Maharashtra Industrial Township Limited (MITL)

Design, Construction, Testing, Commissioning, Operation and Maintenance of Infrastructure Works at AURIC - Bidkin Industrial Area (BIA), Sector B & C on EPC Basis

Request for Proposal cum Request for Qualification

Volume II - Technical Specifications

Part F – Standard Mechanical Specifications

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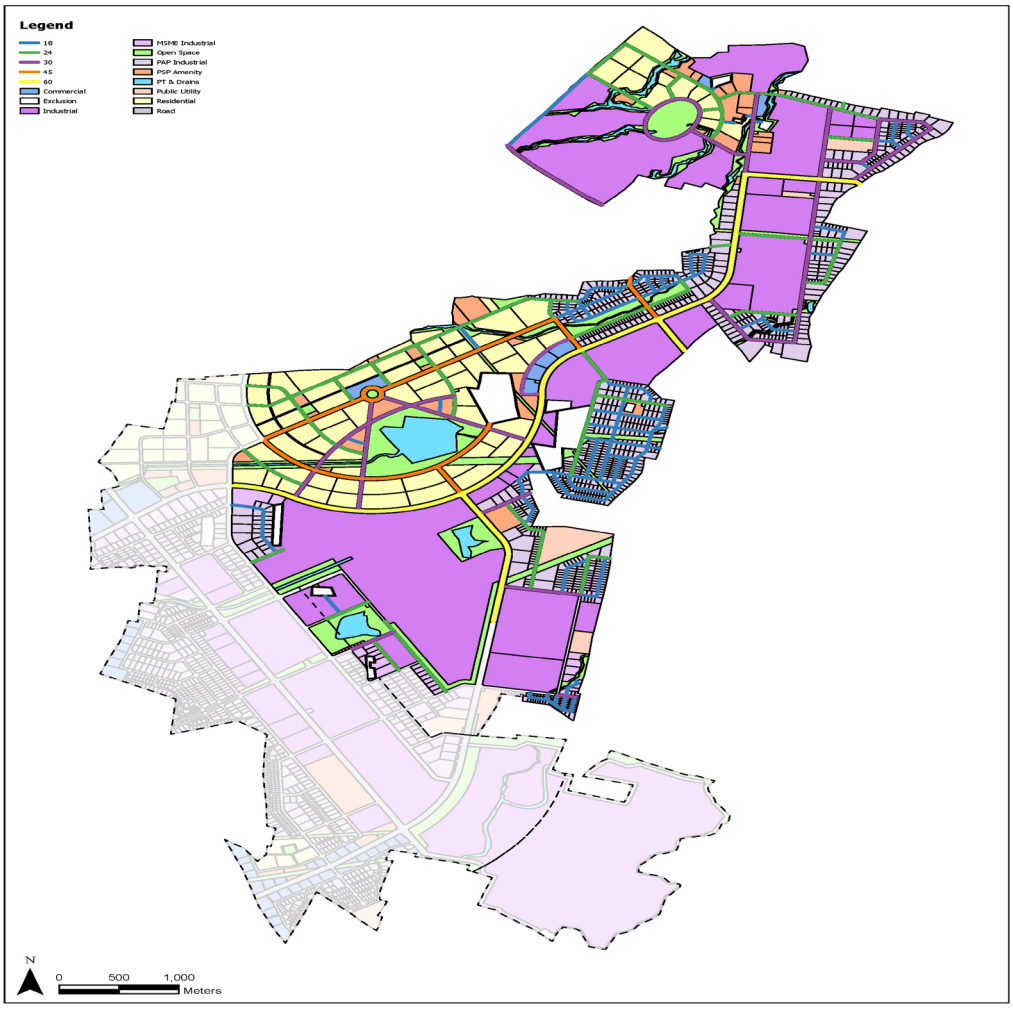


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1 General Information

This specification is intended to cover Engineering, supply and storage at site, erection, testing, commissioning and trial run including operation and maintenance as specified elsewhere of various mechanical plant and equipment as per specification, schedule of items, requirements, terms and conditions and finally as per the direction of the Engineer to make different unit perfectly operative and successful in all respects.

Any plant, equipment or mechanical works which is found to be unsuitable for specific use under the stipulated conditions shall be dismantled and replaced by proper plant, equipment or mechanical works entirely at the cost of the Contractor for successful completion, commissioning and operation of the plant.

The Contractor shall provide all necessary tools and tackles required for erection of works and equipment and instruments for testing and commissioning including all other items necessary for testing and efficient execution of the contract. The Contractor will also provide all labour, supervising and administrative staff along with transport arrangement during erection and commissioning period.

The installation work includes supply of all fittings and fixtures, hardware, consumables and sundry items as required for successful installation and commissioning of the plant.

The scope of work shall not be limited to only supply of items as per schedule but also include all other items not specifically mentioned but required for successful installation and commissioning of the plant/ equipment and to operate properly as per relevant technical specification. The scope will include supply of materials at site in packed and good condition, and any damage is to be rectified or the material to be replaced by the Contractor by new one without any extra cost.

The contractor shall provide and maintain proper secured and covered storage space for storage and protection of tools, materials etc and arrange for trained security personnel for protection of materials and executed works till the time the executed materials and works are handed over to Employer.

All plant and equipment shall be insured against all types of damages, theft etc. during transit, storage, erection and commissioning and insurance coverage will continue till the maintenance period expires and the plant is handed over to the Employer at the cost of the Contractor.

1.1 Materials and Workmanship

1.1.1 General

This specification intends to cover the general standards of materials to be supplied, and the workmanship required to be ensured by the Contractor. All component parts of the works must, unless otherwise specified, comply with the provisions of this part and shall be subject to the Engineer’s approval of Manufacturer’s Quality Assurance Plan (QAP).

1.1.2 Design Standards

The proposed plant and equipment along with their material of construction must conform to the latest revision of relevant IS/ BS/ DIN/ ASTM/ ANSI/ ISO or to any other equivalent standard. The latest edition of all Indian Standard specifications/ other standards till 30 (thirty) days before the final date of submission of the tender, shall be adopted.

The equipment, material of construction and workmanship performed shall comply with these standards. In case any equipment/ item offered to standard other than those mentioned above, the material of construction shall be at least equal to or preferably superior to those specified and details of the superiority shall be furnished.

In the event of any dispute between this specification and the codes of equipment/ item, provisions of this specification shall govern.

1.1.3 Material

Each and every equipment/ item covered in the works shall be most suitable for the duty concerned and shall be new and of reputed make/ approved quality, free from any defect and selected for long life and minimum maintenance. Non-destructive tests, if asked for in this specification, shall be carried out.

Any equipment/ item supplied, if proved to be unsatisfactory after installation, the Engineer shall have all the right to operate/ use the same till the rectification/ replacement is carried out by the Contractor. The rectification/ replacement shall be done without interfering with the overall plant operation as far as possible. Unless otherwise specifically agreed upon in advance the maximum allowable period for the above rectification/ replacement shall not exceed six months.

All submerged moving parts of the plant e.g. shaft, spindle, rotating element, faces etc. and all parts in direct contact with water shall be completely resistant to corrosion and abrasion and shall maintain their properties without ageing due to the passage of time, operating load, environment, heating due to operation or any other cause.

1.1.4 Workmanship

Workmanship and finish in general shall be best of its quality and must be in accordance with latest workshop practice.

Full inter-changeability must be maintained among all components of similar type of equipment/ item. Material of construction of the spares shall be same as it is for original component and shall be interchangeable among similar equipment. Machining limits and fits on renewable parts shall be accurate and to specified tolerances so that replacements can be done easily.

Noise and vibration level shall never exceed the allowable limit for particular equipment. The rotating parts shall be both statically and dynamically balanced so that when running at normal speed at any load upto the maximum, there shall be no vibration beyond permissible limit due to lack of balance.

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

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

Provision of lifting lugs, eye bolts etc. shall be provided to facilitate handling of heavy equipment.

All flanges shall be drilled as per IS:1538.

All flanges shall be full or spot faced at the back and thickness shall be uniform throughout. The periphery of the flange shall be concentric with the bore and finished smooth.

All castings and fabricated items shall be finished smooth all over.

1.2 Equipment Design

All the plant and equipment under this specification must be new and of proper grade and quality suitable for prevailing climatic and working conditions at site. They shall be of sound workmanship, robustly designed for long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period with minimum maintenance. Special care shall be taken for changes in temperature, stability of paint finish for high temperatures, de-rating of machinery, thermal overload services, cooling systems and the choice of lubricants for anticipated high and prolonged operating temperatures. The manufacturer may be called upon to demonstrate this for any component part either by service records or evidence about similar equipment already installed elsewhere or by relevant type test. As far as possible, routine maintenance and repair should not require the services of highly skilled personnel.

The material of construction of the equipment/ item shall be so selected that the economic life of the plant is not less than 15 years taking into account their location and service.

The equipment shall be designed to provide easy access to and replacement of parts which are subject to wear without the need to dismantle/ replace the whole plant. All parts in contact with water shall have a minimum life of 3 years from new to replacement or repair. Where major dismantling is required to replace/ repair a part, the life of such part shall not be less than 10 years.

Design features shall include the protection of plant against any damage caused by vermin, dirt, dust and dampness and to reduce the risk of fire. Plant shall operate without undue noise and vibration, and components shall be designed to withstand the maximum stresses under the most severe condition of normal duty. At site installation the magnitude of peak-to-peak vibration shall be limited to 50 microns, and noise level shall be limited to 85 dBA at a distance of 1.86m. The materials shall be highly resistive to change their properties due to passage of time, climatic condition and service environment or due to any other cause which may have an adverse effect on the smooth and trouble-free performance or life of the equipment.

Outdoor installed plant shall have additional features to prevent unauthorized operation or tampering.

1.3 Testing at Works

1.1.5 General

Tests of the equipment/ item at the manufacturer's works shall be carried out in accordance with the specifications and the Engineer's approved QAP. All inspection, examination and testing shall be performed conforming to relevant Standards. The Engineer shall witness the tests and inspect important plant and equipment as specified in this specification of relevant equipment/ item. In respect to other equipment, the manufacturer shall carry out the tests and test results to be furnished.

The instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 15 days prior the test date in which they will be used. The test results/ certificates shall be furnished to the Inspecting Officer after commencement of the tests. The Engineer reserves the right to impound any instrument immediately after test for independent testing. Manufacturer's test certificates showing the readings obtained, calculations and details of relevant calibration certificates shall be produced prior to every test.

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.

If during or after testing, any equipment/ item fails to achieve the specified duty or otherwise proved to be defective the same shall be modified/ replaced as required, re-tested and reinspected, if required, by the Engineer.

At least 21 days advance notice shall be served to the Engineer for witnessing any test.

No material will be accepted without the above described inspection having been carried out unless officially waived in writing by the Engineer.

The inspection of all Electro-Mechanical items shall be carried out by Third Party Agency (TPA) as desired by the employer. The cost involved for the transportation, boarding and lodging of minimum two

numbers of employer's representatives for such inspection shall be borne by the contractor. In case of engagement of TPA, the fees as well as cost involved for transportation, boarding and lodging of Third Party shall be borne by the employer during inspection.

1.1.6 Test Certificate

Each consignment of plant delivered to site must have been tested at manufacturer's works or at other approved test house in accordance with the relevant IS or approved standard (such tests being referred to herein as Works Tests). The test reports for each such consignment must be furnished to the Engineer before delivery at site.

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

1.4 Welding

General

All welded fabrication shall be done as per the latest revision of BS:5135/ equivalent and the Contractor shall submit the detailed drawings of fabrication showing the sizes of welds, weld preparation together with the details of application codes, electrode specification etc. to the Engineer before the commencement of fabrication for approval. No welding shall be carried out without approval of the Engineer and no alteration shall be made to any approved details of weld preparation or size without prior approval of the authority.

Welding Requirements

Inspection and quality of surveillance shall not be limited to the examination of finished welds. All aspects of materials, fabrication procedures and tests procedures shall be subject to the approval of the Engineer. The equipment used shall be most suitable for the quality of work specified. The method employed shall produce best results and to be tested at site by actual demonstration.

Haphazard striking of electrodes for checking arc are not permitted. The arc shall be struck either on the joint or 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 zone affected should be ground finished and examined by dye penetration test.

Final welds shall be suitable for appropriate fabrication of the non-destructive tests of the weld. While grinding is required, the weld shall be blended into the parent metal without gouging or thinning of the present 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. The specified leg lengths, convexity and concavity shall not exceed 1.5 mm.

The non-pressure parts e.g. lugs, brackets etc. shall also be done by qualified welders in accordance with the design details and material specifications. Temporary attachments shall be removed in such a way that the parent metal is not damaged. The temporary attachment zone shall be dressed smooth and examined by dye penetration test.

All tack welds shall be made as per specified methods and by qualified welders. The quantity and size of tack welds shall be kept as minimum as possible but shall be of adequate strength to maintain joint alignments. All tack welds shall be visually checked and if found defective, the same shall be completely removed. During final run of weld, tack welds shall either be removed completely or shall be properly prepared by grinding/ filling their starting ends so that they may be satisfactorily incorporated in the welds. The defects shall be removed by grinding/ chipping/ gouging.

All welding repairs shall be carried out as per the proper welding methods and by qualified welders. Preparation of weld repair shall have prior approval of the Engineer. Re-welded zones shall be checked as per the procedures followed for original welds and the repair procedures shall be approved by the Engineer.

1.5 Castings

Cast iron used for various equipment shall be of close grained, gray, standard quality. The homogeneous structure shall be free from non-metallic inclusions and other injurious defects. The un-machined surfaces of castings shall be smooth and free from all foundry irregularities.

Minor casting defects in depth not exceeding 12.5% of total wall thickness and which will not in any way affect the strength and service of the casting may be repaired by approved welding techniques with prior intimation to the Engineer. The Engineer shall be notified of large defects and no repair welding of such defects shall be carried out without prior written approval from the Engineer. If the removal of metal for repair reduces the stress-resisting cross-section of the casting by more than 25% or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then the casting shall be rejected. Test pieces cast along with the main casting shall be marked, if specified or otherwise, by the Manufacturer to check the physical and chemical properties of the casting.

Any defect considered to be a major defect by the Engineer is not acceptable. Welding repaired castings for minor defects shall be stress relieved.

All castings subject to hydraulic pressure shall be pressure tested to at least 1.5 times the maximum expected pressure or 2 times the working pressure whichever is higher and certified copies of the test results shall be forwarded to the Engineer for acceptance of the casting. Non-destructive tests as desired by the Engineer would be required for any casting having defects whose extent cannot otherwise be judged, or to determine the soundness of repair welds.

1.6 Forgings

All major stress bearing forgings shall be manufactured to standard specifications. Forgings shall be subjected to either magnetic particle test or dye penetration test at the areas of fillets and change in sections. The testing shall be conducted after proof machining (10 microns). Any defect, which will not be finally machined shall be gouged out fully, inspected either by dye penetration test or by magnetic particle test to ensure that the defect is fully removed and repaired adopting approved repairing procedure.

Any indication, which proves to penetrate deeper than 2.5% of the finished thickness of the component, shall be informed to the Engineer giving all details, e.g. location, length, width and depth. For the magnetic particle inspection the choice of wet or dry particles shall be the manufacturer’s discretion. All forgings shall be demagnetized after test and shall be heat treated for stress relief. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may inspect such forgings and identify test pieces to check physical and chemical properties and witness such tests at manufacturer’s works.

1.7 Fasteners and Washers

All bolts, studs, nuts and washers used in the plant shall conform to the requirements of the relevant standard. The fasteners shall be of the best quality of specified grade and machined as required. Bolts shall be of one-piece construction and shall be of sufficient length so that only one thread shall show through the nut in fully tightened condition.

Fit bolts shall be of light drive fit in the reamed holes they occupy and shall have the threaded portion of such diameter that it will not be damaged in driving. The fit bolts shall have identification mark to ensure correct assembly at site.

Washers, locking devices and anti-vibration arrangements shall be provided wherever required. Jointing hardware for the entire plant shall be provided with sufficient spares to cater for 1 year for site losses.

Bolts for structural members shall be provided with taper washers wherever necessary to ensure that no bending stress is caused on the bolt. Where there is a risk of corrosion, the fastener’s design shall take into account the corrosion allowance and the maximum stress shall not exceed half the yield stress of material under any condition. The fasteners subject to frequent adjustment, removal etc. for regular operation and maintenance shall be made of nickel bearing stainless steel.

The manufacturer shall supply all holding down, alignment and levelling bolts complete with anchorage, nuts, washers, dowel pins, packing etc. required to erect the plant on its foundation along with base plates, frames and other structural parts necessary to spread the loads transmitted by the plant to foundations without exceeding the design stresses.

The Contractor shall provide to the satisfaction of the Engineer, reasonable excess quantities to cover wastage of those consumable which may be normally subject to waste during erection and commissioning period.

1.8 Lubrication

The equipment manufacturer shall furnish a complete schedule of recommended oils and other lubricants to the Engineer. The number of different types of lubricants shall be kept to minimum. The details of lubricant such as quantity required, viscosity, make, number etc. to be submitted to the Engineer for approval before incorporating the same in the Maintenance Mnual. For grease lubricated roller type bearings lithium base grease is preferred.

The equipment manufacturer shall also indicate indigenously available equivalent lubricants with complete details to enable the Employer to arrange for regular supply in case of nonavailability of specified brand.

For grease lubrication it is preferred to have 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 shall be avoided. Wherever required 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. The grease nipples shall be of same type and size for each part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

If more than one type of grease is required for particular plant, separate grease gun for each type to be supplied with permanent marking.

Oil container shall be supplied complete with oil level indicator of sight glass type; where this is not applicable, the container shall be provided with dipstick. The indicator shall show the levels at all temperatures, which may occur during plant operation. The maximum and minimum levels shall be clearly visible in the sight glass type from the operating floor and the same shall be easily dismantled for cleaning. The sight glasses shall be firmly held and encased in metal protection in such a manner that they cannot be accidentally dislodged.

The lubrication systems shall be designed not to cause any fire and pollution, and special protection must be taken to prevent any leakage of lubricant and coming in contact with any electrical equipment, heated surfaces or any other source of fire.

Initial filling of oil, grease, electrolyte and similar material for relevant plants shall be done by the Contractor.

All types of lubricants as required for two year’s operation of entire plant shall be supplied by the Contractor.

1.9 Name Plates, Rating Plates and Labels

Name plate and rating plate made of stainless steel shall be permanently fixed at conspicuous position of each item of the plant. These plates shall incorporate manufacturer’s name and address, serial number, type, details of duty at which the equipment has been designed to operate, diagrams, and direction of closing/ opening for valves, direction of rotation of pumps etc. as may be required. The operating and indicating devices shall have securely attached to them or engraved the designations of their function and manner of use.

