Sub Section 5 Mechanical Specifications

1 General

For scope of work refer general scope of work section 4

2 MATERIALS & WORKMANSHIP

2.1 INTRODUCTION

This part of the specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor and mention of any specific material or plant does not necessarily imply that such is included in the works. All component parts of the works shall, unless otherwise specified comply with the provisions of this part or be subject to the approval of the Engineer.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance capacities, certified test reports and other significant information shall be furnished by the Contractor.

2.2 COMPLIANCE WITH STANDARDS

Where reference is made in the Specification to the British Standard Specification (hereinafter abbreviated to 'BS') issued by the British Standards Institution of 2, Park Street, London W.I., or to an Indian Standard Specification (IS) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002, American Society for Testing and Materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A or American National Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A or to any other equivalent standard it shall be to the latest revision of that standard at the tender opening date.

The Contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard, including Indian Standard.

All details, materials and equipment supplied and workmanship performed shall comply with these standards. If Contractors offer equipment to other standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.

In the event of conflict between this specification and the codes for equipment, provisions of this specification shall govern.

2.3 MATERIALS - GENERAL

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the specification, shall be carried out.

All submerged moving parts of the SPS & Plant, or shafts spindles, etc. of the submerged moving parts or faces etc. in contact with various chemicals, shall be corrosion resistant materials. All parts in direct

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contact with various chemicals shall be completely resistant to corrosion or abrasion by these chemicals and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

2.4 WORKMANSHIP - GENERAL

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice.

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All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to may be readily installed.

All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load up to the maximum there shall be no vibration due to lack of balance.

All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings.

All materials incorporated in the work shall be most suitable for duty concerned, free from imperfections, selected for long life and minimum maintenance.

All necessary accessories required for satisfactory and safe operation of the SPS and plant shall be supplied by the Contractor unless it is specifically excluded from his scope.

All valves shall be closing on clockwise rotation of the hand wheel. The effort required to close/open under all operating conditions shall be limited to 7 kg. The direction of opening/closing shall be cast on the hand wheel.

All flanges shall be drilled in accordance with requirements of IS: 1538.

All flanges shall be full or spot faced on the backside. The flange thickness is to be uniform throughout.

Flange outside periphery shall be concentric with the bore. Flanges shall be finished smooth on periphery also.

Castings and fabricated materials shall be finished smooth all over.

2.5 WELDING

2.5.1 Design Approval

Welding shall comply with the latest revision of the BS 5135 code. In all welded fabrications, the Contractor shall submit to the Engineer-in-Charge before fabrication commences detailed drawings of fabrication with sizes of weld and weld preparation together with the details of the application codes. The Engineer-in-Charge shall carry out no welding before approval of the details. No alternations shall be made to any previously approved details of weld preparation or size without prior approval of the Engineer-in-Charge.

2.5.2 Qualification of Welders and Procedures

Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871 part 1. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the Engineer does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each weld shall clearly be identified as to its welder marking the welder's code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures, for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Engineer-in-Charge shall disqualify the welder whose work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS 4870 Part 1.

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2.5.3 General Welding Requirements

Inspection and quality of surveillance shall not be limited to the examination of finished welds. All aspects of materials, fabrication procedures and examination procedures shall be subject to the approval of the Engineer-in-Charge. The equipment used shall be suitable for the quality of work specified. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.

Haphazard striking of the electrodes for establishing arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag. The starting tag shall be of the same material or a material compatible with the base metal being welded. In case of any inadvertent strike on place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.

Generally, a stringer bead technique shall be used with a slight oscillation if necessary to avoid slag and to minimize the number of beads needed to fill the joint. However, the width of the deposited pass shall not exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia., welding shall be done whenever possible, by
2 welders working simultaneously along both sides of the pipe.

All joint fit ups shall comply with the tolerances specified on the manufacturing drawings. The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive “suck back” etc. shall be cause for rejection of welds.

Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm.

The leg lengths shall not exceed the specified size by more than 1.5 mm.

All attachments such as lugs, brackets and other non-pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachment shall be dressed smooth and examined by ultrasonic or liquid penetration methods.

All tack welds shall be made using qualified procedure and welders, the number of size of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removal completely or shall be properly prepared
by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouging. Flame gouging may be permitted provided gouged surface are ground at least by 1.0 mm below the deepest indentation.

All weld repairs shall be carried out using the approved welding procedures and welders. Preparation of weld repair shall have the prior approval of the Engineer-in-Charge. Re-welded areas shall be re-examined by the methods specified for the original welds and repair procedures shall be duly qualified by the Engineer-in-Charge.

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2.5.4 Pre-heating and Post - heating Treatment

Pre-heating and post heating treatment shall conform to the relevant application codes. Pre- heating not exceeding 121 Degree Celsius for all carbon steel construction above 25 mm thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre-heating will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS
4870 Part I Table 6 to represent 30% of the long seams and each welder's performance would be
mandatory.

2.5.5 Electrodes

The makes and type of electrodes to be used shall be submitted for approval of the Engineer. All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

2.5.6 Examination/NDT/Radiography

The various stages of examination and types shall be a stipulated in the respective fabrication codes. Radiographic examination shall be carried out as per provision of BS 2600 or BS 2910 : Ultrasonic tests where called for shall be carried out as per provision of BS 3923; magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

2.5.7 Stainless Steel Welding

All wires consumable such as electrodes, fillers wires, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the Engineer. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.

All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperature recommended by electrodes manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven.

The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.

Argon gas with purity 99.5% shall be used for shielding and purging. The gas manufacturers shall certify the purity of gas.
Non destructive examination of these welds shall be carried out to ensure quality of weld.

The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

2.6 CASTINGS

Cast iron shall be of standard grey close - grained quality. The structure of the castings shall be homogenous and free from non-metallic inclusions and other injurious defects. All surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.

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Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer-in-Charge shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Engineer-in-Charge. if the removal of metal for repair should reduce the stress resisting across section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then that casting shall be rejected. Test coupons cast simultaneously with the main casting shall be identified by the Engineer-in-Charge
to check physical, chemical analysis of casting.

Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Castings subject to hydraulic pressure shall be pressure tested to 1 ½ times the rated pressure or, twice the working pressure, whichever is higher and certified copies of test reports shall be forwarded to the Engineer-in-Charge as soon as each test has been completed. Non-destructive tests as directed by the Engineer-in-Charge will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

Unless otherwise specified casting shall be produced to the following standards or equal :

Sr.	Component		Grade
(a)	Grey Iron	:	BS 1452 Grade 220
(b)	Carbon Steel	:	BS 3100 Steel Alloy
(c)	Stainless Steel	:	BS 3100 Steel 316 C16
(d)	Copper & Copper Alloy	:	BS 1400
			Group A Grade LG2
			Group B Grade CT1, AB2
			Group C Grade G1

2.7 FORGINGS

All major stress - bearing forgings shall be made to a standard specification. Forgings shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5%
of the finished thickness of the component, shall be reported to the Engineer giving the details like location, length, width and depth. For the magnetic particle inspection the choice of wet or dry particles shall be at the Contractor's discretion. All forgings shall be demagnetized after test and shall be heat-treated for the relief of residual stresses. The name of the maker and particulars
of the heat treatment proposed for each such forging shall be submitted to the Engineer-in-
Charge. The Engineer-in-Charge or the Inspector may inspect such forgings and identify test coupons to check physical and chemical analysis and witness such tests at the place of manufacture with a representative of the Contractor.

2.8 PIPES AND SPECIALS

All interconnecting piping included in these tender's are of CI and piping within the filter bed is PVC except for potable water supply and chemical

piping. The pipe shall be as per the specifications. Use of tailpiece will be allowed for adjustment of length.

Piping for water supply shall be GI Class 'C'. The piping for chemical dosing shall be HDPE/PVC/PP/SS316, whichever is best suited. The piping includes joints, gasket and supports. The fasteners and washers used shall be of GI.

2.9 VALVES

All the valves shall be hydraulically tested open ended. Valves bodies for all valves shall be tested for either side (except for non return valves, where it will be one side) to one and half times the maximum pressure or twice the working pressure, whichever is higher, for a duration of 10 mts, during which there should not be any leakage.

Sluice valves shall be double-flanged and shall have disks (gates) manufactured in close-grained cast iron or equal material unless otherwise specified. The seats and faces shall be of bronze and rings shall be forced fitted. Sluice valves of nominal dia 300 mm and above shall be provided with gunmetal "shoe" and "channel" arrangement so that the gate shall be guided throughout its travel. Total side clearance between shoe and channel shall be less than 1.5 mm. Valve spindles shall have thrust flange to take up axial thrust.

The spindle shall be of high tensile brass.

The valves shall be suitably designed to protect the disk edge from corrosion and erosion.

Non-return valves on the main pump delivery branches shall possess non-slam characteristics with minimum shock on closing.

Packed glands shall be arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipe. Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing. Sluice valves shall have seat arrangement for ease of maintenance.

Each valve or its operating equipment shall bear an approved nameplate stating its function. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

All gate valves shall have non-rising spindles.

2.10 SUPPORT OF PIPENETWORK AND VALVES

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valves, meters, strainers and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect. All brackets or other forms of support, which can conveniently be
so designed, shall be rigidly built up of steel by riveting or welding in preference to the use of castings. No point of passage of pipes through floor or walls shall be used as a point of support, except with the approval of the Engineer in charge.

2.11 DESIGN LIFE

The works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the

choice of lubricants for possible high and prolonged operating temperatures. The Contractor shall be called upon to demonstrate this for any component part either by service records or evidence of similar equipment already installed elsewhere or relevant type test. Routine maintenance and repair shall as far as possible not requires the services of highly skilled personnel.

The Plant shall be designed to provide easy access to and replacement of component parts, which are subject to wear, without the need to replace whole units. No parts in the contact with water shall have a life from new to replacement or repair of less than five years. Where major dismantling is unavoidable to replace a part, the life of such part shall not be less than ten years.

Design features shall include the protection of plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light temperature and any other cause, which may have a detrimental effect upon the performance, or life of the works.

Plant located outside lockable areas/buildings shall have additional features to prevent unauthorized operation.

2.12 LUBRICATION

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer-in- Charge for approval before incorporation in the Instruction Manuals. In the case of grease lubricated roller type bearings lithium base grease is preferred.

Contractors shall indicate indigenously available equivalent lubricants, with complete duty specification, to enable the Employer to arrange for regular supply.

Where lubrication is effected by means of grease, preference shall be given to a pressure system, which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month and grease systems having shorter periods between greasing should
be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. All grease nipples shall be
of the same size and type for every part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

Where more than one special grease is required, a grease gun for each special type shall be supplied and permanently labeled.

Oil containers shall be supplied complete with oil level indicator of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The levels shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant and they shall be easily dismantled for cleaning. All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.
All lubrication systems shall be designed so as not to cause a fire or pollution hazard and
particular care shall be taken to prevent leakage of lubricants and to avoid

leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential source
of fire.

