 1000 mm diameter/square (> 1 m ² area)	10% quantity or minimum 1 number whichever is higher per size/class and type.
Note: Manufacturer shall test all the sluice gates internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, clearance check test, leakage test, movement test, dimensional check certificates, actuator internal test records for gates etc. as per approved QAP and data sheet of sluice gate for review, record and dispatch clearance prior to dispatch of material.	

➤ EXPANSION BELLOWS

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on bellows at required test pressure depending on PN ratings/design pressure rating(s) of bellows for minimum duration of 15 minutes or as specified in applicable testing standards.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components of bellows shall be furnished for PMC/Client's review and approval as stated in the data sheets.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The bellows shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

- Bellows shall be tested for axial expansion and compression test as per applicable standards.
- Dye penetration test (DPT) shall be carried out for weld joints on expansion bellows exceeding size of 1 meter (NB Dia.) selected randomly from entire project (tender) lot.

PERFORMANCE WITNESS

Size of Expansion Bellows	Performance Test to be Witnessed/Reviewed for each size/rating and type (Also see note below)
Up to 500mm diameter	Visual/Performance test witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> 500mm diameter	10% quantity or minimum 1 number whichever is higher per size/rating and type for hydro test and rest shall be review of internal documents.
Note: Manufacturer shall test all the expansion bellows internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of expansion bellows for review, record and dispatch clearance prior to dispatch of materials.	

➤ PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.) AND CI/DI FITTINGS

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions.
- Mass/Weight check and thickness check shall be carried out as per approved QAPs and applicable standards.

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on pipes at random at required test pressure for minimum specified duration in applicable testing standards.
- All other tests shall be carried out as per applicable standards.

PERFORMANCE WITNESS

Size, Class and Type of Pipes and Fittings	Performance test to be Witnessed/Reviewed for each size/class and type of pipe and fittings (Also see notes below)
Up to 300mm diameter	Performance witnessing is not required.
> 300mm diameter and Up to 900mm diameter	10 % quantity or minimum 1 number whichever is higher per type size/class/length and type.
> 900mm diameter	25% quantity to be witnessed.
Notes: 1) Manufacturer shall test all the pipes & fittings internally and shall provide their internal test records for hydrostatic test along with material test certificates, mass/weight check statement, dimensional check certificates etc. as per BOM and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials.	

- 2) For pipes **above 300mm dia. and up to 900mm dia.** size, if the total quantity required for entire pumping system/project is **less than 250meters**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC.
- 3) For pipes **above 900mm dia.** size, if the total quantity required for entire pumping system/project is **less than 150meters**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC.
- 4) For all fittings of all sizes if the total weight of total quantity required for entire pumping system/project is less than **750kg**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/PMC.
- 5) For all fittings of all sizes if the total weight of total quantity required for entire pumping system/project **exceeds 750kg**, performance tests shall be witnessed as per governing standards and approved QAPs and other relevant documents and tender specifications.

➤ **MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL**

MATERIAL TEST CERTIFICATES

- Material tests certificates for all important components of the equipment hook, wire rope, brakes etc. to be furnished at the time of inspection.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

OTHER TESTS

- All motorized material handling equipment shall be tested for overload tests at 125% of the rated load.
- All manual chain pulley blocks/HOT etc. shall be tested for overload tests at 150% of the rated load.
- Speed of lifting, long and cross travel as well as and deflection check shall be conducted as per governing standards.

PERFORMANCE WITNESS

Type & Capacity of Material Handling Equipment	Performance Test to be Witnessed/Reviewed for each type and capacity
(Electric/Manual) CPB/HOIST/HOT-Monorail/ Chain Hoist – Any capacity	Visual/Performance witnessing is not required. Manufacturer shall test all the CPB/Hoist, HOT/EOT (up to 3 MT) internally and shall provide their internal test records along with material test certificates for all major parts as per tender, dimensional check certificates etc. as per approved QAP and data sheet of CPB/Hoist, HOT/EOT (up to 3 MT) for review, record and dispatch clearance prior to dispatch of materials.
EOT/HOT Crane - Up to 3MT	
EOT/HOT Crane > 3MT	10% Quantity or Minimum 1 No. whichever is higher per size (capacity) and type shall be witnessed at manufacturers' works for performance test as per approved QAP and data sheet.

- **CHLORINATION SYSTEM, CHLORINE SCRUBBER/LEAK MITIGATION SYSTEM**
Visual/Performance witnessing is not required.

The complete chlorination system shall be offered for inspection and testing after installation at site.

- **PROCESS EQUIPMENT-GRAVITY SETTLING TANKS**

(GRIT/DETRITOR MECHANISM, PRIMARY CLARIFIER, SECONDARY CLARIFIER, CLARI-FLOCCULATOR, REACTOR CLARIFIER, SLUDGE THICKENER etc.)