Details of proposed inscriptions shall be submitted to the Engineer for approval before taking for manufacture.

Above plates and labels on electric equipment shall be of non-flame propagating materials, either non-hygroscopic or transparent plastic with engraved lettering of contrasting colours. Fixing shall be done by

means of non-corrosive screws or drive rivets. Uses of adhesives are not permitted.

Warning labels shall be provided wherever necessary to warn against risky circumstances or substances. Inscriptions or graphic symbols shall be in black on yellow background and of internationally accepted standards.

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

1.10 O&M Manual

The Contractor shall furnish Hard copies and Soft copies of operation and maintenance manual specific for the plant equipment and installation, giving detailed description, 'as built' assembly drawings, parts lists, operating instructions, repairs and periodical maintenance. The said manual shall not merely contain manufacturer's literature and brochures, which shall be in addition to detailed manual prepared for the plant. All records, drawings, wiring diagrams, curves etc. shall also be a part of the manual.

The Operation and maintenance manual shall include the followings:

- Schedule of equipment supplied along with manufacturer's name and address, model number, catalogue number etc.
- Schedule of routine, periodic, preventive and breakdown maintenance for all the equipment.
- Schedule of spares supplied with their part identification numbers.
- Schedule of tools and tackles supplied
- Sectional arrangement drawings of major item e.g. pumps, valves etc. with part identification list, metallurgy of component and with dismantling procedures.
- General arrangement drawing of whole plant showing the 'as built' installation
- Schematic diagram showing cooling and lubricating system of bearings
    - Full and comprehensive operation and maintenance instructions including fault detection for all equipment supplied
    - Copies of Test Certificates
    - Pump performance curves as tested
    - System head curves with superimposed pump curves for parallel operation of both Horizontal centrifugal pumpsets pumps
    - Schedule of recommended lubricants and their equivalents, which must be locally available.
    - Schematic diagram of Electrical installation (System Panel, Control Panel etc).

1.11 Painting

General

The equipment manufacturer shall clean, prepare the surface and apply primer/ protecting coating as per specification at their works.

Parts to be painted may be cleaned but surface defects shall not be filled in before testing at the manufacturer's works. The items subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out, if required, by washing with an approved dewatering fluid prior to surface treatment. Unless otherwise specified, all painting shall be done strictly in accordance with the paint manufacturer's instructions.

All protective coating shall be suitable for use in hot and humid climates and toxic zone.

Painting at Shop

All stages of painting including cleaning, surface treatment etc. at the manufacturer's works may be inspected by the Engineer at his discretion.

Cast iron and mild steel items shall be sand blasted to near mirror cleaning before painting. Sharp corners, edges etc. shall be broken before sand blasting.

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

Painting at Site

After site receipt, all items of plant shall be examined for damage of paint and the damaged portions shall be cleaned to the bare metal; rust, if any, to be removed; procedures as mentioned above to be followed and finally paint coats to be done with similar paint.

Cast iron and mild steel 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 inclusive of the primer coats. All sharp edges, fasteners and other items difficult to be painted shall receive brush coats 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. For fabricated steel work the same shall be done after assembly.

Before finalizing the paints, the Contractor/ manufacturer shall submit to the Engineer the full details of paints he proposes to use together with colour charts for gloss finishes for approval.

All paint and coating thickness shall be measured by approved Elcometer or coating thickness gauge.

1.12 Packing and Protection

Before dispatch from manufacturer's works the equipment shall be adequately protected and packed so as to reach the site intact and undamaged. The method of protection and packing must be suitable to withstand the conditions, which may be experienced in shipment and delivery to site. It shall also be suitable to withstand long period of storage at outdoor. The Engineer shall be given at least 15 days notice before packing.

Any crate/ package should not contain items of plant intended for incorporation in more than one part of the works.

All items of plant shall be clearly marked for identification as per packing list, which shall be placed in each crate/ package and protected in a waterproof cover.

All crates and packages shall be clearly marked with water and weatherproof paint to show the weight and position of sling attachment. They shall also be marked to identify the packing lists.

Bearing surfaces and similar bright parts shall be protected from corrosion by application of rust preventive lacquer, high melting point grease or similar fluid. Sufficient quantity of appropriate solvent shall be provided with the packing for removal of this protection.

Each crate/ package shall have a clear indelible and as far as possible, indestructible unique identification cypher, also quoted in the packing list inside it. Three copies of packing lists shall be sent separately to the Engineer at the time of shipment.

All flanges and matching surfaces shall be protected by wooden templates or similar. The fasteners used for securing these templates shall not form part of final installation.

1.13 Guarantee

All equipment/ items shall be guaranteed against defective design, manufacture and/ or workmanship for a minimum period of 18 months from the date of dispatch or 12 months from the date of successful commissioning whichever is later. The Contractor shall be responsible for complete operation and routine as well as breakdown maintenance of the installation including supply of all spares and consumables during the guarantee period and the cost shall be included in the offer, as per details provided in the BOQ. No extra payment will be made on this account.

In case the electromechanical equipment are installed but cannot be commissioned due to unavailability of clear water to the pumping station, the following shall be ensured by the Contractor:

a) The defects liability period of the electromechanical equipment including all works of pumping

station shall be one year from the date of the taking over of pumping station as per contract.

b) In case of non-commissioning of the pumping stations due to reasons cited above, all remedial measures shall be taken up by the Contractor to ensure performance of all electromechanical equipment as per specifications without any additional cost to the Employer.

In case the electromechanical equipment are not installed in order to match the sequence of completion of Water supply system, the supplied electromechanical equipment are to be stored in an covered lockable storage space to avoid any deterioration of the quality of the electromechanical equipment. All remedial measures shall be taken up by the Contractor to ensure performance of all electromechanical equipment as per specifications without any additional cost to the Employer.

1.14 Acceptable make

The equipment offered shall be of reputed make with proven performance and ISO: 9000 and 14000 organization. The manufacturer must have supplied equipment of similar types and duties as indicated in the specifications. Installation means equipment supplied/ installed under separate work orders.

The Employer reserves the right of selecting the make of the pumps and other mechanical equipments. The Contractor shall take prior approval from the Employer before placement of order to their vendors/ suppliers.

Pump Specification

1.15 Submersible Pump

General

- Submersible pumps shall be of the single-entry design and supplied with boltless self-ligning duck- foot assemblies giving automatic connection to the discharge pipe work.
- The total head capacity curve shall be continuously rising towards the shutoff with the highest at the shutoff point.
- Pumps shall be suitable and efficient for single as well as parallel operation between the maximum and minimum system resistances.
- The pumps shall be designed to handle solid sizes of up to 80 mm. Pumps shall run smoothly without undue noise and vibrations.
- The pump set shall be suitable for starting, with the discharge valve open and/or closed.
- The pump set shall be capable of withstanding the accidental rotation in the reverse direction.

Construction Features

i) Pump shall be centrifugal, vertical spindle, non-clog, wear resisting, single stage type.
ii) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed to allow free passage of solids. The volute tongue shall be filed to a smooth rounded edge.
iii) A double mechanical seal shall be provided to protect the motor from ingress of liquid 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. Sensors are to be provided to detect if leakage of liquid into oil housing is above 30% concentration.
iv) 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.
v) The Impeller shall be a non-clog open/semi-open type for raw sewage and sludge application and an enclosed type for clear water/treated sewage/filter rate pumping application with smooth blunt edges and large waterways so as to allow free passage of the large size solids. It shall be free from sharp corners 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 pumps higher than 1000 m3/hr.
vi) The critical speed of the rotor shall be at least 30% above the operating speed.
vii) Pump sets shall have double bearings. The bearing life shall be a minimum of 40,000 hrs. of operation.
viii) Each pump shall be complete with a CI delivery connection arrangement, for fixing to the concrete floor of the suction well. All necessary SS fixtures required for guiding the pumps during lifting/lowering shall be provided. The installation shall facilitate the automatic installation and removal of the pump without a person entering the wet well. Each pump shall be provided with a SS-316 lifting chain, with suitable provision for engaging the hook of the crane at 1 m intervals.
ix) Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at a low level, even whilst the pump is submerged, without the need for personnel to enter the wet well. This automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with the necessary accessories. All links and cables shall be multi-stranded SS.
x) The submersible pumps shall be suitable for operation with or without submergence.
xi) The pump shall start and stop automatically based on the level in the wet well.
xii) The synchronous speed shall not exceed 1500 rpm at 50 Hz supply.

Material of Construction

The material of construction for submersible pumps shall be as follows:

Component	Material
Impeller	SS: ASTM A 743 CF8M
Casing	CI, IS: 210 Gr FG 260 with 1.5 to 2 % Nickel
Shaft	SS: BS:970 AISI Gr 316
Bush	Bronze IS 318 Gr LT B2
Guide Rail Pipe	Bronze IS 318 Gr LT B2
Fasteners and Foundation Bolts	SS: BS:970 AISI Gr 316

- Material test certificates furnished by the contractor shall have the approval of the Engineer.
- The submerged cable shall be a multi-core flexible cord, Vulcanized rubber insulated with tough rubber sheath, and outer PCP sheath to BS 6500.
- Where both, thermal protection and moisture-sensitive devices are incorporated within the pump, both devices shall be brought out via separate conductors within the motor cable although, one such conductor may be common.

1.16 Centrifugal pump

i) Centrifugal pumps shall have head/quantity characteristics that fall continuously from the maximum pressure at closed valve conditions and are steep for variation in head to have a minimal effect on the quantity discharged.
ii) The design speed of any pump with a duty flow greater than 20 l/s shall not exceed 1500 rpm. The pump motor rating shall exceed the maximum pump power consumption over the operational range of the pump by at least 10%.
iii) The waterway through the pump shall be smooth in finish and free from recesses and obstructions. Impeller passageways shall be as large as possible. The leading edges of the impeller vanes shall be rounded and smooth.
iv) Water velocities in the pump suction side shall not exceed 1.5 m/s, and on delivery branches of a pump, the velocity shall not exceed 2.0 m/s when the pump is operating within its specified duty range. Within this working range, there shall be no discernible noise due to hydraulic turbulence or cavitation within either the pump or its associated pipework and valves.
v) The NPSH requirements of the pumps, based on the 3% output drop criterion, shall be at least 2 m less than the NPSH available at every working condition.
vi) The velocity of vibration shall be within 4.5 mm/sec. The combined noise level of the pump motor system shall be limited to 85 dB(A) at a distance of 1.0 m from the equipment, at the manufacturer's works / free field condition at the site after erection.
vii) The pump shaft shall be of SS BS:970 Gr 410S21 compatible with the impeller, which shall be of stainless-steel ASTM A743 CF8M, and the impellers and shaft sleeves shall be secured to the shaft through a key/s. The impeller retaining nut shall be fitted with a locking device. The pump casing shall be of cast iron to IS 210 Gr. FG 260, wearing rings shall be of bronze to IS: 318 Gr. LT B2 and shaft sleeve shall be of SS ASTM A 743 CA 15.
viii) All parts exposed to wear shall be adequately protected using renewable sleeves, bushes, wear rings etc. which shall be arranged for easy inspection, adjustment, or replacement without removal of the pump casings, pipework, etc, or the need to disturb the drive shaft alignment.
ix) The pump thrust shall be taken by a combined thrust and radial-type bearing assembly capable of taking the weight of the moving parts and the hydraulic load under all conditions of the operation, with a minimum life of 100,000 hours.
x) Bearing cooling arrangement if used, shall be designed on the closed-circuit principle; open discharge of cooling water into the pumping station drainage system is not permissible.
xi) The pump casing and other parts of the pump subjected to pressure shall be hydraulically tested by the manufacturer to at least one and a half times the maximum working pressure.
xii) Integral inlet & discharge flanges shall be provided and integral lifting lugs shall be incorporated.
xiii) Facilities shall be provided for the removal of air during priming and for draining.
xiv) Glands may be fitted with mechanical seals or conventional soft packing. The gland arrangement shall be designed for easy adjustment and removal of the seal.
xv) When soft-packed glands are used suitable means shall be provided for collecting and preventing

splashing of the gland leakage water.

xvi) Drainage and gland leakage water shall be piped into the building drainage system.

xvii) The shaft of the pumps fitted with conventional packed glands shall be fitted with removable gland sleeves.

xviii) The rotating element of the pump and the motor shall be readily removable from the pump casing without the need to disconnect the adjoining pipe work.

xix) Rotating assemblies of the pumps of 100 mm dia. inlet and over shall be statically and dynamically balanced and shall be designed so that the first critical speed is at least 50% greater than the maximum operating speed.

xx) Lubrication arrangements shall be so designed that there is no contamination of the pumped fluid.

xxi) On pumps of 75 mm inlet and over, tapping shall be provided at both the suction and discharge flanges of suitable size for pressure gauges.

1.17 Submersible Sump Drainage Pumps

i) Sump pumps shall be open-impeller, centrifugal-type, vertically mounted and closely coupled to their fully submersible electric motors.

ii) Sump pumps of 1.5 kW and under shall incorporate an integral level detector, control and motor starter and shall be powered only with a suitably fused three-phase or single-phase low-voltage supply and with supply isolation at the supply point.

iii) Sump pumps over 1.5 kW shall be controlled and started from the supply point. Control shall employ adjustable float-level switches mounted near the pump.

iv) Pumps shall be supplied with all necessary pipework to discharge to surface drainage. Each pump shall be provided with delivery reflux and isolating valves, and suitable lifting gear for lowering and lifting the pump from the sump.

v) Pumps weighing 40kg or more shall be lowered into the sump on guide rails and be located to their respective discharge pipework with an angle flange connection and self-locating clamps.

vi) Pump impellers shall be designed to pass solids of the sizes which pass through the inlet ports of the pump and shall be capable of pumping solids of up to 50 mm.

Pump Performance Guarantees

i) The pump performance guarantee shall relate to the flow rate, the total head, and the efficiency of the pump when tested at the manufacturer's works.

ii) The pump shall operate at its design point within acceptance tolerances for flow rate and total head laid down in BS EN ISO 9906:2000.

iii) Each pump shall be tested at the manufacturer's work in accordance with BS EN ISO 9906:2000 or other relevant standards in conjunction with one of the contract motors.

iv) This test shall be carried out on at least one pump set using the flexible coupling and contract drive shaft arrangement to establish that the drive arrangement with supports and couplings operates satisfactorily under all operating conditions.

v) Where similar drive shaft arrangements have been installed by the operator, and have been proven satisfactory in service, this requirement may be withdrawn subject to the approval of the engineer.

vi) A test shall be carried out of the performance from the closed valve to the maximum quantity that can be delivered under abnormally low discharge heads.

vii) Sufficient reading shall be taken at each test to produce accurate curves of the heads, flow, pump speed and power required at pump coupling throughout the operating range of the pump.

viii) Vibration and noise dB(A) levels shall be measured and shown to be acceptable and shall have the Engineer's approval. The operator shall have engineer approval and provide acceptable test certificates, showing the NPSH requirement for the pump is at least 2m less than the NPSH available under all working conditions.

ix) in the absence of the approved test certificates the supplier shall carry out a test on one pump of each type to verify the NPSH requirement based upon the 3% output drop criterion and shall take approval of the Engineer.

x) The certificates shall be submitted to the Engineer immediately following each of the tests

mentioned above. Performance curves shall also be incorporated in the operation and maintenance manual.

Single Pump Operation

i) Head / Quantity Curve
ii) Motor kW input/Quantity curve
iii) Overall efficiency/quantity curve
iv) NPSH required/quantity curve
v) Vibration and Noise dB(A) levels

Parallel Pump Operation

i) Head / Quantity Curve
ii) Motor kW input/Quantity curve
iii) Overall efficiency/quantity curve
iv) NPSH required/quantity curve
v) Vibration and Noise dB(A) levels

Valves and Appurtenances

1.18 General

a) Valves shall be suitable for use with the fluid being conveyed at the temperatures and pressures required for the application. Generally, pressure designation shall not be less than PN 10.
b) Valves shall have integral flanges drilled as specified in BS 4504 where applicable. Flanges to other standards shall be used only if approved and provided that any differences do not affect mating dimensions. The back faces of the flanges shall be machined.
c) Sluice valves and butterfly valves shall be suitable for flow in either direction.
d) Sluice valves shall comply with IS 14846, BS 5150 or 5163 as appropriate.
e) Butterfly valves shall comply with IS 13095 or BS 5155 / AWWA-C-504/1980
f) Reflux/check valves shall conform to IS 5312 -1986/2007 or BS 5153
g) Valves shall be suitable for frequent operation, and for infrequent operation after long periods of standing either open or closed.
h) The rubber used in valves shall be ethylene propylene rubber (EPDM) or styrene butadiene rubber (SBR). It shall comply with the requirements of IS 13095 or Appendix B of BS 5155, be suitable for making long-term flexible seals, and be resistant to anything causing deterioration of the flexible seal.

1.19 Gate Valves (Sluice Valves)

a) Gate valves shall comply with IS14846 or BS 5150 and be of the solid wedge-gate type with non-rising stems. Valves less than 600 mm in diameter shall be resilient-seated type unless otherwise specified.
b) Gate valves up to and including 1000mm nominal diameter shall conform to the requirements of IS 14846 or BS 5150 for copper-alloy faced or resilient-seated valves with solid or split wedge, except that gate valves up to and including 600mm nominal diameter may conform to BS 5163.
c) Valve spindles shall be of the internal non-rising type. The valve spindle seal shall be replaceable with the valve fully open and the main under pressure.
d) Valves 450mm and over shall be fitted with integral by-passes and gate jacking screws.
e) Valves below 80mm NB shall comply with BS 5154.
f) Valves of Dia 450 mm and above shall be provided with enclosed gear arrangements for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% above the maximum specified rating. Valves and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
g) All valves, spindles and hand wheels shall be positioned to give good access to operational personnel.
h) All the hand wheels shall be arranged to turn in a clockwise direction to close the valve. the direction of rotation of opening and closing of the valve shall be indicated on the hand wheels. The material of construction of the Valve shall be as follows:

Component	Material
Body and Doors	CI IS 210 Gr. FG 260
Spindle	SS BS: 970 Gr 431
Seating rings	SS BS: 970 Gr 316
Back Seat Bush	Bronze IS:318 Gr LTB2
Shoe and channel linings	SS BS: 970 Gr 316

1.20 Double Flanged Butterfly valves

General

Butterfly valves shall be of wafer type double flanged and short body type conforming to IS: 13095 or AWWA suitable for installation with the valve shaft in any position. The body and disc shall be ductile iron. The drive shaft and end shaft shall be of stainless steel IS: 6603 Gr 12 Cr 12. Body seat shall be of stainless steel and disc seat of nitrile rubber. The disc shall rotate through 90 deg. from the full open to the tight shut position. Suitable stops shall be provided inside the body so as to prevent further rotation beyond fully open or fully closed position. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation. The driving end sealing shall preferably be of the gland and stuffing box type. The stuffing box shall be easily accessible for adjustment and replacement of packing without disturbing any other part of the valve or operating assembly. The depth of the stuffing box shall not be less than 50 mm or the diameter of the shaft, whichever is lower. As an alternative, ring type sealing may be provided at the driving end. The gear unit of the valves shall be grease-lubricated with proper sealing and packed with grease for lifetime service. The valve shaft shall have a minimum shaft diameter extending through the valve bearings and into the valve disc as specified in the relevant codes. The shaft should also be sized to withstand the maximum torque that will be imposed by the operator. Stub shaft construction, if offered, shall have each stub shaft inserted into the disc hub for a distance of at least 1.5 times the shaft diameter.