The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for the commercial operation of the plant for two years after the Taking-over Certificate has been issued.

2.13 NAME PLATES

Each item of the plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate, each of stainless steel. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of plant has been designed to operate, and such diagrams as may be required by the Engineer-in-Charge. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

Details of proposed inscriptions shall be submitted to the Engineer-in-Charge for approval before any labels are manufactured. Such nameplates, rating plates and designations shall be of stainless steel with engraved or stamped lettering items such as valves shall have direction of rotation for closing and opening indicated.

Name plates, rating plates and labels shall be of a non-flame propagating materials, either non-hygroscope or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non-corrosive screws, drive rivets or adhesives shall not be used.

Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background and to internationally recognized standards.

Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

2.14 NUTS, BOLTS, STUDS AND WASHERS

Nuts, bolts, studs and washers for incorporation in the plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined
on the shank and under the head and nut. Bolts shall be of one-piece construction and shall be of
sufficient length so that only one thread shall show through the nut in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

Washers, locking devices and anti-vibrations arrangements shall be provided where necessary and shall be subjected to the approval of the Engineer-in-Charge. Jointing hardware for the entire plant shall be provided with sufficient spares to cater for site losses.

Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts nuts and studs shall be designed so that the

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maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Contractor shall supply all holding down, alignment and leveling bolts complete with anchorage's, nuts, washers and packing required to attach the plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

The material of nut, bolts, studs and washers for wetted/submerged areas shall be of SS:316 and
others shall be of GI (specifically nut bolts of Aerators, bridge, Filter press, gates, screens, CL_2 doser, sludge agitator should be only of S.S. either submerged stage or open in air).

2.15 ALLOWANCE FOR WASTAGE

The Contractor shall supply to the satisfaction of the Engineer-in-Charge reasonable excess quantities to cover wastage of those consumable which will be normally subject to waste during erection, commissioning and setting to work.

2.16 PAINTING - GENERAL

The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the plant at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out if necessary by washing with an approved dewatering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

All protective coatings shall be suitable for use in warm humid climates.

2.17 PAINTING AT PLACE OF MANUFACTURER

All stages in painting including cleaning and surface treatment in the manufacturer's works shall be available for inspection.

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting.

A primer coat of a zinc rich epoxy resin based coating with at least at 75 microns dry film thickness is to be provided. In addition the parts are to be provided with adequate number coats
or coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.

2.18 PAINTING AT SITE

Immediately on arrival at the site, all items of plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

Steel and cast iron parts received at site shall be provided with adequate number of further coats
of coal tar epoxy polyamine coating to a total dry film thickness of 275 microns

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including the primer coats. All sharp edges, nuts, bolts and other items difficult to be painted shall receive a brush coat of specified paint before application of each coat of epoxy based coal tar paint giving
a total dry film thickness of at least 275 microns. In the case of fabricated steelwork this work shall be done after assembly.

Before painting is commenced the Contractor shall submit for the approval of the Engineer-in-Charge, full details of the paints he proposes to use together with colour charts for the gloss finishes. All paint and coating thickness shall be measured by approved Elcometer or coating thickness gauge.

2.19 LIST OF STANDARDS

The titles of various standards referred to in the Specification are indicated hereunder for ready reference. This list does not necessarily covers all the Standards referred to :

Standard No		Title
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 te (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 se
IS 1537	-	Vertically cast iron pressure pipes for water, gas and sewage
IS 1538	-	Specification for cast iron fittings for pressure pipes for water, 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 sw gear and control gear
IS 3109	-	Short link chain, Grade M (4)
IS 3177	-	Code of practice for electric overhead traveling cranes and g cranes other than steel work cranes.
IS 3618	-	Phosphate treatment for iron and steelfor protection agains corrosion
IS 3624	-	Vacuum and Pressure gauges
IS 3815	-	Point hooks with shank for general engineering purposes
IS 3938	-	Electric wire rope hoists
IS 4029	-	Guide for testing three phase induction motors
IS 4460	-	Method for rating of machine cut spur and helical gears
IS 4691	-	Degrees of protection provided by enclosure for rotating elect machinery
IS 6005	-	Code of practice for phosphating of iron and steel
IS 8329	-	Centrifugally cast (spun) ductile iron pressure pipes for water, gas sewage
IS 11592	-	Code of practice for selection and design of belt conveyors
IS 13349	-	Cast Iron Single faced thimble mounted sluice gates
BS 436	-	Spur and helical gears
BS 466	-	Specification for power driven overhead traveling crane, semi-Gol and Goliath cranes for general use

BS 545	-	Specification for bevel gears (machine cut)
BS 721	-	Specification for worm gearing
BS 970	-	Wrought steels for mechanical and allied engineering purposes
BS 1397	-	Specification for industrial safety belts, harnesses and safety
BS 1400	-	Specification for copper alloy ingots and copper alloy and l conductivity copper castings
BS 1452	-	Specification for flake graphite cast iron
BS 1663	-	Specification for higher tensile steel chain Grade 40 (Short link pitched or calibrated) for lifting purposes.
BS 2573	-	Specification for classification, stress calculations and desig mechanisms

Standard No		Title
BS 2600	-	Radiographic examination of fusion welded butt joints in steel
BS 2903	-	Specification for higher tensile steel hooks for chains, slings, blo and general engineering purposes
BS 2910	-	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 3017	-	Specification for mild steel forged ram 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. Part - I : Welding of Steel
BS 4871	-	Specification for approval testing of welders working to appro welding procedures Part - I : Fusion Welding of Steel
BS 4942	-	Short chain link for lifting purposes
BS 5135	-	Specification for arc welding of carbon and carbon manganese ste
BS 5316	-	Specification for acceptance tests Part - 2 for centrifugal, mixed f and axial pumps- Test for performance and efficiency
BS 6072	-	Method for magnetic particle flaw detection
BS 6405	-	Specification for non-calibrated short link steel chain (Grade 30) 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 wel for high temperature service
ASTM A-276	-	Specification for stainless steel and heat resisting steel bars shapes
ASTM A-351	-	Specification for castings, Austenitic - Ferritic (Duplex), for Press Containing Parts
ASTM A-743	-	Specification for casting, Iron - Chromium, Iron - Chromium-Nick Nickel Base corrosion Resistant for General Application
ASTM A-744	-	Specification for casting, Iron Chromium - Nickel, Corros Resistant
ASTM B-148	-	Specification for Aluminum - Bronze Castings
IEC – 189	-	Low frequency cables and wires with Parts 1 & 2 PVC insulation PVC sheath
AWWA C 501	-	Casting Iron Sluice Gates

3 MECHANICAL EQUIPMENT

3.1 GENERAL

The contract includes design, manufacture, testing at works, supply and delivery at site, unloading, storing till the time of erection, installation, testing and commissioning of mechanical equipment as mentioned in the following sections. The scope of the work shall include but not be limited to the following:

The mechanical equipment consists of gates, screens, raw sewage pumps, screens, grit removal system, air blowers, diffusers, sludge pumps, etc. The equipment should be selected to suit the performance requirements and the prevailing site conditions. The mechanical equipment includes electrical motor, wherever applicable and shall meet the requirements as specified under electrical specifications. The requirements of various mechanical equipments for SPS and STP are described hereunder.

3.2 MECHANICAL EQUIPMENTS

3.2.1 Manual Coarse Screen

Lift able trash screen shall be rectangular in shape.

The screen shall be fabricated out of stainless steel flats and all fasteners shall be of stainless steel.

The rectangular trash screen shall comprise 10 mm thick and 50 mm wide in section with 40-mm clear space between two flats.

The screen shall be lift able with guide channel arrangement.

The trash screen provided for the Sewage Pumping Stations shall move vertically up or down in guide channels that are securely fixed to the sidewalls of the inlet chamber by means of suitably sized and spaced rag bolts of approved material. Each screen shall have two lifting hooks, spaced sufficiently apart from the centre at the top of the screen frame. An electric hoist of approved design and quality for lifting each screen will also be provided. The side of the screen shall have replaceable wear shoes of gunmetal.

Stainless steel roller shall be provided on the screen frame, two on each side, to enable the screen to move smoothly in the guide channels. The framework shall be provided only on the downstream side of the screens.

3.2.2 Mechanical Deep Screens

3.2.2.1 Purpose and Scope

Mechanized screens should be suitable for installation in Sewage pumping stations for removal of floating wastes coming along with sewage. These screens should be capable to screen out most of the medium and large floating material such as plastic bags, floating debris, weeds, paper wastes, clothes and rags etc. which are generally clogging the impellers of the pumps installed downstream of the screens.

The operation of the screen shall be automatic. An ultrasonic type differential level controller shall be provided to sense the head loss through the bar and give the signal to the traveling aking

mechanism to start its operation.

The sensor will signal the raking mechanism to operate continuously till the head loss is reduced to a preset level.

A complete electrical control system shall be supplied with each screen and shall be mounted independently near to the screen installation. The system shall provide for total automatic operation of the screen with the feed back from the level controller.

3.2.2.2 General Material and Equipment Requirement

a. Fabrication and design features:
   - Use power grinder to dull and produce smooth edges
   - Use bolted field connections. Field welding will not be allowed
   - Design all components for continuous 24 hours per day service.

b. The screen shall be so constructed so as to mechanically remove the waste from the bottom most portion of the bar portion using a traveling type raking mechanism without shutting the water flow through the screen. The raking mechanism shall then travel up to the top of operating platform and automatically discharge the waste through a discharge chute.

c. The screen shall have very sensitive protection against overload conditions, which might damage the equipment.

d. All screens shall be constructed and shipped as an integrated product comprising of frame structure and guides, rake and rake arm mechanism, dead plates, cog wheels, sprockets and chains, discharge chute, drive unit and cover apron.

e. The screen shall be supplied factory assembled and duly tested at manufacturer's works before dispatch. This integrated and factory assembled screen shall involve minimum dismantling and assembly at site for erection.

f. Upon receipt at site these shall be installed resting on the channel floor and mechanically or chemically anchored to the parallel sidewalls of the channel (without making grooves in concrete or breaking open the concrete side walls and thereby weakening the civil structure) in a way that there are minimum chances of misalignment.

g. All parts shall be designed to withstand the stresses that will be imposed upon them during handling, shipping, erection and operation.

h. All stainless steel fabricated materials will be pickled and passivated before dispatch to remove ferrous contamination, if any.

3.2.2.3 SPECIFICATIONS

3.2.2.4 Material of construction

All parts of screen including fixed bars, raking mechanism, screen frame and guide rails, dead plate and discharge chute shall be constructed from stainless steel material SS 304 for long life in aggressive sewage environment. Suitable measures should be taken to ensure long life of parts like bearing, chains, sprocket and cogwheels etc. which are not made from stainless steel material.