Visual/Performance witnessing is not required.

Manufacturer shall carry out internal inspection for the offered equipment and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance prior to dispatch of materials.

➤ **AIR AND GAS BLOWERS–ROOTS TYPE (TWIN/TRI-LOBE), SCREW TYPE, HYBRID BLOWERS**

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted at 2 times the maximum working pressure of the blower.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

STRIP TEST

- A standard strip test shall be conducted on minimum 1 number of blower and the clearance shall be within the limits including applicable tolerances as per standards.
- Manufacturer shall provide internal test certificates of strip test for review and acceptance by PMC and Client.

MECHANICAL BALANCING

- Major rotating components of the blower shall be individually statically as well as dynamically balanced preferably at rated speed as per governing and applicable standards.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

MECHANICAL BALANCING

- Major rotating components of the blower shall be individually statically as well as dynamically balanced preferably at rated speed as per governing and applicable standards.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

VISUAL INSPECTION

- Entire lot as per tender/BOQ shall be offered for visual inspection. The blowers shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

Blower shall be performance tested as per BS 1571/applicable standards.

PERFORMANCE WITNESS

Blower Rating (Based On Drive Motor Rating)	Performance Test to be Witnessed/Reviewed for each duty and type preferably with JOB MOTOR (Also see note below)
Up to 30kW motors	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given below prior to dispatch.

> 30kW and Up to 160kW motors	10% quantity or minimum 1 No. whichever is higher per duty/type.
> 160kW	25% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Note: 1) Manufacturer shall test all the blowers internally and shall provide their internal test records along with material test certificates for all major parts as per tender, hydrostatic test certificate, dimensional check certificates, dynamic balancing etc. as per approved QAP and data sheet of each blower for review, record and dispatch clearance prior to dispatch of materials.</p> <p>2) Blowers with drive motor ratings $\geq 45\text{kW}$, ONE JOB motor of each rating, out of the project (tender) lot, shall be sent to the blower manufacturers' works for performance testing of blower. In case of testing of blower(s) with job motor(s), witnessing of inspection test of motors @ motor manufacturers' works shall stand waived and if blower(s) are to be performance tested with shop motor(s), inspection tests of motors shall be witnessed by the Client/PMC/TPI @ manufacturers' works as specified in technical specifications of electrical works.</p>	

➤ BLOWERS

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components viz. impeller, scroll, main frame, shaft, bearings etc. shall be furnished for PMC/Client's review and approval as stated in the data sheet.

ELECTRICAL EQUIPMENT

- TC for dielectric test of motor and control / starter panel and other electrical accessories/components shall be submitted for review and acceptance by the Client/PMC.

VISUAL INSPECTION

- Entire lot as per tender/BOQ shall be offered for visual inspection.
- Dimensions, sheet and paint thickness and BOM shall be verified by the Client/PMC/TPI.

PERFORMANCE TESTING

Turbo blowers shall be performance tested as per governing standards at manufacturers' works.

PERFORMANCE WITNESS

Blower Rating	Performance Test to be Witnessed/Reviewed for each duty and type (Also see note below)
For All Ratings	25% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Note: 1) Manufacturer shall test all the blowers internally and shall provide their internal test records along with material test certificates for all major parts, dimensional check certificates, dynamic balancing etc. as per approved QAP, data sheet and drawings of each blower for review, record and dispatch clearance prior to dispatch of materials.</p> <p>2) Blower to be subjected to functional testing (on no-load condition) and which is to be witnessed shall be selected randomly by Client/PMC/TPI.</p>	

➤ AGITATOR/MIXER

Visual/Performance witnessing is not required.

Manufacturer shall carry out internal inspection for the offered equipment and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance prior to dispatch of materials.

➤ SLUDGE DEWATERING DEVICE/EQUIPMENT (CENTRIFUGUE/BELT FILTER PRESS)

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

ELECTRICAL EQUIPMENT

- TCs for motor and control panel etc. shall be submitted for review and acceptance by the Client/PMC.

VISUAL INSPECTION

- Entire lot as per tender/BOQ shall be offered for visual inspection.
- Dimensions, paint thickness and BOM etc. shall be verified by the Client/PMC/TPI.

PERFORMANCE TESTING

Equipment shall be performance tested as per governing standards at manufacturers' works.