Butterfly valves for pneumatic operation shall be fitted with pneumatic actuator and limit switches for auto operation. Time of opening and closing of valves shall be between 10-30 seconds. Pneumatically operated valves shall also be fitted with manual override facility and hand wheels for manual operation. Double acting solenoid valves shall be used for air connection to each valve.

Each valve shall be provided with lifting lugs.

Butterfly valves shall be installed into the pipe works in such a manner that they can easily be removed from the line for dismantling and replacement of the seats which shall be of rubber unless otherwise specified. For the rubber seated valves, the valves shall be air tight in the closed position with a disc differential pressure as specified.

Hand wheels of butterfly valves shall be made of malleable iron with arms and rims of adequate strength. The hand wheel diameters shall not be more than 600 mm. Hand wheels of diameter 300 mm or less shall be of cast iron of rugged design and shall provide positive grip on the chain even under the most severe operating conditions. The operator shall be complete with chain guides. The chains for the chain wheels shall be of endless type.

Butterfly valves shall be suitable for mounting in any position. The valve shall be free from induced vibrations. Butterfly valves shall be suitable for bi-directional pressure testing with dead-tight shut-off even after long period of operation.

The valve seat shall be of replaceable design. When the valve is fully closed, the seal shall seat firmly. The seat surfaces shall be machined smooth to provide a long life for the seal. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

The shaft shall be stainless steel with bronze or equivalent seal with self-lubricating bearings. Disc pins shall be stainless steel. Rings shall be bi-directional self-adjusting suitable for pressure or vacuum service. Removal and replacement of seals shall be possible without removing the operating mechanism, valve shaft and without removing the valve from the pipeline. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel. Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be of worm and worm wheel design type, totally enclosed, grease filled and weather proof. The operation with gearing shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N. The valve disc shall have a 90 degree turn.

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.

It should be possible to open the valve with upstream pipe fully filled and downstream pipe empty. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the discs by tapered stainless steel cotter pins.

Valves shall be provided with a continuous mechanical position indicator to show the position of the disc, mounted on the driven shaft end.

Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully open or closed position (i.e. set points).

Valves shall be capable of closing against the maximum flow that can occur in practice. The breakaway torque under maximum differential head conditions shall be within the manufacturer's limits.

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

All hand wheels shall be provided with an integral locking device to prevent operation by unauthorised persons.

Material of Construction

Item	Materials of Construction
Body	Ductile iron
Disc	Ductile iron
Shaft	Stainless steel BS 970 Grade 413 S19
Disc seal ring	EPDM
Disc seal retaining ring	Stainless steel ASTM 351-CF8M
Body seat	Stainless steel AISI 316/ nickel weld overlay micro finished/integral micro finished seat with valve body
Shaft bearing	Bronze with EPDM `O' ring seal
Internal fasteners	Stainless steel SS 316
Nuts, bolts & washers for pipe flanges	High tensile steel hot dip galvanized
Coating	Internal and external with electrostatic epoxy powder coating or liquid food grade epoxy coating with minimum dry film thickness of 250 microns

Valve Actuator

The valve actuators shall have inbuilt starter and three phase motor suitable for operation at 415V, ± 10%, 3 phase, 50 Hz, ± 6% electric supply and the actuator shall have IP-68 degree of protection. Each actuator will have two nos. Travel Limit Switch, two nos. Torque Limit Switch (0 to 100% adjustable type). Each Limit Switch shall have 2 nos. NO & NC contacts, Actuator shall be used for open / close as well as inching operation both from local as well as remote P.B. Station and shall have 15 minutes continuous rating.

Each actuator shall have a local / remote selector switch and open / close / stop bush buttons in the actuator. Potential free contact shall be provided for remote indication of valve full open, full close, motor on, motor off.

Each actuator shall be provided with a manual override and hand wheel for manual operation as and when required. All the actuators shall have local mechanical position indication. Suitable potentiometer shall be provided for remote, valve position indication.

1.21 Automatic Air-Relief Valves

Air valves shall be provided for installation at high points or changes in gradient in pipelines, and elsewhere as specified or shown on the Drawings, to achieve the following: -

a) To exhaust air automatically during filling, the air is released fast enough to prevent back pressure restricting water inflow.
b) To ventilate a pipeline automatically during emptying, the air inflow is fast enough to prevent the development of negative pressure.
c) To release air automatically during normal working.

Conditions (a) and (b) shall be met by using an orifice capable of handling large volumes of air at a high-flow rate in either direction. Condition (c) shall be met by using a small orifice capable of discharging small volumes of air as they accumulate.

Valves shall have approved screens to prevent the ingress of foreign matter.

Air valves shall be of one of the following types: -

a) Double valves shall combine both large and small orifices in one valve. The large orifice shall be sealed by a float, and the valve shall be designed to avoid premature closing of the valve by the discharging air. The small orifice shall be sealed by a float at all pressures above atmospheric, except when air accumulates in the valve body.
b) Single large orifice type for automatic ventilation or exhaust of pipeline.
c) Single small orifice type for automatic release of air under normal working pressure.

Large orifice air valves, including those incorporated in double air valves, shall be constructed so that the airflow holds the valve open during the discharge of air, at all flows, including sonic velocities. When coupled to their respective isolating valves, they shall be capable of admitting or exhausting the required quantities of free air without the pressure differential across the combined air valve and isolating valve exceeding 0.5 bar.

Small orifice air valves, including those incorporated in double air valves, shall be capable of discharging not less than 0.5 m^3/min of free air when the pressure in the pipeline is at the maximum working pressure.

Balls or floats shall be of ABS, vulcanite, rubber-covered metal or stainless steel, and shall operate automatically at all pressures up to the test pressure. Orifices shall be bronze or stainless steel.

Air valves shall be designed so that each float seats against its orifice or causes the orifice to be closed without leakage at all pressures between 0.2 bar g. and the specified test pressure. Balls and seats shall be designed to minimize adhesion of the ball to the seat. They shall be of a type proven to be suitable for the specified duties.

Each air valve shall be provided with an isolating valve. Air valves with a connection to the main pipeline not exceeding 25 mm diameter shall have an integral lever-operated isolating ball valve. All other air valves shall have a separate resilient-seated, double-flanged, lever-operated butterfly valve.

Each small orifice or double air valve shall be fitted with a test cock in the valve body for verification that the small orifice air valve is operating properly.

The body ends shall be flanged with raised faces and drilled to BS 4504 for the nominal pressure specified.

1.22 Kinetic Double Air Valve

a) The valve shall be capable of exhausting air from pipe work automatically when filled. Air being released at a sufficiently higher rate to prevent the restriction of the Inflow rate. Similarly, the valve shall be capable of ventilating pipe work automatically when being emptied. The air inflow rate is sufficiently high to prevent the development of a vacuum in the pipeline. The valve shall automatically release air accumulating in pipeline work during normal working conditions.
b) The air valve shall be of double orifice type with a large orifice for ventilation for the exhaust of the pipeline and a small orifice for the release of air under working pressure. The valve shall be suitable for maximum working pressure in the system. All air valves shall be provided with an isolating sluice valve and flanged end connection.
c) The air valve shall be designed to prevent premature closure before all air has been discharged from the line. The orifice shall be positively sealed in the close position, but float (Ball) shall only be raised by the liquid and not by a mixer of air and liquid. The sealing shall be designed to prevent the floats from striking after a long period in the close position.

d) All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / for branch Dia ratio greater than 3). The diameter of the compensation pad will not be less than 1.75 times the O.D. of the branched outlet. The plate thickness for pads will be the same as that of the main.
e) For outlets with an above ratio of less than three, then the joints will be of plate reinforcement type.
f) The aperture of valves must be properly designed for which the contractor shall submit design calculations for necessary approvals before the procurement of valves.
g) The air valve should be as per IS: 14845 of minimum PN 1.0 rating.
h) All branched outlets including air valve tees will be provided with one 15mm BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with a copper washer for sealing.
i) All flanges will be drilled as per I.S. 1538.
j) The gaskets shall be of nitrile rubber.

1.23 Reflux /Check Valves

Reflux/check valves shall be designed for rapid closing without slamming no later than the moment forward flow stops. The valve size and design shall be chosen to give the best performance possible, taking into account the system where the valve is installed. The effect of any surge vessel in the system as well as the static and dynamic heads, shall be included in the assessment. Valves shall conform to IS 5312 Part 1 & 2. Hydraulic passages and doors shall be designed to avoid cavitation.

If self-closing without slamming cannot be achieved, external mechanisms may be used to control the closure rate. Details of the mechanisms will be subject to approval. Valves of 450 mm and above shall be provided with supporting feet. Swing door valves of size 600 mm and above shall be of multi-door type. Maximum pressure drop across the valve shall be 0.4 mm WC.Valves shall preferably be fitted with resilient faces or seats. The material of construction of the valve shall be as follows:

Component	Material
Body & Door	CI IS 210 GR. FG 260
Body and door ring	SS ASTM A743 CF8, BS 970 GR. 316 S11
Hinge Pin	SS BS 970 431 S49
Bearing	Teflon

1.24 Knife Gate Valves

General:

The construction of Knife gate valves shall be under the specifications mentioned hereunder. The Knife gate valves shall be capable of performing the isolation duties in wastewater treatment plants & pumping stations. These shall be suitable for use at the suction and delivery side of pumps as well as in branch lines in sludge handling application of treatment plants and pumping stations, and shall be so constructed that there is no undue wear or deterioration during their operative life and so designed that the maintenance is kept to a minimum. The contractor shall provide these valves manufactured by an ISO: 9001-2008 certified company manufacturing the underspecified product for at least 5 years.

Design & Constructional Details:

The Knife gate valves shall be manufactured generally as per the latest AWWA C520-14 standard. The valve should be bonneted up to 600 mm and bonnetless for higher sizes. Valves should be lug-type construction up to 600 mm in size and full-flanged construction for higher sizes. The valves should be provided with flange drilling suitable to mount between flanges as per ANSI B 16.5 150 with raised face or DIN PN10 or IS 1538- 1993 Table VI.

Other constructional features and details of components of the required valves are to be as under:

i. The valve body should be of Cast ductile iron construction as specified. Valves up to 600 mm in size should be designed to withstand 10 bar pressure and valves above 600 mm in size should be designed to withstand 4 bar pressure generally applicable in sewerage pumping stations and treatment plants. If the line/system pressure is more than 4 bars then the valve design/material of construction should be suitably modified to meet this requirement when specifically pre-informed by the client.
ii. The valve should be provided with a gate made of stainless steel of grade as specified and the gate should have a bevelled knife edge at the bottom to cut through and easily enter the solids settled in the bottom and ensure positive shut-off/closure in the sewage environment.
iii. The Valve should be designed for sealing in a unidirectional flow application.
iv. The valve should be provided with a replaceable type of flexible sealing arrangement 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 sealing system should be field-replaceable at the site.
v. 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 to avoid seal wear and achieve drop-tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.
vi. The bonneted valves up to 600 mm in size shall have a glandless design to avoid repeated tightening/replacement of gland packing. The stuffing “O” ring seal should be pressurized by a thrust washer from both sides and should be pressurized/tightened by a thrust retainer nut.
vii. The bonnet-less valve above 600 mm in size shall be provided with sufficient ply of gland packing in the in-built stuffing box to seal the rear opening. The packings should be of graphite synthetic yarn to reduce friction and offer a higher life. Provision shall be made to enable tightening the gland packing by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of gland packings should be possible in the installed condition of the valve without there being line pressure.
viii. The spindle should be double start / single start and non-rising type for compact & safe operation. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing.
ix. The operation of the valves shall be motorized.
x. In case the valve is to be operated from afar then it shall be provided with joining couplings, extension spindle, spindle guides and mounting pedestal with suitable anchor bolts/anchor fasteners on the platform.

Material Of Construction:

The material of construction for various components of valves shall be as under.	
Body	: Ductile iron to BS 2789 Grade 420/12
Seal Retainer ring	: Stainless steel to ASTM A351 Gr CF: 8
Inlet Seal / Rubber Seals / O rings	: EPDM Rubber
Knife gate	: SS BS:970 Gr 316
Spindle	: SS BS:970 Gr 316
Assembly bolts, nuts and fastener	: SS BS:970 Gr 316
Spindle nut	: Brass/DI
Bracket / Adapter plate	: Mild Steel to IS: 2062 grade A, Epoxy Painted
Packing	: Synthetic yarn with PTFE

Painting:

The following painting procedure shall be adopted for the valves:
i. Surface Preparation: Blast clean to near-white metal finish.
ii. Finish Painting: Suitable coats of epoxy paint to achieve a minimum DFT of 100 microns inclusive of priming. Primer painting / pre-painting before leakage testing shall be allowed.

1.25 Ball Valves

Ball valves shall conform, where applicable, to IS 9830-2003 or BS5159. Multi-piece bodies shall be used where work on the ball and seats, when installed, may be needed. If valves need removal for servicing, one-piece bodies may be used.

Seat materials shall be chosen for long life, with erosion and corrosion resistance.

Ball supports shall be of the floating ball or trunnion type. If line pressure is too low to ensure a positive leak-free seal, built-in seat loading devices or specially shaped seating shall be used to ensure sealing.

1.26 Pressure Relief Valve

Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurized in excess of the present maximum allowable pressure. The valves shall be drop tight under normal operating conditions.

The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valves.

The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weight or from a spring.

1.27 Pressure Reducing Valves

Pressure reducing valves (PRV) shall be constructed of cast iron to BS EN 1561: 1997 Grade 220/260 or ASTM A 126 Class B. The ported guide, seat ring and trim shall be of gun metal to BS EN 1982: 2008 Grade LG2C or stainless steel to AISI grade 303. The valve shall be capable of operation in any position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be easily renewable. Valves shall be double flanged. All controls and piping shall be of non-corrosive construction.

Pressure reducing valves shall be capable of maintaining a constant downstream pressure from a higher constant or variable upstream pressure and they shall be drop tight under no flow conditions.

The valve operation shall be achieved by the interaction of the inlet pressure, outlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valve.

The pilot valve or relay system shall be actuated by a diaphragm connected to the outlet pressure on its underside and a constant pressure on its upper side derived either from weights or from a spring.

Body ends shall be flanged and drilled to BS EN 1092-2.

Electric Actuator

Actuators shall be suitable for the medium, climatic, environmental and pressure conditions of the system in which they are to be fitted. Actuators shall be provided with:

a) AC Electric Motor.
b) Reduction gear unit.
c) Torque switches mechanism.
d) The limit switch mechanism, complete with a set of limit switches, and \two spare sets for the suitable position.
e) Hand wheel, for manual operation.
f) Valve position indicator.
g) Hand-auto lever with suitable locking arrangement.
h) A single-phase space heater in the switch compartment.
i) Blinking light throughout the valve operation.
j) Junction box for terminating power and control cables.
k) With additional accessories for integrating with the PLC system.

The actuator shall be suitable for operation on 415V, 3 phase, and 50 Hz power supply. The motor

winding insulation shall conform to class B as per the relevant BS and the motor shall be protected by suitable thermal overload relays. The actuator shall be capable of producing not less than 1 1/2 times the required operator torque at the required time cycle, of valve operation. The transmission shaft connecting the actuator to the valve shall be provided with 2 bearings one at the actuator end and one at the valve end with universal couplings at suitable places. The required numbers of switches/contacts meet the requirements for the PLC system.

The electric motors shall be of the squirrel cage type as per IS 325 with insulation to IS 1271 Class B. The windings shall be impregnated to render them non-hygroscopic and oil-resistant. All internal metal parts shall be painted. The motor shall be rated for 15 minutes. They shall also be suitable for operating on the specified electric supply and shall satisfactorily open and close the valve under variations of the electric supply specified.

The motor shall be protected by a suitable overload protection device.

The reversing contactor starter and local controls shall be integral to the valve actuator. The starter shall comprise mechanically and electrically interlocked reversing contactors of appropriate rating fed from a 110 Volt control transformer. The common connection of the contactor coils at the transformer shall be grounded. HRC cartridge-type primary and secondary fuses shall be provided.

Local control shall comprise pushbuttons for open, close and stop operations and a Lockable Local/Remote/off selector switch. The control schematics shall be subject to approval.

Internal wiring shall be 650/1100-volt grade PVC insulated stranded copper conductor of a minimum of 1.5 sq. mm for control circuits and a minimum of 4 sq mm copper for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type. Cable entries shall be suitable for PVC- insulated/sheathed, armoured cables. A separate terminal box shall be provided for the heater. A separate terminal box shall be provided for cabling to control circuits.

The actuator enclosure shall be fully weatherproof and hose-proof to IP 67 and shall be fitted with an anti- condensation heater, which shall be switched off when the motor is running.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of the valve, or upon actuation by the torque when the valve disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the valve is fully closed.

The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during the opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque that the switches are required to operate.

Non-adjustable limit switches shall stop the motor and give an indication when the disc has attained the fully open or closed position.

The adjustable limit switches shall have control rated 2A, 48 V DC for specified system interlock, at the desired value position in both the opening and closing directions.

Motor operators shall be provided with clearly visible local valve position indicators mounted on the operator assembly to indicate whether the valve is fully open, fully closed or in an intermediate position.

Settings and emergency operations shall be possible with the use of a hand wheel. The Handwheel shall be of stainless steel and the drive mechanically independent of the motor drive and any gearing should limit the operating torque at the hand wheel to less than 15 kg and be such as to permit emergency manual operation in a reasonable time. During electric operation, the hand wheel shall not rotate.

Actuators shall be adjusted at the manufacturer’s works, to ensure that they provide the correct, fully, open position and fully closed position. Mechanical adjustable stops shall be provided to prevent over-travel of the valve in the open and closed positions.