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Eligibility criteria for manufacture of the screen:

Only such screen manufacture will be considered as eligible who have manufactured and supplied at least two (2) nos., of similar screen to sewage pumping stations having a capacity of minimum 20 MLD during past two (2) years.

As screens are required in stainless steel material to withstand the corrosive and aggressive sewage environment hence the screen manufacturer is expected to follow the best manufacturing practice mentioned here under to further eliminate the possibility of corrosion of screen in such a corrosive atmosphere:

The screens should be manufactured in a stainless steel clean area i.e. in a plant where no ferrous material is cut or welded or handled. This is required for ensuring that no ferrous contamination
/ pick up takes place while screen manufacturing since the stainless steel surfaces subjected to ferrous pick up gets corroded.

Further to this the manufacturer of screen must have the facility for pickling and passivation to remove any ferrous contamination that might have taken place during manufacturing / handling / movement of raw and fabricated material.

3.2.2.5 Drawings & Documents

Drawings for the following shall be submitted for approval before taking up manufacturing of screens:

- General Arrangement drawing of screens with pre-requirement of civil structures
- Bill of Material (BOM) & Wiring diagram of control panels
- Quality Assurance Plan

All drawings shall be submitted in 3 copies of which one will be returned duly commented / approved.

Approval of manufacturer's drawings shall not relieve the manufacturer of his responsibility for supplying equipment confirming to the Technical Specification laid herein for any mistakes, errors or omissions in his drawings.

3.2.2.6 Screen Construction:

The bars shall be designed to have a tear drop profile so that they are wider on the upstream side and narrower on the downstream side. This is required to ensure that choking of bars due to stones and other hard material does not take place. The tear drop profile shall be 10mm wide in the front and 8 mm wide at the back and the depth of bars should be at least 40mm.

The bar rack shall be firmly anchored to the channel floor and supported by a dead plate at the top.

The face of bars towards the incoming water should be half round (dia 10 mm) to ensure minimum resistance to the flow and avoid turbulence and also to offer guide and support to the rake during its travel.

The rake shall be made of Ultra High Molecular Weight Poly Ethylene (UHMWPE) of 20 mm thickness so as to avoid the Galling between rake and bars. Further to this the rake should be provided with rounded off cavity to match the bars with a view to avoid sharp corner contact between the rake and bars thereby

minimizing wear and tear.

The rake arm shall ride on a cogwheel / roller in a single guide channel (min. thickness 5 mm in stainless steel) on each side of the rake and will be lifted away from the dead plate on the downward travel direction. Upon reaching the bottom of its travel the rake would be rotated / swung into the bar screen to remove the collected debris.

To effectively remove the debris from the bottom most part of the bar screen, the rake should engage with the bars from the start of its inwards rotating motion.

The rake arrangement shall be precisely spring loaded to ensure that the rake is always pushed on
to the dead plate.

The dead plate shall be minimum 3 mm thick in stainless steel shall be suitably braced to ensure rigidity and prevent caving / bending due to increased water flow in monsoon. It shall be so designed that during power failure or under maintenance period manual screening shall be made possible.

The sprocket for screen chains shall have chilled tooth bearing surfaces and the chain and sprocket shall be of the same material.

The cogwheel and chains should be so located that these generally remain out of the flow of water during normal plant operation. An exception to this would be allowed only in case when water depth is greater than 2 m.

The screen should have integrated scraper for discharging the screenings to discharge chute. The scraper / wiper shall be cushioned during travel to the rest position by a shock absorber.

The rake mechanism should be operated by an Electro brake motor and be suitable for automatic operation controlled by a level sensor and electric control cabinet. Torque switch should be provided to protect the screen from damages resulting from excessive torque.

The screen shall be provided with non-corrosive apron and enclosure at the top above the platform.

After fabrication and assembly the stainless steel parts and all welded joints are to be further cleaned by acid pickling and after than they should be passivated to remove any ferrous contamination that might have taken place during manufacturing / handling / movement of raw and fabricated material.

3.2.2.7 Level Controller

The level controller shall be of ultrasonic differential type.

3.2.2.8 Electrical motor

The motor shall be of TEFC type with IP 55 protection and suitable for operation on 415V $\pm$ 10% and frequency of 50 Hz $\pm$ 5%.

3.2.2.9 Control Panel

The control panel shall have IP 65 protection, painted with epoxy paint and shall be comprising of

- Mushroom head emergency stop.
- Electronic overload relays for motor protection / reset switch.

- Circuitry to operate the screen with ultrasonic level sensor.
- Selector switches to operate the screen in Auto, of and JOG mode.
- Provision to run the screen on timer in case of failure of level sensor.
- Phase sequence motor.

3.2.2.10 Shop Testing

The screen should be completely manufactured and offered for inspection at the plant of the manufacture confirming the above mentioned eligibility criteria. A screen assembled by a vendor and offered for inspection at the plant of a vendor/ sub contractor shall not be accepted. The screen shall be subjected to following tests at manufacturer's premises for third party inspection with TMC representative(s):

Dimensional Check: The overall dimension of the screen shall be conforming to the approved drawings.

Operational Test: The complete screen including its carriage, rake, drive system and brake motor shall be mechanically operated and tested to verify interference free movement and satisfactory operation.

3.2.3 Belt Conveyor

A common belt conveyor shall be provided for collecting screenings from mechanized fine screens and manual screen. The length of the combined belt conveyor will be as per requirement
of screen channel. The conveyor will drop the screening through chute in a wheeled trolley of approximate 0.5m3 capacity. This trolley will be housed in a roofed enclosure with proper access.

Belt conveyor assembly shall consist of two pulleys with their shaft and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys shall have three roll twenty-degree troughing idlers. The bottom level idlers for belt return shall be flat roll -type.

At the end of the belt drive, an adjustable scrapper shall be provided on the screening hopper for diverting the screening through chute to the wheeled trolley.

The belt material shall be two - ply nylon or equivalent with 3 mm neoprene covering on carrying side and 0.75 mm neoprene covering on pulley side. The speed of the belt will be between 25m to 30 m per minutes. The width of the belt shall be minimum 600 mm. The power transmission shall be by means of TEFC motor coupled to the reduction gears. The gears shall have service factor of not less than 2.25.

The whole conveyor shall be supported on steel structure over the screen channel.

3.2.4 Submersible Pumps

3.2.4.1 General

(a) The total head capacity curve shall be continuously rising towards the shut off with the highest at shut off.

(b) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistance.

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(c) The pumps shall be designed to handle solid sizes of up to 100 mm for handling raw sewage and sludge.

(d) Pumps shall run smooth without undue noise and vibration.

(e) The pump set shall be suitable for starting with discharge valve open and/or closed.

(f) The pump set shall be capable of withstanding the accidental rotation in reverse direction.

3.2.4.2 Features of Construction

(a) Pump shall be centrifugal, vertical spindle, non-clog, wear resisting, single stage type.

(b) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow free passage of solids. The volute tongue shall be filed to a smooth rounded edge.

(c) Double Mechanical seals shall be provided to protect the motor from ingress of sewage along the shaft. The preliminary and secondary seals shall be oil-lubricated with tungsten carbide or silicon-carbide faces and they shall be equipped with an electrical monitoring system for seal failure detection.

(d) Impeller shall be non-clog enclosed type with smooth blunt edges and large water ways so as to allow free passage of the large size solids. It shall be free from sharp comers and projections likely to catch and hold rags and stringy materials. The number of impeller vanes for pumps up to 1000 m3/hr shall be limited to two and shall be limited to three for the pumps higher than 1000 m3/hr.

(e) The critical speed of the rotor shall be at least 30% above the operating speed.

(f) Pump sets shall have double bearings. The bearing life shall be minimum 40,000 hrs of operation.

(g) Each pump shall be complete with a cast iron delivery connection arrangement for fixing to the concrete floor of the suction well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails / rope from access level. It shall be provided with all necessary fixings for guiding the pumps during lifting/lowering.

(h) The pump delivery size shall not be less than 200 mm.

(i) Each pump shall be provided with an automatic coupling device for attaching the chain pulley block hook to the pump at low level, even whilst the pump is submerged, without the need for personnel to enter the well. This automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with necessary accessories. All links and cables shall be multi-stranded stainless steel.

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j) The materials of construction for submersible pumps shall be as follows:

Sr. No.	Component	Material
i)	Impeller*	Stainless steel: ASTM A 743 CF8M
ii)	Casing*	Cast Iron to IS : 210 Gr. FG 200 with 1.5 to 2% Nickel
iii)	Shaft*	Stainless Steel: BS : 970Gr. 316
iv)	Bush	Bronze IS 318 Gr. L TB2..
v)	Guide rail pipe	Stainless Steel: BS : 970 Gr. 304
vi)	Fastens and Foundation Bolts	Stainless Steel : BS : 970 Gr. 316

* Material test certificates shall be furnished by the Contractor

3.2.4.3 Induction Motor (Submersible Pump)

Performance and Characteristics

(a) The submersible motor shall conform to IS: 9283: 1979 and the submersible cable shall conform to clause no. 4.4 of the IS: 9283: 1979.

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

(i) Variation of supply voltage from rated motor voltage : ± 10%
(ii) Variation of supply frequency from rated frequency : ± 5%
(iii) Combined voltage and frequency variation : ± 10%

(c) The starting current of motor shall not exceed 200% of rated full load current for star/delta starting and 600% of rated full load current for DOL starting, under any circumstances.

(d) Motors shall be suitable for full voltage direct-on-line starting or star-delta starting.

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

(f) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified.

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

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

(i) Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard, IS: 9283-1979.

(j) The enclosure for motor shall be IP-68.

(k) Protection against increase in stator winding temperature (150°C) bearing temperature, leakage in stator housing and terminal box shall be provided.

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Minimum three number thermistors in series are to be provided to sense the stator winding temperature. Sensors are to be provided to detect if leakage of sewage into the oil housing is above 30% concentration.

(l) Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

(m) The power rating of the motor shall be larger of the following:

(i) 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 48.5 Hz.

(ii) Maximum Power input while operating single pump corresponding to the speed of 50 Hz. .

3.2.4.4 Submersible Cable

(a) The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5 core flat type. The size of the conductor shal1 be adequate for continuous use under water and air. The half core shal1 be used for earthing.

(b) The control cable shall be PVC insulated PVC sheathed, flexible, flat type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor (Thermistors) shall be 3 core x 2.5 sq. mm copper conductors and for bimetallic thermal switch 2 core x 2.5 sq. mm copper conductor shall be provided.

(c) In case a joint is required to be made between the lead cable supplied with the motor and the user's cable connectors, a detailed procedure of cable jointing to make a watertight joint shall be provided by the manufacturer.

(d) The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

3.2.4.5 Earthing

(a) Earthing of the motor shall be done in accordance with the relevant provisions of 18:3043: 1966.

(b) For the purpose of earthing these motors, earthing connection may be made to discharge pipe.

3.2.4.6 Insulation

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

(b) The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropicalising treatment shall be as per the applicable standard.