PERFORMANCE WITNESS

CENTRIFUGUE/BELT FILTER PRESS	Performance/Functional Test to be Witnessed/Reviewed for each duty and type (Also see note below)
Entire Lot	10% quantity or minimum 1 No. whichever is higher per duty/type.
<p>Note: 1) Manufacturer shall test equipment internally and shall provide their internal test records along with material test certificates for all major parts, dimensional check certificates etc. as per approved QAP, data sheet and drawings of each equipment for review, record and dispatch clearance prior to dispatch of materials.</p> <p>2) Equipment (Centrifuge/BFP) is to be provided for functional test (on no-load condition) to be witnessed by Client/PMC/TPI (the equipment to be witnessed shall be selected randomly by Client/PMC/TPI).</p>	

IMPORTED PROCESS OR OTHER EQUIPMENT

Imported equipment like

- AIR/GAS BLOWERS,
- PUMPS ETC. AS APPLICABLE

For all process or other major equipment specified above or such other which are imported (bought from outside India), Contractor shall arrange to inspect such equipment by reputed third party inspection agency eg SGS/Bureau Veritas/TUV as per approved quality assurance and inspection plans at manufacturers' works without any extra cost. The test/performance certificates and relevant supporting documents shall be submitted to Client/PMC/TPI for review and approval. The imported equipment/materials shall be dispatched only after obtaining dispatch clearance from Client.

NOTES:

For all major equipment/items specified above, where factory inspections are exempted as clearly specified above, all tests as per relevant and applicable standards as well as approved QAPs, data sheets, documents and drawings must be carried out by the manufacturers'/vendors etc. and test certificates, MTCs etc. shall be submitted to the PMC/TPI prior to dispatch for getting dispatch clearance of the Client/PMC/TPI.

All other items not explicitly mentioned here but are in the scope of the tender (project) are exempted from performance tests @ manufacturers' works' to be witnessed by Client/PMC/TPI. However all tests as per applicable governing standards should be carried out by the manufacturers' and such test reports along with MTCs, dimensional verification certificates (if and as applicable) shall be submitted to the Client/PMC/TPI for review and acceptance for getting get dispatch clearance.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

The Client or his authorized representative may visit the works during manufacture of various mechanical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials

are used for the same. He shall be given full assistance to carry out stage inspection. Client's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the mechanical system/equipment before it is being put into service. All test equipment and instruments shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, final selection will be done with the approval of Engineer in charge.

APPROVED VENDOR LIST FOR MECHANICAL EQUIPMENT

ITEM DESCRIPTION	APPROVED MAKE
Centrifugal / Centrifugal Non-Clog Pumps (For Dry Pit Installation)	Beacon Weir / Jyoti / Kirloskar / KSB / Wilo / Worthington (WPIL) / Grundfoss / Xylem
All Accessories and Equipment / Fixtures/ Instruments / Machinery related to Floating Intake well (Including Metallic Pontoon jetty, Flexible Corrugated Pipes, HSCF pump set, Floaters etc. all allied equipment's)	GWSSB Approved Vendor List from GWSSB web site
Vertical Turbine (V.T.) Pumps	Kirloskar / Mather & Platt (Wilo) / Worthington (WPIL) / Xylem
Submersible Centrifugal / Centrifugal Non-clog Pumps (For Wet Pit Installation)	Aqua / Kirloskar / Kishor / KSB / ABS / Xylem / Grundfoss / Wilo / Ebara
Submersible Centrifugal / Centrifugal Non-clog Pumps (For Dry Pit Installation)	Aqua / Ebara / KSB / Xylem / Grundfoss / Wilo
Drain / Dewatering / De-silting Pumps (Submersible / Horizontal)	Aqua / Kirloskar / Kishor / KSB / ABS / Xylem / Grundfoss / Wilo / Jasco / Lubi / MBH / Pullen
Valves (Sluice Valves /Butterfly Valve/Non-Return Valves (Single / Multi door) / Dual Plate Check Valves /Butterfly Valves / Air Valves)	Kirloskar / R&D Multiple / GM Engineering
Zero Velocity Valve	Flownix / IVC / IVI / L&T / Jash / Vag Valves
Knife Gate Valve	Jash / Fouress / Hi-Tech / Vass (Dezurick) / Vag / Orbinox
Ball Valves	Audco / BDK-Weir / Intervolve / Kirloskar / Saunders / Mevada (Saturn) / Hi-Tech / Virgo / Hawa Engineers / GM Engineering
PP / uPVC Valves (Ball, NRV, Gate, etc.)	GF-GEORG Fischer / Dinesh Plastic / UNP / Astral / Parth
Expansion Bellows	Dhruv / Precision / Technoflex / Precise Engg. / Flexican Bellows & Hoses / Flexpert Bellows / Sur Industries (Surflex) / Athulya Bellows / Stanfab Engineering
Sluice Gates / Open Channel Gates	Jash / IVC / IVI/ Apollo Screens
Electric Actuator	Auma / Rotork / Emerson
HOT / EOT Crane and Pulley block / Grit Removal Mechanism with Grab Bucket	Morris / Indef / Safex / W.H. Brady / Anker / Japs / Apollo Screens
Gear Boxes – For Process and such equipment (Not applicable for valves, gates, etc.)	Elecon / CPEC / Premium Transmission (PTPL) / Bonfiglioli / Radicon (PBL) / Shanthi Gears
D.I. Pipes	Electro Steel / Kejriwal / Lanco / Jindal / Electrotherm / Srikalahasthi / Welspun
D.I. Double Flanged (DI DF) Pipes & Fittings.	Electro Steel / Kejriwal / Lanco / Jindal / Electrotherm / Srikalahasthi / Kiswok / Truform / Chandranchal // Welspun (DI pipe for DI DF Pipe manufacturing shall be as per approved make of DI Pipes only)