Valve Packaging and Installation

Marking and Packing

Each valve shall be indelibly marked with the diameter and pressure rating and carry a unique reference number to enable each item to be clearly identified with works fabrication records; works test certificates, delivery notes and the like.

Wherever possible, the identification marks shall be painted on the outside of the item, but where there is not enough smooth surface area for the identification marks, they shall be put on rust-proofed metal tags secured to the item with galvanised wire or chain (not through flange holes).

Valves shall be packed in the `closed' position except that uncarted resilient seat gate valves for transport to tropical areas shall be in the `open' position.

Valve Handling

The Contractor shall provide all equipment needed to handle and install valves and associated equipment without damage to any coatings. The equipment shall include lifting beams, reinforced canvas slings, protective padding, cradles and the like. Wire rope or chain slings shall not be used for handling these items.

Temporary packing, coverings or crates provided for protection in transit shall not be removed (except for inspection purposes after which they shall be replaced) until immediately before installation.

Valve Installation

Valves shall be installed and commissioned in accordance with the manufacturer's instructions. After installation, valves shall be cleaned, gates, discs, seats and other moving parts closely inspected, foreign matter removed, and the valves checked for ease of operation. Moving parts shall be lightly greased or otherwise treated in accordance with the manufacturer's recommendations.

Unless otherwise specified or directed by the employer’s representative, butterfly valves shall be enclosed in chambers, installed with the shaft, horizontal, and supported. They shall be installed so that when the valve is opening the lower portion of the disc moves in the direction of the main or normal flow.

Unless shown otherwise on the Drawings, gate valves shall be installed, with their shafts vertical.

Gate valves without external gearing, and not otherwise required to be in a chamber, may be buried. The buried part of the valve shall be protected as specified. Unless otherwise specified, backfilling shall be to just below the top of the valve or shaft shroud, and a surface box shall be provided.

Jointing, sleeving, external wrapping, anchor and thrust blocks, valve chambers, valve marker posts and the cleaning and disinfection of valves shall be executed as specified for the associated pipeline.

1.28 Sluice Gates.

The construction of sluice gates shall be in accordance with the specification and generally as per AWWA C 501 or IS 13349. The sluice gates shall be capable of performing the duties set in the specification without undue wear or deterioration. They shall be constructed so that maintenance is kept to a minimum. All parts of the sluice gate, including mechanism components shall be designed for the heads specified with a minimum safety factor of five. All sluice gates shall be of the raising spindle type.

All sluice gates shall be electrically operated. Specifications of all types of gates shall be approved if provided by the Contractor, the actuator specs shall be approved by the Employer’s representative.

Constructional features

The sluice gates shall be the standard design of the manufacturers and robust construction. The special features shall be as follows:

Frame:

The frames shall be of ample section and cast in one piece. All surface-forming joints and bearings shall be machined. The frame shall be of the flange back type and machined on the rear face to bolt directly to the machined face of the wall thimble.

Guide:

The guide shall be bolted to the frame or cast integrally with it and machined on all bearing and contact faces. The length of the guide shall be such that it should support the gate upon the horizontal line of the stem nut pocket. Arrangements shall be such that they should support the gate upon the horizontal line of the stem nut pocket. Arrangements shall be made to prevent lateral movement of bolted-on guides. They shall be capable of taking the entire thrust produced by water pressure and wedging action. Wedges or wedge facings shall be attached to the guides at the point where, in the closed position, they will make full contact with the wedging surface on the slides.

Seating Faces

The seating faces shall be of full width, solid section. They shall be secured firmly by means of counter-sunk fixings in finished grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place as well as free from distortion and loosening during the life of the sluice gates.

Wedging devices

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices required providing contact between the slide and frame facing when the gate is closed position. All faces shall be machined accurately to give maximum contact and wedging action. Wedges shall be fully adjustable with suitable adjusting screws and lock nuts and so designed that they will remain in the fixed position after adjustment.

Gate slides

The slide shall be with strengthening ribs where required and a reinforced section to receive the seating faces. The slide shall have tongues on each side extending its full length and tongues shall be machined accurately on contact surfaces. Surfaces of the slide that meet the seat facing and wedges shall be machined accurately. The maximum allowable clearance between the slide and slide gate shall be 1.6 mm. An integrally cast stem nut pocket with reinforced ribs shall be provided above the central line of the slide.

Stem nut and Lift nut

A gate shall be provided with lower fixed stem nuts for connecting the stem to the slide and a revolving lift nut located in the lifting mechanism in the headstock. They shall be of ample design to endure the thrust developed during gate operating under maximum gate operating condition loads in opening and closing directions. The stem nut and slide shall be constructed to prevent the turning of the stem nut in the pocket of the slide. The stem nut shall be threaded and keyed or threaded and pinned to the stem.

Stem

The operating stem shall be designed for tensile strength to withstand 90 kg effort on the crank and for a critical buckling compressive load assuming a 36 kg effort on the crank. The threads of the stem shall be machine cut or rolled and of the square or acme type. The number of threads per inch shall be such

as to work most effectively with the lift mechanism used. The top of the stem shall be provided with a stop collar. The stem shall be provided with a polycarbonate cover fixed to the headstock.

Stem coupling

The coupling shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.

Stem guide

Stem guides shall be cast, with bushings and mounted on cast brackets. Guides shall be adjustable in two directions and so constructed that when properly spaced, they shall hold the stem in alignment. The number of stem guides shall be such that the unsupported length of the stem shall not exceed one hundred times its diameter.

Lifting Mechanism

Sluice gates shall be operated through a suitable lifting mechanism, which shall incorporate gearing if required. The lifting mechanism shall be suitable for operation by one man under all conditions. The lifting mechanism shall incorporate a strong locking device, suitable for use with a padlock or padlock and chain. The manual operation shall be of the hand wheel crank-operated type and shall have a lift nut threaded to fit the operating stem. The crank shall be removable. Ball or roller thrust bearings shall be provided above and below the flange on the lift nut to take the load developed in opening and closing the gate with a torque of 14 kg-m on the crank. Fittings shall be provided to lubricate gears and bearings. The design of the lift mechanism of the hand- operated gates shall be such that the slide can be operated with a torque not more than 7 kg-m on the operator after the slide is unseated from wedges based on the operating head. The maximum crank radius shall be 380 mm.

Gears and bearings

All gears and bearings shall be enclosed in cast iron housing with labyrinth seals. The lifting mechanism shall be of cast iron pedestal, machined and drilled, to receive the gear housing, and suitable for bolting to the operating floor. The gates shall close with clockwise rotation of the crank. The direction of rotation to close the gates shall be indicated on the lift mechanism. A suitable means shall be provided for lubricating the stem threads directly adjacent to the lift nut. An inspection cover shall be provided to access the lift nut and gearing.

Fasteners

All anchor bolts, assembly bolts, screws, nuts etc., shall be of ample section to safely withstand the forces created by the operation of the gate.

Wall thimbles

The wall thimbles shall be made of cast iron and supplied along with the gate. The wall thimbles shall provide a rigid mounting and be designed to prevent the warping of the gate frame during installation. The cross- section of the thimble shall have the shape of the letter ‘F’. The front, or mounting flange, shall be machined and attached to the thimble with bolts and studs. The depth of the wall thimbles shall not be less than 300mm. To permit entrapped air to escape as the thimbles are being encased in the concrete, holes not less than 35 mm diameter at not more than 600 mm span, shall be cast or drilled in each entrapment zone formed by the reinforcing ribs or flange and water stop.

Material of Construction

Frame, Guide, Thimble, Stem : C I conforming to IS 210 Gr 260 Guide Bracket, Wedges,

Door Sealing faces : bronze conforming to IS 318 Gr LTB 2
Spindle : SS AISI 431

Flush bottom resilient seal : Natural or synthetic rubber conforming to IS: 1855
Anchor bolts : SS conforming to IS 6603
Hand wheel : Cast iron
Stem cover : Polycarbonate transparent tube.

Parameters

Type : Rectangular rising spindle.
Size: : As per requirement
Applicable code: : IS 13349
Class : 1
Maximum seating head: : as per design
Unseating head :as per design Maximum distances between gate centers:
Line and operating platform : as per design.
Tests : Seat clearance checks, moving tests, leakage tests and Hydrostatic tests as per IS 13349/ AWWA C 501 shall be conducted at the Manufacturer's works in accordance with the Inspection category.

Headstocks

Where remote operation of penstocks, gate or butterfly valves is required they shall generally be as shown on the Drawings, using headstocks or headstocks with operating shaft extensions.

Headstocks for direct connection to valves or penstocks shall be for use with non-rising stem valves. They shall be cast iron and fitted with position indicators. Stem bearings shall be gunmetal bushed.

If operational conditions require, hand wheels shall operate through bevel gears.

If the installation requires, extensions shall be provided between penstock or valve and headstock. Extension lengths shall be adjustable during assembly on Site. Universal couplings shall be fitted next to the valve and the headstock, and the two couplings shall be arranged to give a linear transmission of rotational movement between the headstock and penstock shaft.

1.29 Open Channel Gates

General:

The construction of cast iron open channel gates shall be as per IS 3042 or equivalent standard. The open channel gate shall be capable of performing the isolation duties in wastewater treatment plants for those applications where the height of the water is at least 300 mm less than the height of the opening/shutter.

They shall be so constructed that there is no undue wear or deterioration during their operative life and so designed that maintenance is kept to a minimum.

Design & Constructional Details

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

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

The spindle shall be raising type and provided with a stop nut to avoid over-closing of the gate. The rising spindle shall be provided with a transparent scratch-proof and UV-resistant polycarbonate cover tube to protect the threaded portion from the effects of dust, dirt and rain. The operating arrangement shall be

electrical with manual override.

Material Of Construction:

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

Gate frame, shutter/Door : Cast iron IS 210 FG 260
Side Guides : Cast iron IS 210 FG 260
Door Sealing faces : Bronze, conforming to IS 318 Gr LTB 2 Assembly bolts, nuts and fasteners : Stainless Steel ASTM A 276 type 304
Stem & connecting pin : SS AISI 431
Yoke : Mild Steel to IS: 2062 grade A, epoxy painted.
Headstock : Cast Iron IS 210 FG 260
Spindle cover tube/pipe hood : Polycarbonate

Painting:

The following painting procedure shall be adopted for the gates:
Surface Preparation : Blast clean to near-white metal finish using shot blasting.
Priming : 1 coat of Epoxy primer.
Finish Painting : Epoxy paint for gate assembly. Minimum DFT 250 microns inclusive of priming. Yoke & Headstock are to be provided with red oxide primer and epoxy Grey paint having a minimum DFT of 150 microns, inclusive of priming.

Shop Testing:

Following shop tests at the manufacturer's place will be conducted.

a.	Movement Test	The Movement test should be conducted in an assembled condition using stems & headstock. The gate should be operated once from full closed to full open and back to full closed condition with a maximum. The force of 135 Newton-meters on the crank or hand wheel.
b.	Dimensional Check:	Important Dimensions shall be checked with reference to the approved GA drawing.
c.	Seat clearance check:	With the gate in closed condition, a 0.1 mm thick feeler gauge should not pass through the sealing faces.
d.	Material Testing:	Material test certificates for components, such as Frame, Side guides, Shutter, Rubber seals, & Spindle to be furnished for review at the time of inspection.
e.	PMI test:	Positive Material Identification (PMI) test to be conducted for Seating/Sealing faces, Rubber Seal Retainer Bar & Stem/ Spindle during the inspection.
f.	DFT measurement:	DFT of Paint with reference to approved G.A. drawing to be measured with a paint thickness measurement gauge during the inspection

Material Handling Equipment

1.30 Electrically Operated Hoists

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

The electric hoist shall confirm to IS: 3938 and 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. The main girder shall be single unit, welded or joint is not accepted.

Drums shall be machined 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.

The load chain on a pulley block shall be of alloy steel of grade not less than 80 and shall be calibrated to IS 6216: 1971.

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 a minimum ultimate tensile strength of 1.6 X 106 KN/m2.

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

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

Drive motors shall be designed for frequent reversal, braking and acceleration and shall be as per IS: 325. Pendant control switch, controllers and resistor, controls, electrical protective devices, cable and conductors, earthing guards etc. shall be as per IS: 3938. limit switches shall be provided for over-hoisting and over- lowering. The electrical hoist shall be of class II duty.

25% overload test, speed tests, limit switch tests and brake tests shall be conducted for the hoist and trolley at the manufacturer's works.

1.31 Hand-operated Hoist and Trolleys

The manual hoist shall be complete with a hand chain, trolley, pulley block, hook, hand and load chains, brakes, and other accessories. They shall comply with the latest applicable standards, regulations, and safety codes in the locality where the equipment will be installed.

Each hoist shall be operated on a monorail (I-beam). The factor of safety shall not be less than 5. The load chain may be heat-treated to give ductility, toughness and as per IS 3109/BS 1663/BS 3114. The load wheel is to be made of heavy-duty malleable castings. the hand chain should be as per BS 6405, and the hand chain wheel may be made from pressed sheet steel with roller-type guarding. Gears shall be cut from solid cast or forged steel blanks or stress-relieved welded steel construction. Pinions shall be of forged carbon steel or heat-treated alloy steel. strength, Quality of steel, heat treatment, face, pitch of teeth and design shall be as per BS-436, BS-545 and BS 721. Spur and helical gears must comply with BS 436, and worm with BS 721. The bearing must be ball and roller type as per IS 2513 / BS 2525-32. Proper lubricating arrangements are to be provided for the bearing and pinion. The brakes for the lifting gear shall be automatic and always in action.

The proof testing of each chain pulley block is to be carried out as per the latest applicable standards. the safe working load is to be marked in such a way that it is visible from the operating level.

1.32 Manually Operated Travelling Crane

The crane bridge shall consist of a single bridge girder carrying two wheels at each end of the span. The

steel used shall be tested quality steel conforming to IS 2062. The girder shall have enough strength to carry the test load without causing undue stress or deflection.

The long travel bridge wheels shall be rimming toughened, heat-treated carbon steel or low alloy steel or CI. they shall be double-flanged type. The wheels shall have antifriction ball/roller bearings. The Wheels shall be machined on their treads to match the runway rail section. The bridge shall have a geared shaft and pulley connecting to opposite wheels of the span, to achieve the long travel motion of the bridge, by means of a chain. The runway rails of adequate strength and rigidity, rail clamps and other accessories for mounting the rails and suitable end stops for the bridge shall be supplied.

1.33 Trolley and Chain Pulley Block

The chain pulley block shall be operated on the lower flange of the bridge girder.

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

The hand chain for the hoisting and traverse mechanism shall hang well clear of the hook, and both chains shall be on the same side. the hand-chin wheel shall be made from pressed sheets and provided with roller-type guarding to prevent snagging and fouling of the chain.

All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat-treated alloy steel. Gears shall be as per BS 436/IS: 4460.

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

The travelling trolley shall be made of rolled steel as per IS: 2062. The side plates of the trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. the two side plates shall be connected by means of an equalizing pin.

Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

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

The break for the lifting gear shall be automatic and always in action. It shall be a screw and friction disc type self-actuating load pressure brake. Breaks shall offer no resistance during hoisting.

A ratchet and pawl mechanism shall be provided to arrest the full load from lowering due to gravity. The ratchet and pawl shall be of steel, hardened and tempered to attain the required wear resistance and toughness.

1.34 Jib Crane

A fixed jig crane shall be provided for lowering/removal of equipment/parts to/from the reactor tanks floor and transferring the same outside the reactor area. The crane capacity shall be 1.25 times the maximum weight to be handled or 1.5 tons, whichever is greater.

The lift and reach of the crane shall be suitable for the equipment/parts to be handled. The crane shall be capable of being swiveled by 360 deg. All material used in the construction shall be corrosion resistant, and the MS used shall be galvanized. Rope chains and pulleys shall be of SS construction. Hardware shall be of SS 316.

The jib crane shall also be provided for submersible pumps in the reactor tank and the thickened sludge sump.

1.35 EOT Crane

The crane shall be electrically operated, bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall be confirmed to BS 2573, IS: 3177 or relevant internationally approved standards.

The crane bridge shall consist of bridge girders on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access the walkway with a safe hand railing as required along the full span length of the bridge girder. The steel shall be of tested quality as per ASTM A36, except that plates more than 20 mm thick shall conform to IS 2062, BS 4360 or relevant international standards. All antifriction bearings for bridge and trolley track wheels, gearboxes and bottom sheaves on the hook shall be lubricated manually by hand-operated grease pump through respective grease nipples.

The wheelbase and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevents skewness. Bridge and trolley track wheels shall be of forged steel double-flanged type. The wheel dia. and rail sizes shall be suitable for the wheel loads. The crane rail shall be manufactured from wear-resistant austenitic manganese steel. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Walkways shall be at least 500 mm clear inside width with a 6 mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolleys from running off the bridge shall be abutted against the ends of rails and welded to the girders. A bridge and trolley stop to match the wheel radius shall be provided before the buffer stops.

All exposed couplings, shafts, gears, wheels, pinions, chain drives, etc., shall be encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 100,000 operating hours. Electromagnetic or hydraulic thrust breaks shall be provided for the main hoist. One electromagnetic brake shall be provided for each of the cross-travel and long-travel motions.

The hook shall be solid forged, heat-treated alloy or Carbon Steel suitable for the duty service. They shall have swivels and operate on ball thrust bearings with hardened races. The lifting hooks shall comply with the requirements of IS 8610 or BS: 2903 / BS: 3017 or relevant internationally approved standards and shall have a safety latch to prevent the rope from coming off the hook. Hoist rope shall be extra flexible, improved plough galvanized steel rope with well-lubricated hemp core and having six strands of 37 wires per strand with a minimum ultimate tensile strength of 1.6 X 106 KN/m2 of right-hand Ordinary laid construction. The ropes shall have a safety factor of 6 on the specified working load and shall also conform to the IS: 2266. Rope drums shall be grooved and shall be either cast iron, cast steel or welded steel as per IS:3177, BS:466.

Gears shall be cut from solid cast or forged steel blanks or shall be stress-relieved welded steel construction. Pinions shall be forged carbon or heat-treated alloy steel. The strength quality of steel, heat treatment, face, pitch of the teeth, and design shall be confirmed to BS: 436, IS 4460 and BS: 721.

A nameplate showing the capacity, year of manufacturing and rated capacity of the crane, in a figure not less than 150 mm height, shall be placed on each side of the crane girder.

The deflection test shall be done as per IS:3177.

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

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

- "start" and "stop".
- Long travel -' Right' and 'left'.
- Cross travel 'To' and 'Fro'.
- Hook 'Hoist' and 'Lower'.
- Red indicating lamp for supply 'ON' indication.