(c) The stator winding shall be made from high conductivity

annealed copper conductor. PVC insulated winding wires conforming to IS: 8783: 1978 for wet
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.

3.2.4.7 Temperature Rise

The temperature-rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall not exceed
35°C. During the test, the temperature of the cooling water may not exceed 35°C. As the cable resistance will also be substantial, it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

3.2.4.8 Constructional Features

The motor shall be suitable for continuous use in fully or partially submerged condition. A built in cooling system must allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not, by providing either external or internal cooling arrangement.

3.2.4.9 Terminal Box

Terminal box shall be of weather proof construction to eliminate entry of water and suspended matter. The terminals shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearance.

3.2.5 Cast Iron Sluice Gates

The construction of cast iron sluice gate shall be in accordance with the specifications mentioned hereunder and as per IS: 13349-1992. The sluice gate shall be capable of performing the duties set out in this specification without undue wear or deterioration. They shall be constructed, so that maintenance is kept to a minimum. The sluice gate shall be rising spindle type.

3.2.5.1 DETAILS OF CAST IRON SINGLE FACE THIMBLE MOUNTED SLUICE GATE

1.	Applicable standard	:	IS: 13349-1992
2.	Shape of water way	:	Square / Rectangular / Circular
3.	Size (W x H) in mm	:	mm x mm
4.	Operating head from surface of water to center line of gate in meters	:	meters
5.	Design head in meters	:	
	Seating head	:	meters
	Unseating head	:	meters
6.	Distance between center-line of water way to base	:	meters

	of operating platform		
7.	Method of operation	:	Manually geared operated.
8.	Length and shape of wall thimble	:	As per site requirement
9.	Stem	:	Rising type
10.	Type of closure	:	Conventional Closure / Flush Bottom closure
11	Seating face	:	The maximum clearance between the seating surface with the slide in the closed positions hall not exceed 0.10 mm. The seating face should be fitted in dove tailed machined grooves.
12.	Side and Top wedges	:	Separately adjustable type
13.	Shop Testing	:	following shop test at manufacturer site will be conducted as per procedure mentioned hereunder

a Movement Test

Movement test should be conducted in horizontal/vertical assembled condition using stems & headstock. The gate should be operated once from full close to full open and back to full close condition with a max. force of 135 Newton-meter on the crank of hand wheel.

b. Shop leakage test :

Shop leakage test by applying unseating hydraulic pressure will be conducted at manufacturer's shop. A hydrostatic pressure equal to maximum seating/unseating head shall be applied to gate
at center line of gate opening from the back, i.e. Unseating face of the gate in closed position, through pump. The suitable sealed calibrated pressure gauge put on the unseating face of the gate shall indicate constant reading equal to unseating pressure head. The pressure gauge shall
be placed at center line of the gate and should indicate the actual pressure being encountered by
the gate. It will not be allowed to put pressure on any other location like delivery line of pump set, etc.

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 litres per minute 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. Hydrostatic Body test
After the leakage test hydrostatic body test will be conducted as manufacturer's shop A
hydrostatic pressure equal to 1.5 times the maximum operating head should

be applied on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.

Torque test at operating head

Torque test at operating head would be head conducted at applicable head at manufacturer's shop for gates upto 2000 x 2000mm size

Dimensional Check

Important Dimensions shall be checked with reference to approved GA drawing. Seat clearance

check

With the gate in closed condition 0.1 mm thick feeler gauge should not pass through between
seat facings

14. Indicator on C.I. headstock to be provided for gate travel with transparent / galvanized pipe hood and full scale and with additional mechanicals top nut on threaded stem.

15. Indicate number of hand wheel revolutions required to fully open the gate.

16. Wall guide brackets, bearing and coupling with housing shall be provided as per site requirement and/or as per I.S. 13349

17. Gate Make

18. Material Construction

	Part		Material
a.	Gate frame, shutter, wall thimble, headstock, stem guide bracket, wedging device, stop nut, lifting mechanism, pedestal gear house and nuts	:	Cast Iron IS-210 Grade FG-200
b.	Flush bottom seal retainer bar, anchor bolts and buts	:	Stainless Steel AISI-410
c.	Wedge, wedge facings,	:	Naval Brass IS – 291 Grade 1, Grade 2 seating face/seat facings
d.	Flush bottom seal (if Required)	:	EPDM Rubber
e.	Stem Nut & Lift Nut	:	Leaded Tin Bronze IS– 318 Grade LTB-2
f.	All Fasteners & bolts	:	Stainless Steel AISI-304
g.	Stem & stem extension, stem coupling	:	Stainless Steel AISI-410

19. Painting

a. Paint for gate assembly and stem guide brackets : Ordinary Black Bituminous Paint

b. Paint for headstock pillar : Grey Enamel Paint

3.2.6 Knife Gate Valves

Knife gate valves shall be suitable for use at suction and delivery side of pumps. 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. The valve should be bonnet-less and suitable for face to face flange connection in between pipelines. It should be suitable for uni-directional application.

The valve body should be of Cast Iron GR.FG 260. The body shall be designed to withstand 6 bar pressure.

The valve shall be provided with replaceable type flexible seating seats to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seal retainer ring should be designed in a manner so that the flow of the fluid should be away from the sealing perimeter and towards the center of the valve

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.

The valve shall be provided with sufficient ply of stuffing seals in the in built stuffing box to seal the rear opening. The stuffing box should have internal tappers for pushing the seals on to the gate. 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 by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of stuffing seals should be done in installed condition of the valve.

The spindle should be double start threaded and non-rising type for compact and safe operation. The gate movement area should be covered by protection shields. Gate opening indicating arrangement should be provided to find out the extent of gate opening / closing.

Flange drilling suitable to mount between flanges as per IS 1538-1993

Body	:	Cast Iron FG 260 as per IS 2
Knife gate	:	AISI: 304 Gr: ASTM A240
Retainer ring	:	SS: 304 ASTM A351 Gr. CF
Inlet Seal	:	EPDM
Spindle	:	AISI: 410 Gr. ASTM A276
Spindle Nut	:	Cast Iron Gr. FG 200 as per IS 2
Stuffing plate	:	Cast Steel ASTM A216 Gr. WCI
Stuffing seal	:	Synthetic yarn with PTFE
Factory Test:		

Body Test: The valves shall be hydrostatically pressure tested at specified pressure without any visible leakage.

Seat test: The valve shall be hydrostatically pressure tested for seat leakage at 2.8 bars for no visible leakage.

	ZFT-STD-X-CI-F1-M
Body (Housing)	Cast Iron Gr. FG 260 as per IS 210
Flange Drilling	Suitable to mount between DIN PN 10/IS:1538-1993 flanges
Knife gate	Stainless Steel ASTM A 240 AISI:304
Seal Retainer Ring	Cast Stainless Steel ASTM A 351 GR. CF:8
Inlet Seal	EPDM Rubber
Gland Packing	Synthetic Yarn with PTFE
Stuffing Plate	Cast Steel Galvanized
Spindle (Stem)	Stainless Steel ASTM A276 AISI:410
Spindle Nut	Cast Iron
Supporting channels	Mild Steel Painted
Adapter plate	Cast iron / Mild steel painted
Hand Wheel	Cast iron as per IS 210 Grade 260
Fasteners	High Tensile Galvanized
Body test	10 bar (hydro-static)
Seat test	2.8 bar (Hydro-static) generally as per MSS SP-8
Painting Internal	Red Oxide
Painting External	Two coats epoxy paint RAL 5022

3.2.7 Non Return Valves

3.2.7.1 Cast Iron Check Valves

60 mm to 350 mm diameter valves shall be swing check- valves of the lever and spring type, flanged, and shall have cast iron body and renewable bronze seat, bronze hinge, stainless steel hinge shaft. The valve shall conform to IS 5312 and, where any of the requirements specified are not covered therein, to U.S. Federal Specification WW-V-51 D, Type IV, and Class A.

Cast Iron shall conform to ASTM A-126-66 and flanges to ANSI B 16.1. The valves shall be designed for low head loss, shall be adjustable for non-slamming closure and shall be seat-tight. An arrow showing direction of flow shall be prominently cast on body of valve. The water working pressure shall be 10 kg/cm square except that the valve shall have pressure rating same

as the piping where the pipe class is higher. Valves shall be from approved manufacturer only.

3.2.7.2 Pump Check Valves larger than 400 mm Diameter

All check valves larger than 400-mm diameter installed on the pump discharge shall be flanged ductile iron body, cover disc, arm and levers. The seat shall be of renewable bronze ASTM B 148. The disc shall be hinged on a stainless steel shaft. The gate pins shall also be of stainless

steel. The valves shall be designed for a working, pressure of 10kg/cm square. Valve operation shall be of the oil cushioned type such that the valve swing to 90 percent closed immediately upon stoppage of flow and cushioning cylinders shall control the final closure, to prevent mechanical slamming, within an adjustable timing of one to three seconds. The valves shall be from approved manufacturers only.

3.2.8 Common Header

This specification covers the requirements for supplying, jointing and testing at work sites of cast iron pipes and fittings used for rising main as common header.

3.2.8.1 Applicable Codes

The manufacturing, testing, supplying, jointing and testing at work sites of cast iron pipes and fittings shall comply with all currently applicable status, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes standards, Engineer- in- Charge decision shall govern.

Sr.	IS Codes	Description
1	1536	Centrifugally cast (spun) iron pressure pipes for w gas and sewage – specification
2	1538	Cast iron fittings for pressure pipes for water, gas sewage
3	3114	Code of practice for use and laying of Cast iron pipes
4	12820	Dimensional requirements of rubber gasket for mechanical joints and push-on joints for use with c pipes and fittings for carrying water, gas and sewage

3.2.8.2 Marking

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

a) The nominal diameter
b) Class reference c) The IS number
d) Date of manufacture and
e) Manufacturer's name, initials or identification mark.

3.2.8.3 Pipe Jointing

Jointing of CI pipes and fittings shall be done as per the requirements of the following specifications and as per the relevant IS. Before jointing, extraneous material, if any, shall be removed from the inside of the pipe.

Cast Iron pipe of class B of socket & spigot/ Flanged end is recommended for the project wherever required. In general socket & spigot pipe will be used in buried condition whereas flanged end pipes will be used for above ground condition.

Type of jointing for socket & spigot pipes should be tyton push on joints. Tyton Joints:
In jointing Cast iron spigot and socket pipes and fittings with Tyton flexible joints the Contractor shall take into account the manufacturer's recommendations as to the methods and equipment to
be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS:
5382/ IS: 12820, is correctly positioned in Line, before the join is made. The rubber rings and

any recommended lubricant shall be obtained only through the pipe supplier or as otherwise
directed by Engineer.