C.I. Pipes & fittings.	Electro Steel / Kejriwal / Upadhaya Valves / NJMW / Eskay (Howrah) / Oriental Castings / BIC
HDPE Pipes	Astral / Dutron / Duraline / Narmada / RIL (PIL) / Penwalt / Anjney / Jain Irrigation / Sangir/ Supreme / Prince / Ashirvad / Balson
PVC / uPVC / CPVC Pipes	Astral / Supreme / Prince / Dutron / Finolex / Jain Irrigation / Vectus Industries / Ashirvad / Caption Pipes / Balson
MS / GI Plates & Sheets	Arcelor Mittal / Tata / Jindal / SAIL / Asian
M.S. / C.S. / G.I. Pipes	Jindal / Tata / Welspun / Asian / SAIL / Any reputed Manufacturer with approved make of MS/GI plates & sheets
Bearing for all rotary equipment	SKF / FAG / NBC / NTN / Timken
Mechanical Seal	Eagle Burgmann / Flow serve / Aesseal / Chesterton / Flexaseal / John Crane / Durametallic
Air Conditioner	Blue Star / Carrier / Daikin / Hitachi / LG / O-General / Samsung / Voltas / Mitsubishi
Paint	Asian Paints / Shalimar / Berger / Dulux / Deep Seal
Chlorination System (Chlorinator, Chlorine Scrubber, etc.)	AllDOS (Grundfos) / Banaco / Capital Controls (DeNora) / Chlorotech / Metito / Supreme Technologies (Evoqua / CIT) / Toshcon Jesco
Chlorine Flow Control Valve / system (Pneumatic type)	Capital Control / Chlorinators inc. & regal systems intl. inc.– USA / Emerson / Forbes Marshall Arca / Samson / ABB / SPX valves & controls (Dezurik) / Mil Controls
Chlorine Scrubber - Air Blower (Centrifugal Fan type) – PP / FRP	Supreme Plastic, Nu Fibro Tech, BS Projects (BSF), Patels Airflow (PAF), Bhagwati Engineering
Chlorine Scrubber - PP Pump	Leak proof / Propeller / BEW-Bhagwati / ALFA Pumps / Engineer Combine / ANTICO
Chlorine Container	ISGEC / Anup / PESO approved Vendor
Chlorine Emergency Kit	Saviour (Sure Safety) / Joseph Leslie / Draeger / Anmol Safety Products / Chlorotech / Toshcon Jesco
Self-Breathing Apparatus	Saviour (Sure Safety) / Joseph Leslie / Draeger / Scott (3M) / MSA Safety / Honeywell
Air Compressor	Ingersoll-Rand / Khosla / Kirloskar / Chicago Pneumatic / Atlas Copco
Agitator / Mixer	Remi / Schurtek / Fibre & Fibre / Milton Roy / Jash (Shivpad) / Ceecon / Triveni / Positive Metering Pumps, Rathi Vessels & Systems / All vendors of Process Equipment - Gravity Settling Tanks / Apollo Screens
Process Equipment - Gravity Settling Tanks: Grit (Detritor) Mechanism (Conventional), Primary Clarifier / Secondary Clarifier, Sludge Thickener / Clariflocculator / Reactor Clarifier	Eimco-KCP / HDO / Jash (Shivpad) / Triveni / Voltas / Geo Miller / Ovivo/ Apollo Screens
Screw (Progressive Cavity) Pumps	Roto / Netzsch / Tushaco / Seepex / UT Pumps / Positive Metering / Hydro Prokav Pumps
Metering / Dosing Pumps	Swellore / V.K. Pumps / Shapotoools / Milton Roy / S.R. Metering / Positive Metering Pumps / ProMinent
Centrifuge	Humboldt / Alpha Laval / Hiller / Gea Westfalia / Flottweg
Air Blower - Twin Lobe	Kay / Swam / Everest / Usha Compressors / Garden Denver / Aerzen / TMVT / ACME
Weighing Scale	AVERY/ ACME / ATCO / AVON / Mettler-Toledo
Tools	Taparia / Everest / Gedor / Jhalani / Mekaster
Office Furniture	Godrej / HOF / Featherlite / Ikea / Nilkamal