A pendant-type push button shall be supported independently of the electrical cable and shall be earthed

separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent overtravel for each of the following:

- for the "UP" and "Down" motion of the hook.
- Long travel motion.
- Cross travel motion.

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

All motors shall be of the quick-reversing type with electrical or mechanical brakes suitable for the duties specified. All movements shall be electrically powered, suitable for operating with the hook loaded. Facilities shall be provided for the accurate location of the hook by means of inching the cross-travel and down-shop travel motions.

Sufficient slings, ropes, shackles, lifting beams, etc. shall be supplied to handle all items of plant covered by the crane. they shall be labelled or marked with a safe working load and the purpose for which they are intended.

The crane and all slings, ropes and other lifting equipment shall be tested by the manufacturer at their place. The test shall be carried out at 125% of the safe working load, and a test certificate shall be supplied.

The operator shall include with the cranes all necessary contactors, control cubicles and protection equipment necessary to operate the crane and provide adequate electrical protection against overload, phase and earth fault and fail-safe protection in the event of a power failure. All access ladders and platforms necessary to carry out maintenance and repair shall be provided and installed by the operator.

All electrical equipment shall be fully tropicalized.

Site tests shall be carried out by the operator, who shall supply the necessary materials for the test load. The test load shall be removed from the site by the operator after successful tests have been carried out.

1.36 Monorail Hoists (Electrically Operated)

The design, manufacture, shop testing, erection, testing & commissioning at the site of the Monorail Hoists (Electrically Operated) shall, in general, conform to the latest revisions of the following Indian Standards. In addition to other standards mentioned elsewhere in the tender documents, subject to any modification & requirement specified hereinafter.

- IS: 2266 Specification for steel wire ropes for General Engineering purposes.
- IS: 594 Technical supply conditions for wire ropes and strands.
- IS: 1835 Specification for Round steel wire for ropes.
- IS: 3938 Specification for electric wire rope hoists.
- IS: 7847 General Characteristics of lifting hook.
- IS: 3815 Specification for point hook with shank for general engineering purposes.
- IS: 807 Code of practice for design, Manufacture, erection & testing (Structural Portion of cranes & hoists)

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

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

The Capacity of the monorail hoist shall not be less than 50% above the weight of the heaviest item envisaged to be lifted during erection and maintenance.

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 must be made from extra flexible, improved plough steel wire, incorporating a well-lubricated hemp core, and consisting of six strands containing 37 wires each, with a minimum ultimate tensile strength of 1.6 × 10^6 kn/m².

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

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

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

The electric hoists shall be of Class II duty.

25% overload test, speed tests, limit switch tests, and brake tests shall be conducted for the hoist and trolley at the manufacturer’s works.

Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthling guards, etc., shall be as per IS:3938. Limit switches shall be provided for over-hoisting and over-lowering conditions. The girder carrying the electrical hoist and the support columns shall have enough strength to carry the test load without causing any deformity under full load conditions and stress.

Pipe and Fittings

1.37 Ductile iron pipes and fittings

a) All Ductile iron pipes shall be class K-9 conforming to IS: 8329. All Ductile iron fittings shall conform to IS: 9523.

b) Socket and Spigot type shall consist of an elastomeric rubber ring gasket for forming an integral joint between pipes or pipe and fitting shall conform to IS: 12820. Flanged Joints, wherever specified in the drawings, shall conform to IS: 8329.

c) All pipes and fittings shall be internally lined with sulphate-resistant higher volumes of slag/blended cement mortar in accordance with ISO 4179/IS: 11906. Higher volumes of slag/blended Cement mortar lining shall be applied at the factory in accordance with the above-mentioned standards. Pipe linings shall be inspected, and any damage or defective areas shall be made good to the satisfaction of the Engineer.

d) On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the pipes and fittings in a clean and acceptable condition.

1.38 Mild Steel Pipe

Technical Specifications for MS Pipeline

This specification covers the requirements for procurement, supply, manufacture/fabrication, transportation, stacking at the site of works, laying, jointing, testing and successful commissioning of all welded Mild Steel pipeline, appurtenances, specials, etc., below/above ground, including associated civil works required for the same.

Standards

Submerged Arc welded Hot finished mild steel Bevelled pipes to be manufactured, supplied and delivered under the scope of this contract shall be manufactured in accordance with and conforming to IS-3589 and/or IS-5504. Pipes shall be applied with Internal & External Protection as per technical specification and as per relevant IS codes (latest revision/amendments).

The following details, standards, and codes are part of this specification. All standards, specifications and codes of practice referred to herein shall be the latest edition, including all applicable official amendments and revisions.

Special attention of the Contractor is drawn to the relevant sections and clauses of the National Building Code of India and BIS Codes (latest editions along with amendments), and the same should be followed strictly in addition to the specification and conditions stipulated in this section.

If for items for which specifications are not specified in this volume and IS specifications shall be applicable, and in case of any discrepancy Employer's Representative's decision will be final and binding.

The following list includes various Indian Standards which are referred to in the specifications and used in construction works. These standards are to be strictly adhered to unless otherwise applicable in the relevant context. These standards are to be followed both in respect of materials, equipment, methods, procedures, etc. and for all the works included in the tender.

It is obligatory that only the latest edition of the standard is referred to and followed, along with all amendments and revisions issued with respect to the standard under consideration. This list is not exhaustive but contains only the standards that are very frequently used in construction works. If a standard exists for a particular item of material or equipment or code of practice, the same shall be followed, whether the same is included in this list, specifications, or other parts of the tender documents or not. Some Indian Standards are referred to in the specifications/drawings/other parts of the tender documents, and they are supplementing this list if they do not find a place in the list.

IS : 2062	Hot Rolled Medium and High Tensile Structural Steel- Specification

IS : 814	Covered Electrodes for Manual Metal Arc Welding of carbon and C-Mn steel.
BS EN 499	Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non-Alloy and Fine Grain Steel. Classification
AWS : A-5.1	Specification for Mild Steel Covered Arc Welding Electrodes.
IS : 3613	Acceptance Tests for Wire Flux Combinations for Submerged–Arc Welding.
AWS : A-5.17	Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding. IS :1377 -Technical Supply Conditions for Threaded Fasteners
IS : 1367	Technical Supply Conditions for Threaded Steel Fasteners (Parts 1 to 3).
IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming-specification
IS : 102	Ready Mixed Paint, Brushing, Red Lead, non-setting, Priming.
IS : 816	Code of practice for use of Metal Arc Welding for General Construction in mild steel.
IS : 4353	Submerged Arc Welding of Mild Steel & Low Alloy Steels – Recommendations.
IS : 817	Code of practice for Training and Testing of Metal Arc Welders.
IS : 1182	Recommended practice for Radiographic examination of Fusion -Welded Butt Joints in steel plants
IS : 2595	Code of Practice for Radiographic Testing.
IS : 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of welds.
ASTM E 94	Guide for Radiographic Testing
ASTM E 709	Guide for Magnetic Particle Examination.
ASTM E 165	Test Method for Liquid Penetrate Examination.
IS : 3600	Methods of Testing Fusion Welded Joints and weld metal in steel (Parts 1 to 9)
IS : 4853	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipes.
IS : 3589	Seamless or electrically welded steel pipes for Water Gas and Sewage (168.3 to 2540 Outside Diameter)
IS : 6631	Specification for Steel Pipes for Hydraulic Purposes
IS : 7343	Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products
IS : 2598	Safety Code for Industrial Radiographic Practice
IS : 5822	Code of Practice for Laying of Electrically Welded steel pipes for water supply
IS : 1608	Metallic material tensile testing at ambient temperature
IS : 9595	Metal Arc welding of Carbon and Carbon-Manganese Steels – Recommendations
IS : 2825	Code of Unfired Pressure Vessels
IS : 5504	Specification for Spiral Welded Pipes
IS: 10748	Hot-rolled Steel Strip for Welded Tubes and Pipes -Specification

Pipe Ends

The pipe shall have beveled ends to an angle of 30°+5° measured from a line drawn perpendicular to the axis of the pipe. The root face shall be 1.6+0.8 mm. The root face of the bevel may be prepared by hand finishing if required.

Length of Pipes

The random length of pipes shall be 5 to 6 meters. In specific locations, smaller lengths can be accepted as per the Employer's Representative.

Straightness of Pipes

Finished pipes shall not deviate from straightness by more than 0.2% of the total length checking for straightness shall be carried out using a taut string or wire from end to end along the side of the pipe to measure, the greatest deviation.

Testing of Pipes

The main tests among others to be conducted on each pipe shall be as per IS-3589 and/or IS-5504 with its latest version.

Sampling of pipes

The sampling of pipes shall be as in IS: 4711 with the latest version/amendment or as directed by the Employer's Representative.

Other Tolerances

As per IS-3589 and/or IS-5504 with the latest version (Except for wall thickness). M.S. Pipes shall be welded either longitudinally or spirally. Before fabrication of pipes and specials/fittings is commenced, the copies of the mill sheets and the manufacturer’s test certificates for plates and other materials required for fabrication shall be submitted by the Contractor to the Employer’s Representative for his approval.

When instructed by the Employer's Representative, the Contractor shall supply free of charge to the Employer's Representative for testing suitable samples of the materials to be used/used in the Works.

Welding

All components of a standard shell, either straight or bent, etc., shall be welded by use of an automatic arc welding machine, by a Submerged Arc welding process, with alternating current. Manual welding shall not be permitted except for sealing runs/ field weld joints and such other minor works at the discretion of the Employer's Representative. The strength of the joint shall be at least equal to that of the parent material. The contractor shall use radiographic quality electrodes and carry out the welding procedure specification (WPS) and Pre-qualification Requirement (PQR). For welding the contractor shall ensure the use of the standard current and arc voltage required for the machine. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Employer's Representative. The values once determined shall be maintained throughout the work, and if any modifications are to be made, a written permission of the Employer’s Representative shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results, and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds. Welding should be carried out inside as well as outside. The contractor should engage all qualified welders for field welding with at least a 6G level qualification. The contractor should submit such a qualified welder's list before taking up welding work. All welding shall conform to the requirements of IS 4353 latest version All longitudinal and circumferential joints shall be double welded butt joints. Field joints shall be from the outside, with a sealing weld from the inside. End preparation for such welding shall conform to IS: 2825.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surfaces of plates match to provide streamlined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thicknesses of shells shall be carried out in the shops. The welding shall be of the best workmanship, free from flaws, burns, etc., and the Contractor shall provide for his electrodes and equipment, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall have to undergo testing. Such testing shall be organized by the Contractor before they are entrusted with the job. Qualification standards for welding procedures, welders and welding operations shall conform to the requirements of IS: 7307 and IS: 7310 (latest) and/or ASME section-IX (latest). Periodical tests as regards their efficiency shall also be taken at intervals of about 6 months and those found inefficient shall be removed from the job. Only those who pass the test shall be posted for the job.

If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be set right to the satisfaction of the Employer's Representative. All such check tests and rectifications of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

A record shall be maintained showing the names of welders and operators who have worked on each joint. Hand welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be, as far as possible, completed by them in all respects, including the sealing run. No helper or other unauthorised

person shall be permitted to do any welding whatsoever. In case of infringement of the above, the persons shall be punished as directed by the Employer's Representative

The welded joint after welding should not become brittle or sensitive to blows, and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal and is to retain its original ductility. No allowance will be made for the thinning of the weld and the weld should at no point be less than the nominal thickness of the plate.

Upon receipt of the order and before the start of fabrication, the Contractor shall submit to the Employer's Representative for his approval the "welding procedure" he intends to use in the shop work. Similarly, before the start of the field welding, the procedure must be submitted to the Employer's Representative for approval. Manual welding shall be adopted only when machine welding is not possible.

Ultrasonic Test of Welded Joints

100% of the welded length in each pipe shall be subjected to an ultrasonic test at the factory. The acceptance/rejection criteria shall be as per API 5L (American Petroleum Institute). The ultrasonic test shall be conducted using the relevant ASME code. (American Society of Mechanical Engineering). The person who conducts the test shall have a certificate as per ISNT or ASNT Level-2 (American Standards and Testing).

Radiographic test of welded Joints

In the case of field joints, a minimum of 10 % of the weld length of each joint at random shall be subjected to a radiography test.

In case of failure of joints, the contractor shall be required to carry out radiography of thrice the number of segments failing during the radiography test. Even after such radiography testing, if any one of the segments fails, the contractor shall be required to carry out radiography of the full joint.

The weld ripples or weld surface irregularities, on both inside and outside, shall be removed by any suitable mechanical process to a degree such that the resulting radiographic contrast due to any remaining irregularities cannot mark or be confused with that of an objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique, either with X-ray or gamma-ray equipment.

The photographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Employer's Representative to identify the defects and determine those which must be removed. Defects that are not acceptable shall be removed by chipping,machining or flame gouging to sound metal, and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Employer's Representative based on the latest standards prescribed by the Indian Standard specifications.

All X-rays shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be always readily accessible for inspection by the Employer's Representative. The Contractor shall provide for the use of the Employer's Representative suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor and shall be handed over to the department on completion of the Contract. All films shall be identified by the number, and a chart prepared to indicate the location of the joint each X-ray photo represents. In the event of additional radiographic inspections required for any work associated with the pipe erection, such inspection shall be performed by the Radiographer at the discretion of the Employer's Representative.

Radiographic Inspection of Welded Joints

All welded joints are to be radio-graphed and shall be examined in accordance with:

IS : 2595	Code of Practice for Radiographic Testing
IS : 4853	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in

	Steel Pipes
IS: 1182	Recommended Practice for Radiographic Examination of Fusion

The reinforcement on each side of all butt-welded joints shall not exceed 1.5 mm.

A complete set of radiographs and records as described in IS: 2595 Clause 14, for each job, shall be retained by the Contractor and kept on file for at least five years.

Radiographers performing radiographs shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices “Recommended Practice for Non-destructive Testing Personnel Qualification and Certification" published by the American Society for Nondestructive Testing, as applicable for the technique and methods used.

Final acceptance of radiographs shall be based on the ability to see the prescribed penetrometer image and the specified hole. Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired.

i. Any type of crack, or zone of incomplete fusion or penetration,
ii. Any elongated slag inclusion which has a length greater than 6 mm,
iii. any group of slag inclusions in a line that has an aggregate length greater than the thickness in a length of 12 times the thickness, except when the distance between the successive imperfections exceeds 6L, where L is the length of the longest imperfection in the group
iv. Rounded indications in excess of those specified by the acceptance standards given earlier.

The destructive test of pipe joints on the field shall be carried out as per IS 3600. For every 200 m length of pipeline laid, one destructive test of the field joint shall be carried out.

The welded joints shall be tested for Tensile test, Bend test & tree-panned plug-in accordance with the procedure laid down in IS No. 3600 of 1966 and the latest version of all parts of the code "Code of procedure for testing of fusion welded joints and weld metals in steel".

Test pieces shall be taken by the contractor from the welded joints at the position on fabricated pipes pointed out by the Employer's Representative.

The sample so taken shall then be cut to the exact shape and dimensions machined as described below and handed over to the Employer's Representative for testing.

Pipe laying

Bedding

Bedding for the pipeline shall be of two different classes, depending on the soil strata as per the direction of the Employer’s Representative.

When the soil strata in the trench is soil (other than soft or hard rock), the trench shall be properly compacted, and no extra bedding shall be provided. The bottom of the trench shall be prepared in such a way that the profile of the pipe shall touch the bottom of the trench at 120º from the center of the pipe. This profile of pipe at the bottom of the trench for uniform support shall not be made more than 2 days prior to the actual laying of the pipe.

When soil strata in the trench are rocky or consist of any unsuitable material which is likely, in the opinion of the Employer’s Representative, to cause damage to the pipe, then sand/murmur bedding shall be provided. The bedding material shall be clean, well graded, and free from topsoil, clay, or vegetable matter and approved of the Employer’s Representative. If the material supplied is unclean, it shall be washed. In no case shall it contain more than 3.5% by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt and organic impurities, as described in IS 383, shall apply.

The bedding shall be done as under:

i. The filling and compaction shall be done up to the appropriate depth.
ii. The bedding shall be compacted, at optimum moisture content and by mechanical equipment with suitably shaped tamping feet/ plate, to 90% modified proctor density.
iii. The compacted fill shall be re-excavated in a profile to match the pipe profile to form a “cradle” which will provide a 120-degree uniform support to the pipe.
iv. The appropriate depth is such that after re-excavating the fill minimum of 150 mm of sand bedding material shall remain below the bottom center of the pipe.
v. The profile of pipe in compacted fill for uniform support shall not be made more than 2 days prior to the actual laying of pipe.

Laying Program.

The Contractor shall submit a detailed bar chart for the procurement and laying of the pipeline, which shall be subject to the Employer's Representative's approval. In preparing this bar chart, the Contractor shall plan his activities such that the laying of pipes shall closely follow the procurement schedule, and no pipes shall remain stacked at the site for more than one month or as decided by the Employer's Representative. The Contractor shall submit the procurement schedule of pipes and fittings for the Employer's Representative's approval.

Together with the chart, he shall submit a methodology describing how he will carry out this Work within the contractual period and the required resources in terms of construction equipment and other facilities that he shall utilise to complete the work.

The pipes and specials supplied shall be transported by the contractor to their respective positions at the risk and cost of the contractor and installed in their respective position. Conveyance from a stacked place until the pipes and specials etc., are lowered and laid into trenches or on a pedestal shall be done by the contractor at his own cost. The pipe can be assembled in the position either by providing cranes, portable gantries, shear legs or any other equipment approved by the Employer's Representative, and pipes shall be laid conforming to IS-5822-1994. Normally, not more than 2/3 pieces of total length not exceeding 24m shall be aligned, tacked and kept in position on temporary supports. Further work shall not proceed until those pipes are fully welded. The free end of the pipeline shall be held in position by two ceilings to avoid deflection due to temperature variations during the day. Preferably, the assembly of pipes tack welded with runs of welds should be done, or continuity of work can be maintained by adding more pipes on the second day in a similar manner after completion of welding of previous joints during the night.

Lowering and Jointing

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged, and if necessary, additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the coating of the pipe is not damaged in any way during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in the correct line and level by using the levelling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joint are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4 mm If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends into contact and alignment. It may also be necessary for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for the correct line and level, it shall be finally supported on wooden beams and wedges and tack-welded. Some portion of the trench may be refilled at this stage to prevent the pipeline from losing its alignment. The tack-welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time, shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench and the welding pits shall be

cleaned of guniting rebound. The welding pits shall be filled and compacted in 150 mm layers with the bedding material.

Except for routine welding of joints, no other work shall be done in the absence of the Employer's Representative.