Permissible deflection at socket & spigot joints wherever necessary to deflect pipe from a straight line shall not exceed the following:

Sr.	Nominal Diameter, mm	Allowable angle of deflection
1	80 to 300	5.0 degree
2	350 to 400	4.0 degree
3	450 to 750	3.0 degree

Flanged Joints:
The gaskets used between flanges of pipes shall be compressed fibre board or natural/synthetic rubber conforming to IS:638, of thickness between 1.5 to 3mm. The fiberboard shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square metre shall be not less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified.

3.2.8.4 Cleaning of Pipe and Fittings

Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by Engineer-in-charge to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions Engineer-in-charge considers that damages may have been caused to the pipeline, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, Contractor shall amend the work and carry out such further tests as are required by Engineer-in-charge.

3.2.8.5 Use and Laying of Cast Iron Pipes

Excavation, backfilling, laying & jointing of pipe should be strictly as per IS: 3114- 1994 (Code of practice for laying of Cast Iron Pipes).

The pipe and fittings shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If a pipe is mishandled either accidentally or due to carelessness during unloading or lowering, it should be thoroughly inspected before laying and shall be rejected if found unsuitable.

3.2.8.6 Hydraulic Testing of Pipe Line

After the pipes and fittings are laid, jointed and the trench partially back filled except at the joints the stretch of pipeline as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the pipeline is provided with concrete thrust block or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until at least two days have elapsed.

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The exposed joints shall be carefully examined and all such joints showing visible leaks shall be rectified until watertight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by Contractor at no extra cost to Engineer-in-charge and the test shall be repeated to the satisfaction of Engineer-in-charge.

Pressure test: The field test pressure to be imposed shall be not less than the greatest of the following

- One and a half times the maximum sustained operating pressure,
- One and a half times the maximum pipeline static pressure, and
- Sum of the maximum static pressure and surge pressure subject to the works test pressure.
- Where the field-test pressure is less than two thirds the works test pressure, the period of test should be increased to at least 24 hours.

Leakage test: A leakage test shall be conducted concurrently with the pressure test. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valve section thereof with in 0.035 N/mm2 of the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

No pipe installation shall be accepted until the leakage is less than the number of cm3/ hr as determined by the formula:

qL = N x D x Sqrt(P)/ 3.3

Where

qL = The allowable leakage in cm3/hr,
N = number of joints in the length of the pipeline, D = Diameter in mm, and
P = The average test pressure during the leakage test in Kgf/ cm

Contractor shall arrange necessary equipment and water to be used for testing at his own cost.
Damage during testing shall be Contractors responsibility and shall be rectified by him at no extra cost to Engineer-in-charge. Water used for testing shall be removed form the pipe and not released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of Engineer-in-charge, the backfilling of trenches shall be done as per specification.

3.2.9 Aluminium Gates

Gates are provided for the control of the flow and for maintenance of the mechanically raked screens, grit removal system and flow division box. The gates and frame shall be of Aluminum. The frame shall be suitable for channel mounting. The gates provided are self-contained type with flush bottom and suitable for channel mounting. The water sealing will be there at two vertical sides and bottom side of gate frame by means of neoprene rubber seal mounted on shutter having forced contact with gate opening. The gates shall be provided with manually operated headstock, which is to be mounted on yoke of the gate frame.

The gate shall be suitable for operation by one person needing effort less than 20 kg. The stem/spindle shall be of SS304. The operating/stem nut shall be of leaded tin bronze as per IS318 grade LTB1 / LTB2. The fasteners and anchor bolts shall be of SS316.

The gates shall be shop tested for smooth operation of complete assembly and the clearance between, which should be within the tolerance limit of the relevant IS.

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3.2.10 Mechanical Fine Screens

General

Mechanically operated Fine Bar Screen completely made of Stainless Steel (SS 304) having
6mm clear spacing between the bars shall be provided in inlet screen channel for screening out fine floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other fine materials from the raw sewage coming from the pumping station / gravity mains.

The screen shall include discharge chute as required to discharge the screenings on the belt conveyor.

The screen shall be factory assembled, tested and shall only be installed at the site avoiding chances of misalignments.

Fine bar screen having 6mm clear spacing between bars and suitable for installation at an inclination of 60 degrees in channel.

Specifications

Material of construction:
The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel for long life in the aggressive sewage environment. No component of the screen assembly shall be made of carbon steel or any other material, which can get corroded in sewage environment.

Screen Construction
The fine bar screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed bars with out engagement of external mechanism / rake mechanism for pulling out the screened material ensuring minimum movement of the mechanism.

The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward and deliver on the up to the discharge chute.

The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow.

The mechanism shall be mechanically operated by hydraulic system and shall be suitable for automatic operation controlled by a level sensor.

The screen shall operate automatically when the upstream water level of the screen increases beyond a pre-set limit and it shall stop at home position when the upstream level decreases to a preset low level due to upward travel of screened material.

The fine bar screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.

The base of the screen shall be fitted with a specially profiled stainless steel plate to direct any grit that may be present towards the screen and taken out along with other screened material thus reducing the possibility of building up of grit in front of the screen.

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Control Panel
The Control Panel shall have IP 55 protection, painted with Epoxy paint and shall be comprising of

- Mushroom Head Emergency stop
- Overload relays for motor protection
- MCB's, HRC Fuses and Glass Fuses
- Circuitry to operate the screen with Ultrasonic type level sensors.
- Selector Switch to operate the screen on JOG mode
- Provision to run the screen with a Timer in case of failure of level sensor. Hydraulic Unit

The Hydraulic Unit shall be comprised of:

- Epoxy painted Oil Tank, Pump, Motor Direction Control Valve and Counter Balance Valve of suitable capacity.
- Filter element and Low oil level indicator shall protect the Hydraulic Pump.
- A Pressure Relief Valve shall control the Hydraulic System.
- The motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415V ± 10% and frequency of 50Hz ± 5%. Testing

The Fine bar screen shall be Factory assembled and subjected to following tests at the
manufacturer's premises.

Dimensional Check: The overall dimensions of the screen shall be conforming to the approved drawings.

Operational Test: The complete screen including its mechanism, hydraulic operating mechanism level probing system and control panel shall be integrated and mechanically operated to verify free movement and satisfactory working.

3.2.10.1 Belt Conveyor

A common belt conveyor shall be provided for collecting screenings from mechanized fine screens and manual screen. The length of the combined belt conveyor will be as per requirement
of screen channel. The conveyor will drop the screening through chute in a wheeled trolley of approximate 0.5 m3 capacity. This trolley will be housed in a roofed enclosure with proper access.

Belt conveyor assembly shall consist of two pulleys with their shaft and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys shall have three roll twenty degree troughing idlers. The bottom level idlers for belt return shall be flat roll -type.

At the end of the belt drive, an adjustable scrapper shall be provided on the screening hopper for diverting the screening through chute to the wheeled trolley.

The belt material shall be two - ply nylon or equivalent with 3 mm neoprene covering on carrying side and 0.75 mm neoprene covering on pulley side. The speed of the belt will be between 25m to 30 m per minutes. The width of the belt shall be minimum 600 mm. The power transmission shall be by means of TEFC motor coupled to the reduction gears. The gears shall have service factor of not less than 2.25 with vertical guides along the belt to prevent material falling dawn.

The whole conveyor shall be supported on steel structure over the screen channel.

3.2.11 Manual Bar Screen

The manually cleaned screen shall consist of bar screen and rake arm. The bar screens shall be fabricated from 50 mm x 10 mm SS 304 flats spaced at clear spacing of 10 mm with structural steel frame work such that all bars project on upstream side and teeth of the rake engages within the clearances of the bars without hindrance. The screen shall be placed at an inclination of 70□. The screen shall be supplied with rake arm with handle of suitable length.

3.2.12 Air Blowers

For specification please refer Volume III A, Scope of work.

3.2.13 Diffusers

For specification please refer Volume III A, Scope of work.

3.2.14 Secondary Clarifier

The Secondary Clarifier Tank shall have central driven clarifier mechanism in MSEP with sewage entry through the central column. The clarifier mechanism shall have fixed half bridge resting on the central column with aluminium chequered plate and G.I. handrails upto the wall.

The clarifier drive will have center mechanism / drive head TEFC motor and speed reducing gearbox. The service factor for the gear will not be less than 2.50. The central drive shall have slewing ring bearing located on the central column. The scrapers ring will be attached to the lower end cage hung and driven by slewing ring drive on the top of the central column. The inlet well shall be hung from the bridge. The MOC of the inlet well shall be FRP. An overload alarm system shall be provided as an overload protection for the drive

The squeezes will be of neoprene rubber. The V-notch weir for the clarifier will be of FRP and fixed to the R.C.C launder with adjustable S.S. fixtures for adjusting the level of the weir to have uniform flow through out the periphery.

All fasteners below the water level will be of SS 316 and the steel structure will be epoxy painted after sand/ball blasting to near white and after applying zinc rich epoxy primer.

3.2.15 Chlorination System

3.2.15.1 Design

The chlorination system will consist of Vacuum type chlorinator. The solution type chlorinator is to be vacuum type separately panel mounted. The chlorination system shall have 15 days storage
of toners for chlorination. The system shall have manual reset visual indicator signals when the chlorine gas supply is exhausted or interrupted. The material of construction of the chlorinator shall be resistant to corrosive action of dry and moist chlorine gas and chlorine solution.

The chlorinator shall be provided for a average flow of 120 MLD with a maximum dose rate of 5mg/litre and achieve a residual chlorine of 0.5 mg/l.

- Each chlorinator shall have the following facilities-
- Manual adjustment of dose rate
- Gas inlet pressure gauge
- Injector vacuum pressure gauge
- Gas filter
- Internal gas inlet pressure reducing valve
- Flexible connectors

- Safety vent

The chlorinator and chlorine cylinder shall be arranged in chlorine house with partition. Doorways to the room shall be shown as outward opening. Suitable storage for empty drums should be provided. The chlorination system will work on 1 working and 1 stand by basis and automatic switch over to standby chlorinator with alarm raising system should be provided.

3.2.15.2 Chlorine Pipe Work

The standard required for the pipes and the fittings shall be as under:

- Pipe work for chlorine gas near the chlorinators shall be of flexible copper pipe.
- Valve shall be of globe type with forged steel body.
- Gland packing shall be of Teflon.
- Pressure gauges of silver diaphragm type.

3.2.15.3 Booster Pump

The Contractor shall supply one centrifugal booster pump for each chlorinator. Water supply will be from the backwash water tank which is to be constructed by contractor at his cost on chlorine house. The pump sets shall be complete with the following units:

- Strainer
- Sluice valve on suction side
- Sluice valve on delivery side
- Reflux valve on delivery side
- Lot GI piping upto the injector
- Pressure gauge on the header

For the post chlorinators the pumps will be so connected that any pump can work with any chlorinator.

3.2.15.4 Safety Equipment

The Contractor shall provide the following safety equipment as a minimum:

- 2 canister type respirators with full face coverage mask suitable for chlorine gaseous atmosphere
- 1 eye wash arrangement/shower & wash basin.
- 25 canisters for respirators
- 2 external wall mounted glass fronted cabinets for the breathing apparatus and for the respirators
- 2 self-contained compressed air-breathing apparatus complete with warning whistle and 2 spare air cylinders.
- Emergency kit for attending chlorine gas leakages (three types)

3.2.15.5 Construction

The conceptual design envisages a structure of chlorine house with cylinder's store. Structure shall be covered with a flat RCC slab. No intermediate column shall be provided in the cylinder store.

One lime pit of sufficient dimension shall be provided adjacent to the cylinder store to enable any leaking cylinder to be immersed in the same easily.

The Contractor shall so layout the units that the minimum handling is involved in picking up the cylinder from the trucks and mounting them on saddles or handling of Cl_2 toner shall be easily/directly done by gantry girder from truck to room and vice-versa.

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3.2.16 Sludge Dewatering System

Sludge Dewatering system consists of centrifuge feed sump with a sludge agitator, polyelectrolyte dosing, centrifuge feed pumps and centrifuge unit. The sludge will be collected in a centrifuge feed sump, which is located at centrifuge shed .Polyelectrolyte will be blended with the sludge in this centrifuge feed sump.

3.2.16.1 Sludge Agitator

The sludge agitator of turbine type mixer driven from overhead motors and gear box each designed to impart turbulent energy into the water shall be installed in RCC tank of M30. The Impeller and Shaft shall be of SS316 construction and coupled to TEFC motor through gear. The service factor for gear will not be less than 2. Impeller speed should be less than 100.

3.2.16.2 Polyelectrolyte Dosing System

HDPE tanks with SS agitators will be provided to prepare and dose polyelectrolyte solution in the sludge sump. Dosing arrangement will be manual. The sludge agitator will also blend the polyelectrolyte with the sludge to form larger flocs and improve dewatering. The impeller and shaft of the agitators are of SS 316. The drive consists of TEFC motor and speed reducing gearbox.

3.2.16.3 Centrifuge feed Pumps

Two units of sludge pumps, with minimum one working unit per centrifuge and one standby unit, of the positive displacement type with a pressure of about 7-8 kg/sq.cm are to be provided.

Pump and motor will be mounted on a common MS fabricated base frame suitably galvanized. The coupling will be flexible coupling. The motor will be TEFC and driven through belt drive.

3.2.16.4 Centrifuge

The centrifuge shall be of continuously operating, solid bowl centrifuge and horizontally mounted. It shall be suitable to handle municipal sludge containing 1% to 4% dry solids to be de-watered upto 20 % minimum and maximum 30% of dry solids per hour. The frame shall be of open design with gravity discharge of the dewatered sludge.

The material of construction at all the parts coming in contact with the liquid shall be in AISI: 316 grade (stainless steel). Construction

(a) Housing:
The housing shall consist of a welded frame with supporting feet, motor bracket, guards and collecting vessel/catcher for the product discharges. Vibration absorbers shall be provided for the machine to supporting feet to prevent most of the vibrations from the machine being transferred to the foundation.

(b) Bowl and conveyor screw:
The decanter shall be equipped with flat angle cone bowl with cylinder and cone. The solids discharge shall have replaceable wear bushings and shall be protected against wear and tear. The conveyor scroll shall be of single threaded design and wear protected.

(c) Drive:
The bowl shall be driven by a V-belt transmission on the shaft at the conical end. Power shall be transferred to the conveyor by a two stage planetary gear box at the opposite end. An overload protection device shall be provided for the gear box.

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(d) Drive motor:
The motor shall conform to IS 325 and shall be of weatherproof, jet proof and tropicalised construction.

The motor shall conform to the following data:

Type of motor	3 phase, 4 pole, 415 V, Squirrel Cage
Type of duty	Continuous (SI) Class of insulation F
Type of enclosure and cooling	TEFC
Degree of protection	IP55
Maximum motor speed protection	1500 rpm Method of starting to suit the duty Motor Thermistor

(e) The material of construction shall be as follows:

Sr. No.	Component	Material
(i)	Bowl	Stainless steel: AISI 316
(ii)	Conveyor	Stainless steel: AISI 316 and wear prote
(iii)	Casing cover	Stainless steel: AISI 316
(iv)	Frame	M.S

3.2.16.5 Filtrate Transfer Pumps

Two units of filtrate transfer pumps with one working and one stand by shall be provided.

The pumps shall be of end suction, horizontal dry-pit type, non-clog, centrifugal type. The volute and impeller will be of cast iron with 1.5% to 2% Nickel. The pump shall be capable of handling solids of not less than 40 mm sphere size. The speed of the pump shall be less than
1,500 rpm.

The pump coupling shall be flexible type and shall be provided with coupling guard. The suction and delivery shall be suitable for flange connection.

The pump shall include base frame, electric motor, coupling, coupling guard, etc. The motor shall be TEFC, 415V, 3-phase AC 50 c/s. The base frame shall be fabricated from structural steel sections suitably galvanized. The motor HP shall be at least 10% more than required at duty point and shall be non-overloading at other points of Q-H curve.

3.2.17 Electrical Operated Trolley (EOT)

It shall be single girder EOT crane with chain electric hoist.

Minimum capacity	2 T
Type of operation	Pendent type
Gantry rail	40 x 40 sq. bar
Power supply	440 V, 3 PH, 50 H

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

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

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

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

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

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

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

Driver motor shall be designed for frequent reversal, breaking and acceleration and shall be as per IS 325. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards, etc. shall be as per IS 3938. Limit switches shall
be provided for over hoisting and over lowering.

3.2.18 Biogas Flaring System

Gas flaring system shall be installed to burn excess biogas generated at the STP. The burning capacity of the flare shall be 200 m^3/hr. The biogas flaring system shall consist of the following equipment.

- Moisture separator
- Flame Arrestor
- Check valve
- Pressure regulating valve
- Flare gas burner (6m height from ground level)
- Pilot gas burner with push button ignition complete with ignition electrode
- Diaphragm type pressure gauge
- Low gas pressure switches.

3.2.18.1 Flare Gas Burner

The Flare Burner for biogas incinerates the biogas completely and releases environment friendly gases after combustion. It thus protects the environment and surrounding equipment.

Complete incineration can be done by having high temperature, tachometric gas mixtures flame. To achieve this aspirator type pre-mixing burner is made for complete combustion.

To start flare burner, spark igniter initiates the pilot burner. The pilot flame is checked with the help of flame monitor (Flame Rod). As soon as the pilot flame is provided a visual indication on the panel will appear than the main biogas control valve can be opened. To prevent blow off at high winds the

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aerodynamically designed windshield is provided.

3.2.18.2 Flare burner

Duty	To flare biogas completely
Capacity	0 - 100 cum/hr
Quantity	1 no.
Type	Aspirator type
Inlet Mounting	Flanged 6" NB as per BS Table 10D. Working pressure 50 mm WC to 500 mm WC

Accessories

SS 316 Wind Shield to prevent blow off at high winds

Provision for fixing of Pilot Burner, HT Electrode and Thermal flame sensor. Material of

Construction

Wind shield	SS 316
Burner	CI Mounting Flange CI
Mounting	Flange mounted vertical position

3.2.18.3 Pilot Burner & accessories

3.2.18.3.1 Pilot Burner

Duty	To ignite the biogas
Type	Premixing type with air aspirations
Material of construction	SS 316
Mounting	Threaded on to Flare Burner

3.2.18.3.2 Ignition System

It consists of SS 316 ignition electrode. The pilot burner will have flame proof solenoid valve.

3.2.18.3.3 Pressure Gauge

Type	Diaphragm type with isolation valve
Range	0-1000 mm WC Type Diaphragm type Dial size 6"
Wetted Parts	SS 304

3.2.18.3.4 Check Valve

Size	6"
Type	Flap type
End flanges	As per SS table 10D Material of Construction
Body	CI
Valve seat	Aluminum/SS/Bronze
Flap	SS 304 / Nylon

3.2.18.4 Gas Flow meter with Indicator and Tantalizer Unit

Flow Indicator / Tantalizer Unit (Electronic Registration)

Flow indicator Tantalizer is used to monitor the flow of gas. Input from venturi type gas flow meter is processed linearly or square rooted to the requirement. Flow rate is indicated on 3½ digit 7 segment LED / LCD display and totalized value of flow on Electromech / LCD / LED counter having reset facility. The general technical specifications are given below:

Power supply	230/110V AC □ 10%, 50 Hz
Operating temperature	0° C to 55° C
Input	220 V AC / 24V DC □ 10%,
Flow rate	--
Display for flow rate	3½ digit 7 segment LED / LCD
Polarity indication	Automatic
Decimal point indication	Factory set to suit range/scale of indicatior Engineering unit selected
Accuracy	Better than □ 0.5% of span
Relay contact rating	1A one changeover at 230V AC resistive
Specifications for totalizing	Totalizing accuracy □ 0.5% of full scale, in Clipping i.e. flow cut-off 0 to 17% of span
Specifications for square	Square rooting accuracy □ 0.5% of full sca

Rooting

Total 2 nos. of gas flow meters of suitable capacity shall be provided for measuring flow rate of biogas at the STP before gas dome and before main line going to DFG station.

Each flow meter shall be provided with electronic gas flow registration unit. These registration units shall be placed in a composite panel at the STP and SPS Panel room. Single phase, 230
Volt AC supply shall be given to the composite panel for gas flow registration units from STP MEP Panel.
Technical Specifications

Type		Microprocessor based Panel mounted Flow
		Indicator/Tantalizer
Input		Analog user configurable to 4-20 mA, 0.5V, and 0-10 V
Display		LED, toggle between rate of gas flow,
		Tantalizer, Peak and Valley
Tantalizer		6 digit confurigable to reset/non-reset options
Rate of Flow		5 digits, configurable to any engineer unit or time base
Alarm/Presets		10A relays configurable to Rate of flow of alarms or p
batching		
Control Output		2 potential free relays, configurable to flow rate alarms or
		Batching
Reset		From front keypad to remote pulse
Programming		User configured zero/span settings for input and output.
Memory		Upto 10 years memory retention in the event of main failure
Transmitter power		24 V DC transmitters supply available from 7000 TR.
Output		4-20 m a, analog output linear to flow

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Power Supply		230 V (10% 50 Hz AC)
Housing		Standard 1/8 D/N ABS panel mounting enclosure

3.2.18.5 Flame Arrestor

Flame arrestor is provided to prevent the passage of flames if formed accidentally in gasholder or associated pipe network. The flame arrestor, a safety device is recommended for use in venting vessels, storage or transport tanks, and protection of fuel / air supply line to gas burners and in industrial plants at temperatures not exceeding above 200^{o}C.

The flame arrestor shall be mounted with the axis vertical and as close as possible to the potential source of ignition. The flame arrestors are provided at the top of each Gas holder. Two nos. flame arrestors are also provided in gas pipeline going to the gas burner and pilot ignition of the gas flare system.