The components of the exposed sections of the pipeline, such as plates and pedestals, shall be so designed that the centres of the plates and pedestals shall coincide with the mean temperature of the locality. For this reason, all work such as fixing flanges, plates, etc., in true alignment and correct position and tack welding pipes shall be done at the mean temperature. For ascertaining the temperature, the Contractor shall provide mercury cups, fix them to the pipe shell from outside, and provide thermometers of the required type and range. No extra payment shall be made for this.

Providing Steel Props Inside the Pipeline

In order to effectively provide cement mortar lining to the inside of the pipes and to avoid difficulties during the work, the roundness of the pipes must be maintained circular till the lining work is taken up. To achieve the same, steel adjustable screw-type props of the screw or similar approved make consisting of a minimum of six legs shall be fixed inside the pipe. The deflection of the Pipe should be limited to 2% of the average diameter. In no case shall the limit be exceeded, even under the full load, in the case of pipes laid underground. The design and drawings of the props that the contractor intends to use should be approved by the Employer's Representative before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of no more than 1.8 meters or as directed by the Employer's Representative. If the Employer's Representative finds it necessary, they must be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full height of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Employer's Representative. The height of earth fills over the pipe top shall normally be such as to avoid flotation under submerged conditions and have a minimum earth cushion of about 1.20 meters over the pipe, whichever is greater. It is also necessary that, in the case of a buried pipe, adequate side supports from the backfilled materials are developed to keep the diametric deflection within the specified limits. Backfilling of the excavated trenches, particularly below the pipe and along the sides, shall, therefore, have to be done with proper care and compaction as desired.

Refilling of Trenches

On completion of the pipe laying operations and successful field testing of joints in any section, for a length of about 200 m and while further work is still in progress, backfilling of trenches shall be started by the Contractor with a view to restricting the length of open trenches.

All backfill material shall be free from cinders, ashes, slag, refuse, rubbish, vegetables, or organic materials, lumpy or frozen material, boulders, rocks or stones or other material which, in the opinion of the Employer’s Representative, is unsuitable or deleterious.

Unless otherwise specified or permitted by the Employer’s Representative, all backfill material shall be compacted by mechanical means using equipment with suitably shaped feet/ plates. At the time of placing the backfill, the Contractor will be responsible for ensuring that the optimum moisture content is achieved so that the required degree of compaction is achieved. If necessary, the Contractor will be required to add water to the backfill material in such a manner that the moisture content is uniform throughout each layer during compaction.

Backfilling shall be done with fine-grained soils with less than 25% sand content, placed in layers of 150 mm. The backfilling material shall be deposited in the trench for its full width on each side of the pipe, fittings, and appurtenances simultaneously. The column of backfill along the sides of the pipe shall be compacted by mechanical means up to 90% modified proctor density. Care shall be taken to ensure that mechanical compacting equipment is not used from the top of the pipe up to 300 mm above the crown of the pipe.

If suitable material for refilling is not available from already excavated material, the Contractor shall import

material of approved quality as directed by the Employer's Representative.

Care shall be taken during backfilling so as not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur.

The Contractor will be responsible for ensuring that the water content of the soil shall be kept as near the optimum moisture content as possible. Regular measurements of the field dry density shall be taken by the Contractor at various levels in the backfilling as required by specifications and the Employer's Representative. Any backfill which fails to achieve the required degree of compaction shall be re-excavated, replaced, and re-compacted to the required density, all at the Contractor's cost.

Only mechanical compaction shall be done unless otherwise specified or approved by the Employer's Representative. No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or approval for the Employer's Representative has been obtained.

Walking or working on the completed pipeline shall not be permitted unless the trench has been filled with the specified bedding and backfilling up to a height of at least 300 mm over the top of the pipe, except as may be necessary for tamping, etc., during backfilling work.

The trench shall be refilled to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place. The surface of the refilled excavations shall be left slightly higher than the adjacent ground and shall be maintained by the Contractor to a smooth, even slope.

Should any subsidence take place either in the filling of the trenches or near about it during the works the Contractor shall make good the same at his own cost. All the surplus excavated stuff (including rock) will be the Contractor's property, and he will be responsible for making proper arrangements for the disposal of the same.

Field Hydraulic Testing Procedure

After the work of laying of pipeline is completed and before putting it into commission, the pipeline shall be tested in the field, if so, directed by the Employer's Representative, both for its strength and leakage. The procedure for the test shall be as follows:

For Pressure testing, the pipeline shall be divided into sections as defined by the Employer's Representative.

The Sectional Field Hydraulic Test shall be carried out after the pipeline section to be tested has been laid, jointed, and backfilled to a depth sufficient to prevent flotation, but leaving the joints exposed which have not been tested. The sections to be tested shall be to the approval of the Employer's Representative and shall not be longer than 0.5km to 1.0km when either the pipeline is laid adjacent to or underneath the carriageway or when the section includes an air valve chamber. The joints between each tested section shall be left exposed until the pipeline has successfully passed the Tests on Completion. The Field Hydro testing shall be carried out such that the whole length of the proposed pipeline is covered.

In addition to the above requirements, the Contractor shall perform a hydraulic test on the first 0.5km length of the pipeline to be laid under the contract. This test shall be undertaken within one month of the Contractor commencing the laying of pipes. Should the pipeline fail the test or the Contractor fail to undertake the test, all laying and welding work shall come to a halt until that section of the pipeline passes a hydraulic test.

Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Washout valves shall be fitted with blank flanges, and these, together with in-line valves, shall be left open. Air valves already fitted shall be permitted to function during the test.

Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be submitted, with the calculations of the forces to be carried to the Employer's Representative for approval.

The method of filling the pipeline with water shall be approved by the Employer's Representative. The

length under test shall be filled, making certain that all air is displaced through an air valve installed at the top of the blank flange situated at the high end of the line. The length shall then remain under constant moderate pressure, 10 to 20m head of water, for several hours until the pressure can be maintained without additional pumping.

The pressure shall then be slowly increased at a maximum rate of 1 bar per minute to the full test pressure, and pumping discontinued for 3 hours or until the pressure has dropped by 10m, whichever occurs earlier. Thereafter, pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped to restore the pressure shall be the measure of leakage from the discontinuation of pumping until its resumption. This test pressure of 8 bar shall withstand the test for 24 hours.

The pipe length shall pass the test if the leakage is not more than 0.33 litres per mm diameter per kilometre per 24 hours for each 100m head of pressure applied.

Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint, the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test.

No pipeline shall be accepted until the leakage on any length is not more than the rate of leakage specified above, and all sources of leakage have been rectified.

The Test on Completion shall be carried out after all the pipeline sections have been satisfactorily tested and the joints between each section have been completed to provide a continuous test length between contract interfaces.

Pipelines shall be tested as above except where the Employer's Representative issues such instructions as are necessary for testing parts of the Works that have been designed for stresses limited by considerations other than those applying to the pipeline systems.

Test Pressures

Test pressures are to be measured in bars at the Centre of the blank flange situated at the lowest end of the pipeline under test. Unless otherwise specified or shown on the drawings, pipeline field test pressure shall be as per the relevant IS codes and standards.

Test pressures for sections of the pipeline containing air valve chambers shall be such that the pressure at the chamber does not exceed the valve design pressure as specified by the manufacturer.

Internal Cleaning of Pipeline

Wherever directed by the Employer's Representative, internal surfaces of pipes, specials, etc. of all sizes shall be thoroughly cleaned by repeated hosing with water and simultaneous rubbing with gunny cloth.

Further, when a section of the pipeline has been laid and all the work inside it has been completed to the satisfaction of the Employer's Representative, its internal shall be cleaned of all dirt, debris, dust, or other deposits.

Pipelines shall be cleaned by repeated hosing of copious quantities of water on the pipe surface and simultaneously rubbing the surface with a gunny cloth. Cleaning with metal cleaning solution, acid, and wire brushing, scrapers, or sandpaper will not be permitted.

Cleaning of laid pipelines will be restricted to cleansing and scraping out of debris and dirt only.

Cleaning shall be done to the satisfaction of the Employer's Representative. The section of the pipeline once cleaned shall not be entered into for any purpose later. Sufficient precaution shall be taken to prevent the ingress of any dirt, debris, or dust inside the section. Failing this, the section shall be cleaned again at the discretion of the Employer's Representative.

In the case of the above-ground pipeline, the length of the section to be taken up for cleaning shall be decided in consultation with the Employer's Representative from the point of view of ventilation, etc.

In the case of a buried pipeline, a section shall be taken up for cleaning after the work of backfilling around and over the pipeline is completed and the spiders have been removed from inside.

During the pipe laying operation in the adjoining section, the Contractor shall take all precautions to prevent ingress of water, mud, debris, dirt, dust, etc. in the cleaned section, failing which the section shall be cleaned again at the discretion of the Employer's Representative. Where deemed necessary by the Employer's Representative, suitable closures shall be provided at the open end or the ends of the cleaned sections. Payment will be made for the work under the relevant items of the Bill of Quantities.

At die end of a season's work, closure shall invariably be provided at all the open ends to protect the Pipeline from ingress of subsoil water, mud, muck, etc.

No separate payment will be made for the work of cleaning and providing closures. The rates quoted for laying the pipes, painting, etc., shall include the cost thereof.

Internal Cement Mortar Lining

This Specification covers the requirements of providing materials and application of in-situ cement mortar lining by mechanical and/or hand application to the internal surfaces of the pipeline in straight sections, long/short radius bends, vertical shafts, and all specials, etc. Laid below ground level, at the surface, to be installed under this contract. After successful completion of the field hydraulic test of the pipeline, the Contractor shall take up the in-situ cement mortar lining to the internal surface of the pipeline. The work shall be started only after obtaining the written approval of the Employer's Representative in this respect.

The work shall be carried out through an access opening by a machine that progresses uniformly through the pipe, applies mortar against the pipe surface and mechanically traverses to obtain a smooth transition of joints. The lining of bends, specials, and areas adjacent to valves shall be machine sprayed as far as practicable and hand-travelled. The all-access openings shall be replaced in position after lining them by hand. The pipeline will be restored to the satisfaction of the Employer's Representative.

AWWAC602	American Water Works Association (AWWA) Standard for Cement Mortar Lining of Water Pipelines - 4 in. and larger – In Place.
IS-3696	Safety code for scaffolds and ladders (Part 1 & II)
ASTM - C40	Test for Organic Impurities in Sands for Concrete

All pipes and fittings shall be internally lined with cement mortar in accordance with IS: 11906/AWWA C602.

Employer's Representative shall have the right to inspect the source/s of material/s, the operation of procurement and storage of material, Cement mortar batching and mixing equipment and the quality control system. Such an inspection shall be arranged if found necessary, at the expense of the contractor, and no additional payment whatsoever shall be made for the same. Employer's Representative's approval shall be obtained prior to starting of lining work.

Cement shall be Portland cement in accordance with IS 8112.

Sand used for lining shall be tested with standard sieves as per IS 460 and requirements specified in IS 11906.

The minimum cement content shall be 1000 kg/m3, and the water: cement ratio by mass shall be between 0.3 and 0.45:1.

The mortar shall stop 100mm back from the faces of any joints. The end faces shall be vertical.

The contractor shall make sure that proper mobilization of the necessary equipment, etc., making access openings wherever required and curing of the mortar-lined pipes, including testing, patching access holes, etc., as described in the following pages. The main items of the work will be generally as follows:

Surface Preparation for Cement Motor Lining

The interior surface of the pipe to be lined shall be cleaned to remove all rust, chemical or other deposits, oil, grease and all accumulations of water, dirt, and debris. The cleaning of the surface shall be carried out with the use of suitable chemical or mechanical means to the approval of the Employer's Representative. The extent of cleaning shall be to the satisfaction of the Employer's Representative.

All loose mill scale, dirt, rust, and accumulation of construction debris shall be removed from the interior of the steel pipeline. The pipeline shall be cleaned by use of a power-driven cleaner incorporating revolving brushes on rotating arms.

Immediately before the travel of the lining machine through the pipeline, all foreign material shall be removed. This includes sand and loose mortar that might have accumulated since the work of surface preparation work was completed.

Mix Proportion for Cement Mortar Lining

The proportion of sand to cement shall not be more than 1.0 part sand to 1.0 part cement by weight. Mortar composed of cement, sand and water shall be well mixed and of proper consistency to obtain a dense, homogeneous lining that will adhere firmly to the pipe surface. The cement mortar mix shall comply with the

strength and density requirements specified in IS 11906/AWWA C602. No admixtures shall be permitted unless approved by the Employer's Representative.

Thickness of Cement Mortar lining

The lining shall be uniform in thickness. The lining thickness shall be 10mm with no negative tolerance and a positive tolerance of 3mm.

Mild Steel Pipe Internal Lining Procedure

The lining shall be placed by the centrifugal method in one course by a machine travelling through the pipe and discharging the mortar at a high velocity overall pipe section and long radius bends. The discharge shall be from the rear of the machine so that the freshly applied mortar will not be marked. The rate of travel of the machine and the rate of mortar discharge shall be mechanically regulated to produce uniform thickness throughout. The mortar must be densely packed and shall adhere to the pipe wherever applied.

Mortar lining shall be mechanically troweled except for the places where hand troweling is expressly permitted by the Employer's Representative.

The lining machine shall be provided with attachments for mechanically troweling the mortar. Both the application and troweling of the mortar shall take place at the rear of the machine so that the freshly placed and troweled mortar will not be damaged. The trowel attachment shall be such that the pressure applied to the pipe will be uniform and produce a lining of uniform thickness with a smooth and even finished surface free of spiral shoulders. The finished surface of the machine, placed troweled lining in the pipe shall be examined according to the procedures as laid down in Indian Standards or any other International Standard whichever is stringent.

Ridges or uneven build-up caused by irregularity in the travel rate of the machine shall not be allowed.

The thickness of the lining shall be ascertained frequently during the placing of mortar and troweling using an approved non-destructive method.

In the stretch of pipe that has been lined and troweled in each day's run, ten places shall be selected in straight sections of the pipe by the Employer's Representative. In each of the ten places, the thickness of the lining shall be re-measured by non-destructive means as directed by the Employer's Representative.

Defects in lining, including but not restricted to sand pockets, voids, over-sanded areas, blisters, cracked and dummy areas, and thin spots, shall be removed, and the area shall be repaired to the full required thickness of the mortar lining. Defective areas encompassing the full diameter of the pipe shall be replaced by a machine. Defective lining rejected at the time of lining shall be removed before the initial setting of the mortar. Defective lining rejected after the initial set shall be replaced or repaired by the most practical method as determined by the Employer's Representative.

Hair cracks or cracks up to 0.25 mm in width and not over 300 mm in length in finished linings may be considered acceptable at the discretion of the Employer's Representative, but larger cracks shall be repaired or removed and redone all as directed by the Employer's Representative.

Cement mortar lining of bends, specials, areas closely adjacent to valves and other such places where machine placing may not be practical shall be performed by hand. The Employer's Representative may order the correction of any defect by hand application. The entire procedure of applying cement mortar lining shall be subject to continuous inspection by the Employer's Representative, but such inspection shall not relieve the contractor of the responsibility to furnish material and perform work in progress in accordance with this standard. All cement mortar lining not applied in accordance with these specifications shall be subject to rejection by the Employer's Representative. The lining so rejected shall be removed and replaced or repaired by the contractor at the cost of contractor.

The Employer's Representative shall have free access to all areas, places or facilities concerned with the furnishing of material or the performance of work under the provisions of this standard.

The contractor shall furnish the Employer's Representative reasonable assistance, without charge, in carrying out the inspection duties and specifically in obtaining information with respect to the character of the material used and the progress and manner of the work.

Pipe Internal Lining Inspection Procedure

The Employer's Representative shall inspect the pipeline following the application of the cement mortar lining to identify defective areas in the lining, to determine the quality of the lining and to determine compliance with this standard.

Every precaution shall be taken to prevent injury to the lining should the lining be damaged through the fault of the contractor. At any time before completion of the contract, such damage shall be repaired conforming to these standards, at the contractor's expense. The repair of damaged lining not attributable to the contractor shall be carried out and paid for on an extra-work basis.

Access Openings for Cement Mortar Linings

The contractor may utilize existing specified manholes, flanged outlets, and pass holes for access and material feed points during the lining operations. All-access openings shall be removed and or replaced in accordance with specifications. Mortar lining of closure and adjacent areas shall be applied by machine or hand methods. Access to the pipeline for placing field-applied cement mortar lining may be obtained by one or more of the following methods: -

Temporarily omitting short "roll out" sections of pipe.

Deferring the installation of the closing sections of the pipe until after completion of the lining. Cutting "half cap" openings in the completed openings.

Cutting temporary feed point manholes in the installed pipeline.

Preparation of pipe surfaces: The interior surface of the pipeline shall be cleaned prior to the placement of cement mortar lining. The pipe interior surface shall be free of oil, grease, and accumulations of water. All loose mill scale, air, rust and construction debris shall be removed from the interior surface of the new steel pipeline. This may be accomplished using a stiff street broom in the large pipe or a drag brush in

the small pipe. Shot or sandblasting is not required.

Hand Application of Cement Mortar Lining

Cement mortar for hand work shall be of the same materials as the mortar for machine-placed lining.

The areas to be lined shall be thoroughly cleaned as specified earlier and, if necessary, shall be moistened with water immediately prior to placing the hand-applied mortar.

Steel finishing trowels shall be used for the hand application of cement mortar, except at bends, the outer edges of hand-troweled areas may be brushed in order to reduce the abutting offset.

All hand-finishing work in a section of the pipeline shall be completed within 24 hours after completion of the machine application of mortar lining in that section. If necessary, application of mortar lining by machine shall be delayed or stopped to assure compliance with this schedule.

Hand-placed mortar shall have a uniform and smooth surface with smooth transitions to adjacent machine-placed linings.

Hand-placed mortar shall have a uniform surface with smooth transitions to the adjacent machine-placed lining.

Materials for cement Mortar for hand work shall be of the same materials as the mortar for machine-placed lining.

Cleaning: Areas to be lined shall be thoroughly cleaned. If necessary, shall be moistened with water immediately prior to placing the hand-applied mortar.

Troweling: Steel finishing trowels shall be used for the hand application of cement mortar, except at bends. The outer edges of hand-troweled areas may be brushed in order to reduce the abutting offset.

Timing: All hand-finishing work in a section of the pipeline shall be completed within 24 hours after completion of the machine application of mortar lining to that section. If necessary, the application of mortar lining by machine shall be delayed or stopped to ensure compliance with this schedule.

Special Requirements at Openings: Laterals and connections to the pipe being lined shall not be left obstructed by the lining operations. Openings in the pipeline for manholes, outlets and blow-offs shall be temporarily closed and covered with removable coverings or other suitable devices to prevent the intrusion of the cement mortar into such openings. On completion of the lining, the contractor shall remove all such covers and shall repair any lining damaged in the process.