Flame arrestor consists of a tube bank made of spirally wound alternate layers of flat and corrugated stainless steel sheets built around a solid core. The tube offers a multiplicity of small holes parallel to the line of flow. The tube element is retained between two flanged end sections and contained within a steel outer shell. The arrestor assembly shall be fitted with a weather hood. The flame arrestor shall be provided with crimped ribbon design. This enables the unit to
be manufactured to very low tolerances and hence can be efficiently size selected to suit the range of application. Pressure drop across the arrestor shall be very low and the unit shall be suitable to take high gas flow rates.

The flame arrestors are designed as per British Standards BS: 7244-1990 to ensure maximum safety.
The flame arrestors mainly consist of an arrestor element, an arrestor housing and associated fittings necessary for preventing flame de-flag ration.
The flame arrestor has been designed specifically for biogas falling in Group 1 of British Standards. (Classification of gases BS 4663 Part 2 and BS 5501 Part 1).

The flame arrestor element is a crimped metal element and is made up of SS 316 to have long life

and maximum quenching of flame.		
3.2.18.5.1 Technical Specificatior		
Size	:	6” NB line
Element	:	Crimped metal element
End connections	:	Flanged as per BS Table 1
Hydrostatic Test Pressure	:	5.0 kg/cm^2
Gaskets	:	CAF Gaskets
3.2.18.5.2 Material of Constructio		
Housing	:	CI
Flame bank	:	SS 316
Nut & Bolts	:	CS
Flanges	:	CI
3.2.18.5.3 Quantity		
6” for gas holders	:	1 No
6” for pipeline in main gas burner	:	1 No

2" for pipeline to pilot burner	:	1 No

3.2.18.6 Moisture Trap

The moisture trap is device used for separation of moisture/vapours in two-phase flow in order to reduce corrosion, control problems, efficient and safe combustion of biogas.

The biogas has H_2O vapours and traces of H_2S. The gas becomes acidic after H_2O and H_2S combines thus starts corroding the piping and equipment. The presence of this causes a deposition of surfaces and control valves thus affecting that function.

The effect of moisture in biogas burning is to have quenching of flame. Also, latent heat of vaporization is consumed by the vapors during combustion thus reducing the efficiency.

The moisture separation can be done by the following methods.

- Centrifugal action
- Impingement action

In centrifugal action the gas is made to rotate at high velocities. The centrifugal force causes the vapours to hit the wall of the chamber. When the vapours hit the wall they also coalesce together to form biogas droplets. These droplets get accumulated in the reservoir just below the moisture separator chamber.

In impingement action the biogas is made to hit a perforated steel wall at high velocity. Due to inertia the vapours do not accompany the biogas after it hits the wall. The moisture vapours then coalesce together to form big droplets and get accumulated in the reservoir. The water accumulated in the reservoir is taken out through auto or manual drain valve. It is proposed to use impingement type moisture trap.

The material for the moisture separator conforms to IS 2062. An epoxy coating is done after surface preparation by sand blasting. The Drip-trap is tested for a pressure of 3.5 kg/cm^2 for any leakage or joints. Compressed asbestos gaskets are provided for strong leak proof joints.

3.2.18.6.1 Installation and Operation

Moisture traps shall be installed as specified below in quantity and size. Connect the drain line to a drain-pit through suitable pipe.
Observe the drain level in the peeping window and if the drain level is high open the drain valve till all the accumulated water is drained.

3.2.18.7 Type

Impingement baffle type. The impingement of gas on specially designed perforated baffles is used to achieve moisture separation. The baffles shall be to the drip trap tank for easy accent for cleaning.

3.2.18.8 Inlet & Outlet Connections

Flanged 4"/6"/8" NB. The flanges will be as per British Standard Table 'D'. The flange shall have two nos. joint grooves 25 mm apart.

3.2.18.9 Moisture Drain

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1" NB outlet port with auto-drain valve.

Baffles

The baffling arrangement of perforated sheets of SS 304 to remove moisture from the biogas. The baffle will have guides so that moisture will coalesce and the droplets are drained and accumulated in the drip tank.

The baffling arrangement is fitted onto the tank so that it can be removed and cleaned for routine maintenance. The top cover shall be flanged for easy access to internals of drip trap.

Testing

The drip traps shall be pressure-tested up to 3.5 kg/cm^2 with compressed air/hydraulically

Painting

All the parts of the equipment shall be painted with two coats of epoxy primer. The external surface shall be painted with epoxy paint. The paint will be done after proper surface preparation i.e. sand blasting as per out standard practice.

3.2.18.10 Welding Joints

All the parts of the equipment – All welding / joints shall be done as per IS specifications.

Flanges and Gaskets
The flanges will be as per British Standard Table 'D' CAP gaskets of 3 mm thickness.

Quantity and Sizes

For common pipelines coming from each UASB Reactor	4 nos
For main gas pipeline	4 nos
For pipeline going to Gas Flare	1 no.
For pipeline going to DF Gensets	1 no.

3.2.19 Instrumentation

3.2.19.1 Level switches

Level switches shall be provided in the sewage sump. The operation of the raw sewage pump
shall be as per the level of the liquid in the sump. During peak all the working pumps shall be in operation and during lean flow only one pump shall be in operation. The start and stop of the pump shall be automatic.

3.2.19.2 Ultrasonic flow meter

The ultrasonic flow meter shall be provided in the downstream side of the grit channel. It shall have digital type indicator, integrator and recorder fixed in the admin block.

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4 ERECTION, TESTING AND COMMISSIONING

4.1 TESTING - GENERAL

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

All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 2 months prior the test in which they are used. The Engineer-in-Charge reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the Contractor prior to carrying out every test showing the reading obtained calculations and full details of the calibration certificates referred to.

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

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

4.2 INSPECTION AT MANUFACTURER'S PREMISES

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

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

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

At least 15 days notice shall be given to the Engineer before the specified tests are carried out.

No material is to be delivered to site without the above described inspection having been carried out or officially waived in writing by the Engineer-in-Charge.

Third party inspection along with the Engineer in charge wherever necessary shall be arranged by the Contractor at his cost.

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4.3 TESTS AT MANUFACTURER'S PREMISES

4.3.1 Pumps

Hydrostatic testing: All pressure parts of pumps prior to assembly, shall be subjected to hydrostatic tests to the satisfaction of Engineer-in-Charge at 1.5 times the maximum pressure obtained with the delivery valve closed and suction pressure at maximum, or twice the working pressure whichever is higher for a duration of 10 minutes.

Balancing Test: Impeller and pump rotating assembly shall be dynamically balanced.

Performance Test: Each pump shall be tested for full operating range individually to BS: 5316: Part 2. Test shall be carried out for performance at rated speed with minimum NPSH as available at Site.

Pump performance shall be within the tolerance limits specified in BS: 5316: Part 2.

4.3.2 Motors

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

4.3.3 Pipe work

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

4.3.4 Valves

All valves shall be hydrostatically tested close ended. Body, seat/door and back seat-test pressure shall be 15 bar, 10 bar and 6 bar respectively.
Valves shall be tested with associated actuators for general performance.

4.3.5 Hoists

The hoist shall be completely assembled in the Contractor's or sub-Contractor's works and shall be subjected to the tests as specified in IS: 807/IS: 3177. The Contractor shall provide the test weights.
In addition a vertical deflection test shall be carried out with the 'Safe Working Load' suspended from the hook with the crab in the center of the span. The ratio of deflection to span shall not exceed that specified in IS 807. Manufacturer's test certificates for mechanical items shall be furnished.

4.3.6 Electrical Instruments

All electrical instruments shall be tested as specified under electrical specifications.

4.3.7 Other Equipment

Other equipment like mixers, air blowers, agitators, etc. shall be tested at works as per the relevant IS standards and test certificate furnished for approval before dispatch.

4.4 ERECTION - GENERAL

The Contractor's staff shall include at least one competent erection engineer with proven, suitable, previous experience on similar contracts to supervise the erection of the Works and sufficient skilled, semi skilled and unskilled labour to ensure completion of the works in time.

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The Contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the Engineer-in-Charge.

One erection engineer who shall be deemed to be the Contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the Contractor shall inform the Engineer-in-Charge
in writing which erector is designated as his representative and is in charge. Erection engineer is to report progress and planning to the Engineer or his representative, who will have one mobile phone with him.

The Contractor's erection staff shall arrive on the site on date to be agreed by the Engineer-in-Charge. Before they proceed to the Site, however, the Contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-Contractor's) supply has arrived on site so that there will be no delay on this account.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the Engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labour in connection therewith. The checking of setting out of any line or level by the Engineer or Engineer-in-Charge shall not in any way relieve the Contractor of his responsibility for the correctness thereof.
Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other Contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of Plant are to be installed and shall bring any deviations from the required positions, lines or dimensions to the notice of the Engineer. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. unless
otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing plant or buildings or any part thereof, the Contractor shall, at no additional cost to the Employer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer's satisfaction.

During erection of the plant the Engineer will inspect the installation from time to time in the presence of the Contractor's site representative to establish conformity with the requirements of the specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Engineer.

4.5 RECORD, PROCEDURES AND REPORTS

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

All the above mentioned records shall be submitted in the final form duly countersigned by the Engineer-in-Charge attesting conformity to specifications and his approval of installation and duly incorporating all the additions, alternations, and information as required by the Engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding any records submitted earlier with bill of

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supply/progress etc. shall be duly bound and submitted

to the Engineer in six copies by the Contractor on his notification of the mechanical completion of erection.

4.6 COMPLETION OF ERECTION

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

Plant in the scope of the Contractor has been erected installed and grouted as per specifications.

Installation checks are completed and approved by the Engineer.

The erected plant is totally ready for commissioning checks.

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

Upon achieving the Completion as described above, the Contractor shall notify the Engineer by a written notice intimating such mechanical completion of units and notify the Engineer for inspection and acceptance of Mechanical Completion. The Engineer/Engineer-in-Charge shall proceed with the inspection of such units within 14 days of such a notice. Thereafter:

The Engineer shall certify completion when there are no defaults in the works and the plant is acceptable or

The Engineer shall inform the Contractor list of deficiencies for rectification hereinafter referred as Punch List and the Contractor shall complete the rectification work within a jointly agreed period before tests on or approval of the same before proceeding with the Tests on Completion or

The Engineer may inform the Contractor that the Works are acceptable with 'punch' list (Items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre-commissioning checks followed by Tests on Completion when the Contractor undertakes to complete such outstanding works within an agreed time during Defects Liability Period.

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

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

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

The commissioning period as notified by the Contractor shall be deemed to occur beyond the date of completion and shall include all periods of pre-commissioning, trails and Tests on Completion.

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

4.7 SETTING TO WORK

On completion of erection the Contractor shall request the Engineer-in-Charge to carry out the installation inspection.

After the plant has been set to work the Contractor shall continue to operate the Plant for a period of one week.