Tests of Cement Mortar Used for Lining: Field Tests.

The following field tests shall be carried out by the contractor at his own cost to determine the quality of the mortar.

Slump Test

Fresh Mortar mixed in power mix may be taken for slump tests; the water content shall be as minimal as possible. The slump test should be done once a day or as directed by the Employer's Representative using the freshly mixed mortar immediately prior to the mortar being fed to the lining machine. The slump shall not exceed 25mm to 30mm. The test should be made in accordance with ASTM C-143. In the event of failure, in respect of the above test, the site Employer's Representative will take suitable action, including stoppage of the work.

Cube Test

After the slump test is carried out, cubes of cement mortar of the size 10cm x 10cm x 10cm shall be taken out. Each block shall be removed from its mould as soon as practicable and cured under conditions of temperature and humidity identical to those in which the lining of the pipe is cured. The number of tests shall be at least 4 cubes for each age and each water-cement ratio. The work cube strength of the test cube shall not be less than 300 kg/cm2 after 28 days of curing or 170 Kg/cm2 after 7 days of curing.

The density of the test cube shall not be less than 2300 Kg/m3.

The casting of the cubes shall be done on all the days of mortar lining. The contractor shall make the arrangements for a cube testing machine at the site. Failure of the cube test may entail partial or whole demolition of such / work, penalties for the contractor concerned and /or other similar steps. In case of any dispute, the decision of the Employer's Representative shall be binding on the contractor.

Specials and Appurtenances: General

Specials, such as tees, Y-Pieces, bends, tapers, and dished ends, shall necessarily be in steel and shall be manufactured as per standards and tested in the same manner as the pipe. Small branches, single-piece bends, etc., may be fabricated at the site, care being taken to ensure that the fabricated fittings have the same strength as the pipeline to which they are to be joined.

Specials shall be fabricated from IS 2062 Grade B Steel to the dimensions shown on the drawings. Specials, such as tees, Y-pieces, bends, tapers, etc., shall necessarily be in steel and shall be in accordance with IS 7322/BS 534/AWWA C208 and ASME standards and tested and laid in the same manner as the pipes.

Standard fittings shall be used wherever possible in preference to fabricated fittings. Standard fittings shall be manufactured in accordance with the standards specified above. Where fabricated fittings are supplied, with the approval of the Employer's Representative, they shall be fully workshop fabricated and tested in accordance with the above standards.

Tees and Branches on steel pipelines must be reinforced by welding reinforcement collars around the base of the branch, and in the case of large diameter branches, increasing the main pipe wall thickness or making use of crotch plates.

The specials and fittings shall be designed by the Contractor and the design calculations (as per the relevant codes) and drawings shall be submitted to the Employer's Representative for approval. For oval-shaped collars, the width shall be at the narrowest point. All other fittings, tees, branches, crosses, and bends are to be designed by the fabricator.

Bends

Bends shall be fabricated taking into account the vertical and horizontal angles for each case.

The bends shall have welded joints, and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.

Bends shall be designed with a deflection angle of a maximum of 2º between segments.

When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from the appropriate formula.

All joints in bends shall be thermally stress relieved as specified.

Details of thrust collar anchor bolts, holding down straps, saddle plate etc. should be furnished together with full specifications in the Contractor’s fabrication drawing.

Manholes

Manholes shall be placed as per the locations indicated in the construction drawing and as directed by the Employer's Representative. Manholes in the pipeline shall be placed in a suitable position in the top

quadrant.

The Contractor shall fabricate different parts of the manhole in conformity with relevant IS specifications, well-established practices and as directed by the Employer's Representative.

The thickness of the Mild steel plate used for the construction of the manhole shall be as indicated in the drawing or as directed by the Employer's Representative. The measurement of the manhole and payment shall include all fabrication and welding to the main pipe and shall be paid based on quantity.

Closing or Makeup Sections

Closing or make-up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for the shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

Test Heads

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding, removal of the head and preparation of the plate edges for the final weld after testing.

No separate payment will be made for such test heads. The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

Flanges

Flanges shall be provided at the end of pipes or special locations where valves, blank flanges, tapers/reducers, etc., have to be introduced. The flanges received from the manufacturers shall have the necessary bolt holes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, to get the desired position of the valves, etc., either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Employer's Representative orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when directed by the Employer's Representative, the Contractor shall provide and weld gusset stiffeners, as directed on site.

Blank Flanges

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and for commissioning a section of the pipeline, or for testing the pipeline laid. For temporary closure, non-pressure blank flanges consisting of mild steel plates and tack-welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per the Employer's Representative’s requirements shall be provided.

Stiffener Rings

The Contractor shall provide stiffener rings wherever directed by the Employer's Representative. The Contractor shall weld the same to the pipes with one circumferential run on each side.

Straps

Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met at the site, the final connection has to be made by introducing straps to cover gaps up to 30cm in length. The straps shall also be provided as per the procedure of fixing expansion joints by the method described in these specifications. Such straps shall be fabricated in the field by cutting pipes, slitting them longitudinally and slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have an inside diameter equal to the outside diameter of the pipe to be connected. A minimum lap of 8cm on either end of the pipe shall be kept, and fillet welds shall be run both internally and externally in the circumferential joint. The longitudinal joints of the collar shall be butt welded. All fillet welds shall have a throat thickness of not less than 0.7 times the width of the weld.

Anchor/Thrusts Blocks

Anchor/Thrust blocks shall be provided at horizontal bends, vertical bends or/ at intervals on pipelines as directed by the Employer's Representative /Consultant. The provision of Anchor Block/Thrust Block shall be finalized during the execution, and the same shall be shown on the L section drawing released for construction, indicating the Chainages/at which the Anchor Block is to be provided. The anchorages shall be made from concrete and constructed to the dimensions shown on the Released Construction Drawings.

Where the faces of Anchor/Thrust blocks are shown to bear against undisturbed ground, the Contractor shall take all necessary measures to ensure that such bearing is given over the full dimensions shown.

Welded pipelines shown on the drawings as having tied couplings and flanges shall require anchor blocks only at the positions specifically noted on the drawings.

Where possible, the base of the thrust block shall be cast against solid rock in order to prevent any settlement. Any material overlying the rock shall be excavated and replaced with class M20 mass concrete. In the event of no rock being encountered, the base of the thrust block shall be cast against undisturbed ground. Any ground which, in the Employer's Representative’s opinion, is unsuitable shall be excavated and replaced with class M20 mass concrete.

Epoxy painting.

Unless otherwise specified, pipes and fittings above ground shall be painted externally. The shop-applied painting is to be stopped 150 mm short at each end of the pipe to facilitate field welding and then made up on-site following testing of the joint.

Painting shall be generally in accordance with the general painting specifications mentioned elsewhere in this document, except for the following.

All pipes and fittings on bridges shall be painted externally with zinc-rich epoxy primer and epoxy paint. Both shop and site applications are to be done by airless spray equipment. Paints of reputed make and approved by the Employer's Representative shall be used. Thinning or heating of paints will not be permitted except with specific approval from the Employer's Representative and in accordance with the manufacturer’s instructions.

Each lot of primer and paint used by the Contractor shall be accompanied by certified copies of the test results on hardness, impact heat resistance and resistance to corrosion carried out by manufacturers in accordance with relevant Indian or International standards.

Surface preparation shall be in accordance with the manufacturer’s instructions, but as a minimum, the pipes shall be abrasive blast cleaned to BS 7079 Grade Sa 2.5 or equivalent to achieve a surface

roughness profile of 40–50 microns. The primer shall be applied within 2 hours of surface preparation before flash rusting can occur. Two coats of Zinc-rich epoxy primer shall be applied by spray equipment on the pipes and fittings.

The priming coat shall be uniform in thickness and free from floods, runs, sags, drips, and bare spots. Any bare spots or defects shall be recoated with an additional application of the primer. All defects shall be rectified as per the instructions of the Employer's Representative.

Though the priming coats become touch dry in 10 to 15 minutes, the finishing coats with epoxy paints shall be applied after allowing the film to cure for at least 48 hours. The final dry film thickness shall be a minimum of 500 microns. This may be achieved by applying in 2 to 4 coats.

On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the pipes and fittings in a clean and acceptable condition.

Inspection and Testing

The entire procedure of applying the paint as specified will be rigidly inspected right from the cleaning stage to the application of the final coat by the Employer's Representative. If, at any time, it is found that the procedure of applying the paint or defects noticed, all such painting work done shall be rectified or redone by the Contractor at his own cost, as directed by the Employer's Representative.

Samples of the paint brought by the Contractor shall be sent to the testing laboratory for testing, as directed by the Employer's Representative. If any sample is found to be not conforming to the specifications, the entire consignment to which the sample may pertain shall be rejected. Samples shall be taken at intervals at the option of the Employer's Representative. All the costs incidental to such testing shall be deemed to be included in the rates quoted by the Contractor.

Pipeline Joints: General

Unless detailed otherwise, all pipes and fittings shall have welded butt joints as detailed in the specifications. Where shown on the Drawings, flanged joints or collar sleeve joints shall be provided.

Sleeve collar joints.

The use of sleeve collars shall generally be limited to the jointing of pipes at tie-ins. The thickness of the external steel sleeve collar shall be not less than that of the pipe itself, and the length shall be a minimum of 300 mm. The sleeve shall be joined to the pipe with an internal full-depth structural weld and external sealing welds to allow the joint to be gas tested. A gas testing hole shall be made at each end of the sleeve, and for the purpose of gas testing, at the joints.

Flanged Joints

Flanges shall comply with IS 7322/BS 4504. The nominal pressure rating shall be at least equal to the highest-pressure rating of the pipes or fittings to which they are attached, but with a minimum PN 1.0. The Contractor shall fabricate flanges meeting the requirements of pipe sizes under this contract or otherwise to suit the abutting valves or other connections if they are not readily available. Flanges shall be provided with all necessary nuts, bolts, washers, and gaskets, as specified herein. The Contractor shall also supply in suitable containers sufficient graphite grease for application to the bolt threads when joints are made.

Slip-on Type Couplings

Slip-on type couplings shall include the following couplings:

i. Straight flexible couplings.

ii. Stepped flexible couplings.

Slip-on type couplings shall be procured from approved suppliers whose fittings meet the same Specification.

The preparation of pipe ends for slip-on type couplings shall be in accordance with the requirements of and the tolerances specified by the joint manufacturer. Couplings shall be installed fully in accordance with the manufacturer's recommendations.

Slip-on type couplings shall be protected if buried with Denso mastic and Denso tape wrapping or similar approved material applied in accordance with the manufacturer's recommendations. Flexible joints shall be harnessed or tied where shown on the Drawings. Flexible couplings shall be supplied with transit protection.

1.39 High Density Polyethylene Pipes (HDPE Pipes)

Scope

This specification covers the requirements of designing, manufacturing, supplying, laying, jointing and testing of High Density Polyethylene Pipes used for water supply at manufacturing and work site.

Applicable Codes

The manufacturing, testing, supplying, laying, jointing and testing of HDPE pipes at work site shall comply with all currently applicable statutes, regulations, standards and Codes. If requirement of this Specification conflicts with the requirement of the standards / Codes, this Specification shall govern.

Codes not specifically mentioned here but pertain to the use of HDPE pipes shall form part of these Specifications.

Designation

Pipes shall be designated as per IS 4984, according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 63 PN 10 DN 200 indicates a pipe pertaining to material grade 63 having a pressure rating 1.0 MPa and outside nominal diameter 200 mm.

Colour

- For the purpose of identification of the pipes, each pipe shall contain minimum three equi spaced longitudinal strips of width 3mm (min) in blue colour, these strips shall be coextruded during pipe manufacturing and shall not be more than 0.2 mm in depth. The material of the strip shall be of the same type as of resin.

- All HDPE Pipes of the same size, same pressure rating and same grade and also manufactured essentially under similar conditions, shall constitute a lot.

Materials

- The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odor, cloudiness or

discoloration of water.

Raw Material

(a) Raw material used to manufacture the HDPE pipes shall be 100% virgin PE compound or Natural black PE resin confirming to IS: 4984, IS: 7328 and ISO: 4427; for this a certification has to be obtained by the pipe manufacturer from the resin manufacturer as per clause 3.2.3 of IS: 4984. The resin proposed to be used for manufacturing of the pipes should also comply with the following norms as per ISO 9080.

Code No.	Title/Specification
IS: 4984	High Density Polyethylene Pipes for Water Supply
IS: 2530	Methods of test for polyethylene moulding materials and polyethylene compounds
IS: 5382	Rubber sealing rings for gas mains, water mains and sewers. Methods for random sampling
IS: 7328	High density polyethylene materials for moulding and extrusion
IS: 7634	Laying & Jointing of Polyethylene (HDPE) Pipes
IS: 9845	Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs
IS: 10141	Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.
IS: 10146	Polyethylene for its safe use in contact with foodstuff, Pharmaceuticals and drinking water.

The resin should have been certified by an independent laboratory of international repute for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10MPa. Internal certificate of any resin manufacturer will not be acceptable.

Certificate for having passed the full scale rapid crack propagation test as per ISO 13478. High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS 7328. HDPE conforming to designation PEEWA-45- T-012 of IS 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min. In addition, the material shall also conform to clause 5.6.2 of IS 7328.

The specified base density shall be between 941.0kg/ m^3 and 946.0kg/ m^3 (both inclusive) when determined at 27°C according to procedure prescribed in IS:7328. The value of the density shall also not differ from the nominal value by more than 3kg/ m^3 as per 5.2.1.1 of IS: 7328. The MFR of the material shall be between 0.41 and 1.10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in IS 2530. The MFR of the material shall also be within ± 20 percent of the value declared by the manufacturer.

The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ±0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS 2530.

Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harm less and shall be selected from the list given in IS: 10141.

Reworked Material

No addition of Reworked/ Recycled Material from the manufacturer‘s own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only100% virgin resin compound.

Maximum Ovality of Pipe

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table 2 of IS 4984. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled, the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

Wall Thickness

The minimum & maximum wall thickness of pipe for the three grades of materials, namely PE63, PE80, and PE100 shall be as given in table 3, 4, & 5 respectively in IS:4984.

Length of Straight Pipe

The length of straight pipe used shall be more than 6 m or as agreed by engineer in charge. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110mm dia shall be supplied in straight length not less than 6m.

Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

Handling, Transportation Storage and Lowering of pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.

The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources exceeding 60oC.
- Pipes shall be stored so that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.
- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.
- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.
- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.
- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the engineer in charge before installation.
- During coiling, care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken so that sharp objects do not scour the pipe.
- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil will depend on the size of the pipe, the SDR of the pipe, and the size of the coil.
- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set
- Bare coils shall be wrapped with hessian cloth for long distance (> 300Kms) transportation. The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.
- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Engineer.
- Damages during transit, handling, storage will be on the Contractor‘s account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer.

Lowering, Laying of Pipes

- Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer, shall be laid.
- While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same as backfill material. While laying in rocky areas, suitable bed of sand or gravel should be provided. The filling of about 10 to 15 cm above the pipe should be with fine sand or screened excavated material. Where hard rock

is met with, bed concrete of M15 or15 cm /20cm thick sand bed as approved by the engineer may be provided

- As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground, can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.

- During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections.

- Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day.)

- For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

- The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

- The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.

- The Installation of flanged fittings such as connections to sluice/air/gate valves and hydrant tees etc., requires the use of stub ends (collars/flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.

- Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.

- PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done.

- When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern. However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.

- Pipe embedment backfill shall be with stone-free excavated material placed and compacted to the 95% maximum dry density.

Jointing of Pipes

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as per IS :4984 shall be selected considering site and working condition, pressure and flow of liquids

Bedding, Backfilling and Compaction

Bedding

In case of sandy strata, no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe.

Back Filling

Backfilling should be placed in layers not exceeding 15cm thickness per layer, and should be compacted to a minimum of 95% maximum dry density. The refilling should be done on both sides of pipe together & height difference in earth fill on each side should not be more to cause lateral movement of pipe.

Most of the coarse grained soil comprising of gravel or sand are acceptable. However silty sand, clayey sand, silty and clayey gravel shall not be used unless proposed to be used in conjunction with gravel or clean sand.

It is very important that the pipe zone backfill material does not wash away or migrate in to the native soil. Likewise, potential migration of the native soil in to the pipe zone backfill must also be prevented.

Heavy earth moving equipment used for backfilling should not be brought until the minimum cover over the pipe is 90 cm in the case of wide tracked bulldozers or 120 cm in the case of wheeled roaders or roller compactors.

Compaction

Vibratory methods should be used for compaction. Compaction within distances of 15 cm to 45 cm from the pipe should be usually done with hand tempers. The backfill material should be compacted not less than 95% of maximum dry density.

Fittings & Specials

Injection moulded HDPE fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be manufactured by injection moulding at factory only. General requirement of Injection moulded HDPE fittings conforming to IS: 8008 Part I.

Bends

HDPE bends shall be conforming to IS: 8008 Part II Specifications.

Tees

HDPE Tees shall be conforming to IS: 8008 Part III Specifications.

Reducers

HDPE Reducers shall be conforming to IS: 8008 Part IV Specifications.

Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VI Specifications. Stub ends will be welded on the pipe. Flange will be of slip-on flange type as described below:

Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc.

Nominal pressure rating of flanges will be PN10.

Welding Procedure

Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with fusion welding using automatic or semi-automatic, hydraulically operated, superior quality fusion machines which will ensure good quality fusion welding of HDPE pipes. If approved by the concerned Engineer, jointing with PP compression fittings may be carried out for smaller diameters of PE pipes (up to 110mm).

Tests to Establish Portability of Work

Pipe specimen shall be subjected to tests specified below in order to establish the suitability of these pipes for use in carrying potable water:

a) Smell of the extract

b) Clarity of the colour of the extract

c) Acidity and alkality

d) Global migration UV absorbing material Heavy metals

e) Un-reacted monomers (styrens) and Biological tests

Hydraulic Testing

Pipes shall be given different hydraulic tests for ensuring quality of manufacture as per clause 16.9.5.6.2 of this specification.

Measurement

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work. Excavation, refilling, masonry and concrete work wherever required shall be measured and paid for separately under relevant items of work.

Payment shall be made as per relevant items in BOQ

Rate

The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/enumerated separately under clause Measurements', which shall be paid for separately.

JOINTING MATERIAL: Detachable Joints

PUSHON JOINTS

For Push-on joints the rubber ring will be inserted through the chamfered spigot end of the pipe. The two pipes shall be aligned properly in the trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot.

After insertion, the correct position of the socket has to be tested with a feeler blade. A penetration gauge shall be used to check each joint after assembly, to ensure that the rubber ring is properly seated.