4.8 INSTALLATION INSPECTION

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

Pumps, piping and valves

The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of joints. Provision of necessary pumps, gauges, blank flanges, tapings etc. for carrying out these tests shall be included
in the Contract.

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

Operating tests shall be conducted on valves.

The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within specified limits.

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

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

Mixers, agitators, air blowers, etc. After erection, these shall be tested for its performance.

Electrical Panels Insulation
Test High Voltage Power Frequency test
Performance Test
Cables Insulation Test Continuity Test
High Voltage Power Frequency Test
Instrumentation

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

4.9 COMMISSIONING

4.9.1 Scope

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

4.9.2 Miscellaneous

Completion checks and commissioning tests on items not covered under above shall be carried out by the Contractor as per the instructions of the Engineer-in-Charge.

4.9.3 Commissioning Date

No item of plant will be certified as commissioned by the Purchaser unless it has successfully passed all the tests called for under the Contract and the following documentation are duly complied and submitted in final formats in duly bound volumes.

A completion of all shop inspection results/reports of the plant/machinery with due attestation that the Plants have been manufactured to specified standards (6 copies)

All erection/construction quality control checks in appropriate approved formats for all installation works with attestation that installation has been carried out as per acceptable/stipulated standards (6 copies).

All “As built drawing” and O & M and Erection manuals. Soft copies of drawings and documents will furnished by the Contractor.

4.10 TENDER DRAWINGS

The following drawing shall be submitted by the bidder with tender:

- G.A. drawing of PS4, PS9, PS10, KPS 1, KPS 2, KPS3 & KPS4.
- Plant Layout with unit sizing
- Sewerage network drawing for Thane city Zone
- Process Flow Sheet with process design/calculations
- Hydraulic Flow Diagram with hydraulic design/calculations
- Process & Instrumentation Diagram
- Single Line Diagram for all Electrical Installations with load calculations
- Instrumentation - Catalogues for all the instruments

4.11 DRAWINGS FOR APPROVAL

The following mechanical drawings shall be submitted for approval:

- Sluice valve

- Knife gate valve
- Non-Return valve
- E.O.T. Crane
- Gates
- Sludge Mixer / Agitators
- Manual and mechanical screen
- Air blowers
- Secondary Clarifier
- Submersible pumps
- Horizontal pumps
- Chlorine dosers

4.12 CONSTRUCTION DOCUMENTS

The Construction Documents are certified Drawings submitted by the Contractor to the Employer or Engineer-in-Charge during the course of the Contract for approval.

The Engineer-in-Charge may require the Contractor to submit for approval additional drawings if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Employer's Requirements and that they are suitable for their intended purpose. These drawings shall form the agreed basis for the execution of the Works. If an approved drawing is revised, revised copies shall be submitted for approval as above and no such revised drawing shall be used for the purposes of the Contract until it has been approved in place of the earlier issue of the drawing.

Approval of drawings by the Engineer-in-Charge shall not be held to relieve the Contractor of his responsibilities under the Contract. Drawings should be got approved from the Dy. Director & Chief Manager and Industrial Safety before starting the site work.

Two nos. of `Approved copies of each drawing will be returned to the Contractor when approval is given if the Contractor so requests.

The Engineer-in-Charge will not permit construction to start on a part or section of the Works unless Construction Documents for that part or section have been approved.

4.13 AS-BUILT DRAWINGS

These drawings shall be complied by the Contractor and shall constitute a permanent record of the Works as executed. These shall include all such drawings, schedules, documentation and calculations as necessary for a complete understanding of the Work design, operation and maintenance.

A3 and smaller sized As-Built Drawings shall be provided on durable paper for reproduction by photocopier. As-Built Drawings larger than A3 shall be provided as a paper copy and also produced in the form of black lines on a durable translucent film from which further paper prints can be taken by others as required. In addition drawings shall be provided as AutoCAD Revision 14 software copy.

Text shall be provided in an industry standard work processing, spreadsheet or database format
as appropriate.

4.14 INFORMATION REQUIRED ON AS-BUILT DRAWINGS

The As- Built Drawings shall consist of the fully up-dated versions of the approved Construction

Documents incorporating any additional information which will assist the Employer in operating

maintaining and if necessary modifying or extending the Works at a later date. These drawings should extend and supplement the information given in Operating and Maintenance Manuals.

4.15 OPERATING AND MAINTENANCE MANUALS

4.15.1 General

The Contractor shall compile operating, maintenance and overhauling instructions for the whole of the Plant. The instructions shall consist of one volume of:
General descriptive text (including drawings for illustration) of the Works described section by section.

Complete operational instructions for the treatment plant. This shall be termed the Operators Manuals. It shall be aimed at the operational staff and shall be written in clear unambiguous text complete with drawings which necessary for clarification of any issues. The manual shall comprehensively detail what to do on a day to day basis and also what to do in the event of fault develop. It shall in addition provide a complete list of the process maintenance tasks the operator should carry out including the intervals between these tasks.

Essential Instructions for mechanical and electrical maintenance of the Plant. These instructions shall be short and concise and set out in consolidated schedule the inspection, lubrication, cleaning and any other type of servicing operations required. The Contractor shall prepare typical maintenance log sheets that the Employer can subsequently use for daily, weekly, monthly or other periodic maintenance and shall form record sheets of plant maintenance operations.

Instructions for use of skilled maintenance personnel in fault location, carrying out routine replacement, withdrawing, dismantling, overhauling, re-assembling and testing the various items of Plant.

Manufacturer's Technical Documentation subdivided into categories for:

- civil
- process
- electrical
- electrical building services
- mechanical building services
- instrumentation and control
- Civil As-Built Drawings
- Comprising the FDS and PLC code
-

Electrical As-Built Drawings: The electrical drawings shall be complete sets including all information necessary for maintenance and spares replacement.

Electrical and mechanical building services As-Built Drawings: The drawings shall be complete sets including all information necessary for maintenance and spare replacement.

FAT records for the Plants and Works

SAT records for the Plants and Works

Each volume shall be subdivided (relating to areas of plant) into sub sections or

sub-volumes in order to ease the location of plant details. Each volume or sub volume shall be provided with a comprehensive index for the volume or sub-volume concerned and the O & M manuals as a whole.

Each volume shall be enclosed within A4 and A3 ring binders having tough grease resistant cover suitable for use on site and designed to permit the easy removal and insertion of the contents. The front cover and spine of each volume shall show details of the project, Employer, Engineer-in-Charge and a volume title.

Text shall generally be enclosed in A4 ring binder except where they accompany A4 text in which case they shall be folded. A1 drawings shall generally be folded and enclose in A4 box files. Where A1 drawings accompany text they shall be folded and enclosed in an A4 plastic wallet, one wallet per drawing.

4.16 SUBMISSION OF DOCUMENTS AND DRAWINGS

Eight (8) copies of each drawing and document shall be submitted by the Contractor to the Engineer-in-Charge for approval. The Engineer-in-Charge will return two (2) approved copies to the Contractor and retain six (6) for the Engineer-in-Charge's office and field use. The contractor, shall also arrange to get the approval on these drawings from the Dy. Director of Industrial Safety and health at his own cost.

The Engineer-in-Charge will signify his approval or disapproval of the Preliminary Phase Drawings within 15 calendar days of submission.

Construction Documents shall be submitted in accordance with the timetable set down in the Program.

The Engineer-in-Charge will signify his approval or disapproval of the Construction Documents within 15 calendar days of submission of each submission.

Draft copies of the O & M Manuals shall be submitted to the Engineer-in-Charge for his approval at least 56 calendar days prior to the commencement of Tests on Completion.
The Engineer-in-Charge will signify his approval or disapproval of the O & M Manuals within 28 calendar days of submission.

Draft As-Built Drawings shall be submitted 30 calendar days prior to the commencement of Tests on Completion.

The Engineer-in-Charge will signify his approval or disapproval of the As-Built Drawings within 15 calendar days of submission.

The Final As-Built Drawings shall be submitted prior to the issue of any taking over Certificate.

To remove doubt the submission dates referred to above shall be the dates on which the drawings and documents are received by the Engineer-in-Charge.

4.17 NOTICE OF OPERATIONS

The Contractor shall give full and complete written notice of all important operations to the Engineer-in-Charge sufficiently in advance to enable the Engineer-in-Charge to make such arrangements as the Engineer-in-Charge may consider necessary for inspection and for any the purpose. The Contractor shall not start any important operation without the written approval of the Engineer-in-Charge.

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5 APPROVED MANUFACTURER/MAKE FOR MAJOR ITEMS

The bidders are to consider the following list of Approved Manufacturer/Make for Mechanical equipment as under:

Component	**Manufacturer/Make**
Sluice Gate	Jash / Yashwant / Oriental / IVC
Mechanical / Manual Screens	Jash Engineering / Huber / Johnson
Belt Conveyors	Voltas / Batliboi / Dynamic
Submersible Sewage Pumps	Kirloskar / KSB Pumps / Kishor Pumps / Grundfos / AE AQUA
Valves/ Knife gate	Kirloskar Brothers / Indian Valve Company / Upadhaya Val / Inter Valve / Jash / Foruss
Cast Iron/ Ductile & GI Pipes ar fittings	Oriental / Electro Steel Castings / BIC / Jindal
Chain Pulley Block	W.H.Brady & Co. / Hercules Hoists / Delta Engineeri Works / Sharp Engineering / SMACO/INDEF.
Mechanical Fine Screens	Jash / Huber / Johnson / Voltas
Mechanical medium Screens	Jash / Huber / Johnson / Triveni
Manual Screens	Voltas / Geomiller / HDO / Batliboi / Triveni
Detritors	Voltas / Geomiller/ HDO / Batliboi / Triveni
Air blowers	Usha / Kay / SWAM / KPT
Secondary Clarifiers	Voltas / Geomiller/ HDO / Batliboi / Triveni
Sludge thickener	Voltas / Geomiller/ HDO / Batliboi / Triveni
Agitators	Voltas / Geomiller/ HDO / Batliboi / Triveni
Diffusers	Grindwell Norton / OTT system / Environmental Dynamics
Chlorination System	Metito / Pennwalt / RR Enterprises / Sumitra
VFD	Allen Bradly / Schneider / ABB / Siemens
Motor (excluding Submersible)	Siemens /ABB / Crompton /Kirloskar
Instruments (Excluding Ultrasonic flow meter)	Fischer Rose Mont / Toshbro / Forbes Marshall / Mikamcl Alfa laval / Manas
Horizontal Pumps	Grundfos / Kirloskar /Johson /Jyoti / Mather & Platt
Knife Gate Valves	Jash / Fouress / Dezurick
Ultrasonic Flow meter	Siemens / Crohne Marshall / Forbes Marshall / Manas
DO measurement	Endress Hauser / Fischer Rosemont / Forbes Marshall / Ha
Hoists EOT	Index / Elephant / Anupam / Speed
Chain Pulley Block Monorail	Hercules / Anupam / Smaco