When it is desired to deflect push-on joint pipe in order to form a long-radius curve, the amount of deflection shall be as per the instructions of the manufacturer and approved by the Engineer. It is important that in making the joint the pipes are maintained in a straight line and the deflection introduced after the joint has been assembled. However, it is preferable that such deflection do not exceed 75% of the permissible deflection at a single joint as stipulated by the manufacturer of the pipe.

MECHANICAL JOINTS

Bolts shall be tightened alternately on opposite ends of joint diameter and in rotation around the pipe. When properly assembled, the gland shall be equidistant from the socket face at all joints. Under no conditions, Extension wrenches or pipe-over-handle or ordinary ratchet wrenches shall be used to secure greater leverage.

FLANGED JOINTS

Flanged joint pipes and fittings shall be firmly and fully bolted with machine bolts provided by the manufacturer. Standard flange drilling of flanged pipes and fittings shall be in accordance with IS: 1538. The nuts and bolts to be used for jointing shall be made of MS for size up to 27 x 120 mm and high tensile steel of approved make for higher sizes. Gaskets used between flanges of pipes shall be compressed fibre board or natural/synthetic rubber of thickness between 2.5 mm to 3 mm in conformity with IS:3114. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per sqm shall not be less than 12 gram/mm thickness.

Slip-on flanges shall be double welded to the pipe with a strength weld jointing the flange hub to the pipe and seal fillet weld inside the flanges at the pipe end. All flanges of the same diameter shall be compatible.

Flexible Coupling

Salient features of flexible coupling are furnished below:

a) Coupling shall be of special design made of cast iron and buffers for high ambient temperature, electrically insulating, and high increased elasticity.

b) Selection criteria and basis has to be obtained from the manufacturer and to be got approved prior to selection of rated nominal torque.
c) It shall able to dampen and prevent torsional vibrations enabling critical speed to be displaced.
d) Flexible buffer shall provide guarantees a limitation of vibration amplitudes for the protection of the whole drive.
e) It shall provide maximum reliability of continuous rating operation
f) It shall be suitable for ambient temperatures of 50° C.
g) Bores to be made as per the drawing supplied.
h) All rotating parts must be guarded to prevent accidents. Coupling shall be installed as per national and local safety codes.

Manufacturer shall get specification approved by Employer / Engineer prior to start manufacturing. Prior to dispatch final inspection at manufacture's works shall be carried out by the Engineer/TPI.

1.40 Double Wall Corrugated (DWC) HDPE Pipes:

APPLICABLE CODES
The manufacturing, testing, supplying and testing at work sites of HDPE-DWC pipes shall comply with IS 16098 Part-II: 2013 and all currently applicable statutes, 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 standards / Codes, this Specification shall govern:

Code No.	Title/Specification
IS 4905	Methods for random sampling
IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers (first revision). Type-I & Type-VI
IS 12235	Methods of test for thermoplastics pipes & fittings.
IS 12235 (Part 1)	Method of measurement of outside diameter.
IS 12235 (Part 5)	Reversion test
IS 12235 (Part 8)	Internal hydrostatic pressure test
IS 16098 Part- II	Structured wall plastics pipes for non-pressure drainage and sewerage- specifications.

Others Codes not specifically mentioned here but pertaining to the use of HDPE-DWC pipes form part of these Specifications.

The manufacturer's own rework material conforming to the requirements given in 3.25 of IS:16098 is permissible. No other rework material shall be used.

MARKING

GENERAL
Marking shall be labelled, printed or formed directly on the pipe or fitting, in such a way that after storage, weathering and handling the legibility shall be maintained. Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipes or the fitting. Minimum Required Marking

PIPES
Each pipes shall be marked at intervals of maximum 3 m, at least once per pipe, with the following information:

a) Manufacturer's name/Trade-mark;
b) Diameter series, nominal size;
c) Stiffness class;
d) Material; and
e) Lot number/batch number containing information regarding period of manufacture.

FITTINGS

Each fitting shall be marked with the following information:

a) Manufacturer's name/Trade-mark;
b) Diameter series, nominal size;
c) Nominal angle;
d) Stiffness class;
e) Material; and
f) Lot number/batch number containing information regarding period of manufacture.
g) BIS Certification Marking each pipe or fittings may also be marked with the standard Mark.

The use of the Standard mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made there under.

PRODUCT IDENTIFICATION

Product markings on Crumpler Plastic Pipe will include the following information to facilitate jobsite inspection.

· Nominal pipe size
· Manufacturer's name
· Date code
· Application standard(s)

WORKMANSHIP / APPEARANCE

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe

MEASUREMENT

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work. Excavation, refilling, masonry and concrete work wherever required shall be measured
and paid for separately under relevant items of work.

INSPECTION AND TESTING:

The pipe shall be delivered to the site after inspection by the nominated inspectors by the Employer.

a) Physical Dimensions and visual inspection: The Manufacturers test reports shall be provided for review.
b) Mechanical Characteristics shall be in accordance to IS 16098- 2013.
c) Ring Flexibility shall be as per IS 16098.

CONNECTING CORRUGATED POLYETHYLENE PIPE TO OTHER PIPE MATERIALS

It is not unusual for corrugated polyethylene pipe to be connected to other types of pipe materials. Available options depend on the joint duality required throughout the system and the particular combination of pipe materials. The pipe can be jointed by heating the pipe ends together, wrapping them with a geotextile, and pouring a concrete collar around them. Although such a connection is dependent on contractor expertise, it will generally limit soil intrusion but not provide a watertight joint. Watertight connections between different materials will require additional fittings and adapters. If those options are not acceptable, a manhole can be used to make the transition.

Pipe manufacturers are a valuable resource during the project planning stage since they are familiar with adapters that work well with their own products.

PLAIN END PIPE COUPLERS

1. Soil Tight Split Coupler – This is a clam Shell type coupler used in Non-Water Tight application. They are used on perforated or solid style CPP pipes at site where the native soil is stiff and cohesive enough to reduce the possibility of a loose soil infiltration into the pipe that could create a flow restriction.

2. Silt Tight Split Coupler – These are Calm Shell type coupler to which a gasket material has been added for the purpose of restricting Silt Infiltration into the pipe at a coupling joint. This non-water tight gasket material meets ASTM-D-1056, Grade 2A2 or ASTM-F-477. The installer should take care to remove all dirt and foreign matter from the pipe ends and gasket material to ensure a secure fit.

BELL & SPIGOT COUPLERS WITH “O” RING GASKETS

These couplers to impede or prevent the infiltration or infiltration of liquids in NONPRESSURE application.

1. 1. Bell & Spigot Couplers with “O” Ring Gaskets:- These couplers are produced on the pipe during the pipe extrusion process. Bell & Spigot pipes are available in 20-foot lengths, each coupler Spigot End comes with a non-pressure pipe water leak restriction gasket manufactured per ASTM-D-477. Should gravity flow pressure tests be required per ASTM-F-1417, one should not test until the pipes have been backfilled or restrained for safety.

2. Shear gasket gravity flow seal couplers: - These pliable couplers with stainless steel clamp- Grip Compression bands have been used for years connecting clay, concrete, steel and plastic pipes in all types of environments. They are impervious to normal water / sewer, chemicals, fungus growth and all other associated in – ground hazards. As with any coupler, before applying, insure that no foreign matter jeopardizes contact between the two surfaces.

3. Mastic Wrap Coupler:- Wrap around style mastic couplers have an outer layer of cross laminated polyethylene plastic and an under layer adhesive surface of rubberized mastic material. In between these two surface layers is a high strength shear and puncture resistant layer of woven polypropylene. This center third layer provides toughness against puncture as well as stretch resistance under earth load shifts or settlements. The Mastic wrap coupler is mechanically sealed by stainless steel screw type hose clamp compression bands. These adjustable compression clamp bands are easily secured using simple tools such as screwdrivers, nut drivers, or socket wrenches. Proper tension on those bands will provide a seal against infiltration and exfiltration in gravity flow, non-pressure pipes. Each mastic coupler comes with three hose clamp compression bands or ties located within the coupler. There is one compression strap located in the heat joint

corrugation pipe valley, and one strap in the first valley on each side of the heat joint. Proper compression tension on each strap (centered over a corrugation valley) will forcibly apply the mastic surface around the corrugation crests and walls to provide a seal. Enough tension should be applied to substantially sink the compression straps into the corrugation valleys below the corrugation crests in order to have a leak resistant seal. Prior to applying the mastic side to the pipe be sure to clean the pipe of soil/dust particles that could interfere with the mastic seal making contact with the pipe surface. Mastic couplers can also be used to couple corrugation pipes manufactured with different corrugation designs of the same pipe size as well as to couple pipes to other pipes made from a different raw material base.

UNLOADING

a) The Contractor should set aside an area for products to be stored on site.
b) This area should be flat, free of large rocks, rough surfaces and debris.
c) It should also be out of the way of construction traffic.
d) Pipe may be delivered either palletized or loose, depending on the type and quantity of product.
e) Pallets may be unloaded with a backhoe, forklift or other piece of equipment and a nylon sling or cushioned cable.
f) The sling should be wrapped around the pallet at the third points as it lifts the pallet onto the ground. As an alternative to using a sling to unload full pallets, the pallet may be opened and lengths of pipe unloaded individually be carefully rolling single lengths of loose pipe from the delivery truck onto the front end loader, then onto the ground.
g) Alternately, the pipe can also be lifted using a nylon sling or cushioned cable at the third points.
h) End handling with a forklift MUST NOT be used as pipe damage will occur.
i) Due to joint weight, larger diameter pipes should not be off loaded by hand.

JOB SITE STORAGE

a) Reasonable care should be used in handling pipe.
b) The pipe should not be dropped, dragged or bumped against other pipe or objects.
c) Palletized pipe should remain in the pallet for jobsite storage.
d) Non-palletized pipe can be stockpiled for temporary storage in a flat debris-free area out of the way of construction traffic.
e) Begin the stockpile with secured timbers spaced the width of the proposed stockpile at a distance not exceeding the third points.
f) For pipe with attached bells, a recommended stacking method is to alternate the direction of the pipe lengths so that the bells are not stacked on each other.
g) As upto three pipes can be laid before alternating directions. Subsequent layers should follow the same pattern as the first but with fewer sticks of pipe in each row.
h) For smooth interior pipe, storage space can be minimized by nesting smaller diameters into large diameter pipe.
i) Factory installed gaskets on the spigot should be protected by positioning them between corrugations.

STRINGING THE PIPE

a) Placing the pipe and accessories along the open trench, or “stringing” Can save handling time.
b) Each pipe length should be laid on a level surface as near as possible to the trench on the side opposite the excavated trench material; allow some space between pipe to protect pipe ends.

c) The pipe should be out of the way of any equipment in a location that will allow excavation to proceed uninterrupted.

LOWERING, LAYING OF PIPES

a) Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Project Manager shall be laid.
b) While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones.
c) PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done
d) When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.
e) However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.
f) Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.

JOINTING OF PIPES

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as specified above shall be selected considering site and working condition, pressure and flow of liquids.

1.4.12.1 JOINTS

Elastomeric sealing rings shall be free from substances that can have a detrimental effect on the pipes or fittings used in conjunction with pipes.

The design of the profile and dimensions of the sealing ring is left to the manufacturer, as long as the pipe with the sealing ring meets the requirements of this standard. Where the design of the socket is such that the ring is not firmly fixed in position, the housing for the ring shall be so designed as to minimize the possibility of the ring being dislodged during insertion of the pipe (or spigot or fitting) to complete the joint. Elastomeric sealing rings shall be in accordance with one of the type (Type 1 to Type 6) of IS 5382. The manufacturer should specify the type of sealing ring (namely Type 1, 2, 3, 4, 5 or 6) that is being offered.

NOTE — A test report or conformity certificate may be obtained from the manufacturer of the sealing ring for conformity to IS 5382.

1.41 RCC Pipes

1.1.7 Scope

This specification covers the supply and laying of R.C.C. The entire work shall be carried out as per latest editions of Indian Standard or equivalent Standards.

1.1.8 Supply of Pipes

The Contractor shall supply the R.C.C. Hume Pipes of various diameters along with complete fittings required for carrying out the work. R.C.C. Hume Pipes should conform to British Standards, as may be required and should be in a good condition. The Contractor must furnish, on being demanded by the Engineer, manufacturer's certificates and/or test certificates from recognised authorities. PCC encasement shall also be provided whenever required as per design requirement.

Alignment, Levels and Grade

The work shall be carried out in conformance to the alignments, levels and grades specified in the drawings. The layout and levels shall be made by the Contractor at his own cost from one reference grid and benchmark given by the Engineer. He shall give all help in instruments materials and men to the Engineer for checking the detailed layout and levels as and when required.

Making of reference layout and level pillars along the pipeline route and maintaining them upto completion of the work shall be the responsibility of the Contractor.

Laying of Pipes

General
The laying of R.C.C. Pipes shall conform to British Standards.

Conditions for Laying
The conditions for laying of pipes to suit the conditions at site and/or as per drawings and instructions.

Culvert Condition
In this condition the pipe is laid under embankment and may project wholly or partly above the original ground surface.

Trench Condition
In this condition the pipe is laid in a trench excavated for the purpose. The trench shall be refilled with thoroughly tamped earth after laying and jointing of pipes in approved manner.

Open Condition
In this condition the pipe is laid such that it projects wholly or partly above original ground surface, there being no super imposed over burden on the pipe.

Bedding and Support

Culvert Condition
In this condition the pipes shall be laid generally on Bedding as per relevant British Standards, unless directed otherwise.

Trench Condition
In this condition the pipes shall be laid generally on Bedding as per relevant British Standards, unless directed otherwise.

Concrete Cradle Bedding
If shown on the drawing or so instructed by the Engineer, the pipes shall be laid on concrete cradles, conforming to British Standards in case of trench condition and culvert condition. Minimum crushing strength shall be 140 kg/sq.cm.

Open Condition
In open condition the pipeline shall be supported over rigid pedestals constructed at intervals not greater than the length of one individual piece of pipe, as per drawings and instructions of the Engineer. In no case shall the joint concrete with a properly shaped out top to receive the pipe.

Joint of Pipes
The provision of British Standards shall be followed for jointing of pipes and every possible care shall be taken by the Contractor to ensure that the joints made are leak proof. Curing of joints shall be done for a period of 10 days.

1.1.9 Manholes

Manholes shall be provided for pipe drains at the change of diameter of pipe, alignment and direction at a max. spacing of 30 m c/c upto 900 mm diameter and 45 m c/c for higher diameters of the pipe. Details of manhole shall be as specified in British Standards.

Each manhole shall be provided with a heavy duty C.I cover as per British Standards.

1.1.10 Inspection & Testing:

As per prevailing practice, the following Review of Reports shall be carried out.

Review of Reports:
The following Reports shall be submitted to the Inspecting Officer at the time of Inspection for review:

During manufacture, Compressive Strength Tests shall be conducted by the manufacturers on 150 mm Concrete Cubes in accordance with the relevant requirements of IS: 456/2000 with up-to-date amendment and IS: 516/1959 (Reaffirmed 1999) with up-to-date amendment, as stipulated in clause 5.5.3 of IS: 458/2003 (Fourth Revision) with up-to-date amendment. The manufacturer shall submit the results of Compressive Strength Tests of Concrete Cubes made from the Concrete used for the pipes. Alternatively, if the manufacturers do not have the facilities for Compressive Strength Test on Concrete Cubes, they shall get the Test done at laboratory at least once in a month and submit the report to the Inspecting Officer for review.

- Manufacturer shall submit his own Certificate for materials of construction used in the pipes.
- Manufacturers shall submit Test Certificate for the Steel used for Reinforcement.
- Manufacture's Test Repot of Rubber Rings shall be submitted for review (in case of Pipes with Socket & Spigot ends).

Tests:
As per prevailing practice, the following Tests / Checking shall be carried out.

- Visual examination,
- Permeability Test and
- Three Edge Bearing Test to produce 0.25 mm crack.
- Any other Tests that are mentioned in IS: 458/2003 (Fourth Revision) with up-to-date amendment shall be carried out if desired by the Consignee.

NOTE:
- The tolerances on Pipes shall be as per clause 8.2 & tolerances on Collar shall be as per Table No.21 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
- Workmanship & Finish of the Pipes & Collars shall be as per Clause 9 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
- The length in which the pipes are to be supplied shall be as per the mutual agreement between the purchaser and the supplier. However, the recommended length above 300 mm Nominal Diameter is 2.5 meters.
- Curing of the pipes shall be done as per Clause 7.4 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
- Rubber Ring chords used in the Pipe joints shall conform to Type 2 of IS: 5382/1985 with up-to-date amendment.

- The following information shall be clearly marked on the each Finished Pipe.
    - Size of Pipe,
    - Class of Pipe, and
    - Name of manufacture.

- The supplier shall guarantee the Pipes and Collars for a period of 12 months from the date of receipt of the materials by the consignee.
- For Reinforced Concrete Pipes Rates must be quoted on the basis of Per Meter length and in the case of Collars Rates shall be quoted on the basis of Per Piece. (The cost of the Rubber Ring shall be included in the Rate per Meter length of the Pipe. No extra payment towards the supply of Rubber rings will be made) as per the prevailing practice, transportation cost for Pipes & Collars shall be quoted separately.

1.42 Dismantling Joints

General

Dismantling joints shall be a double-ended flanged adapter that allows for longitudinal adjustment in piping systems where flanged end pipe is utilized.

Technical Requirements

Double flanged Dismantling joints shall be fabricated from MS plate in such a manner that valves can be dismantled without stress to the joints. These shall be for working pressures of up to 16 kg/cm2 and shall be completely leak proof with proper seal arrangement. Flange dimensions of the joints shall conform to IS: 1538.

Flanged specials shall be supplied with required nuts, bolts, and rubber gaskets. The nuts and bolts shall be of best quality carbon steel, machined on the shank, and electrogalvanized. Rubber gasket shall be as per IS: 5382. Dimensions and drilling of flat gasket will be as per IS: 1538, suitable for making flanged joint. The dismantling pieces shall provide minimum clearance of + 25 mm (total distance 50 mm).

The dismantling joints shall be encased in appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, for direct buried applications. Manufacturer's certification of compliance to the above standards and requirements shall be readily available upon request.

Each dismantling joint shall be pressure tested prior to shipment against its own restraint to a minimum of 20 kg/cm2 for joints up to 700 mm in diameter and to 15 kg/cm2 for joints 750 mm and greater in diameter. A minimum 2:1 safety factor, as determined from the published pressure rating, shall apply.

Coating

All internal surfaces (wetted parts) shall be lined with a minimum of 400 microns of fusion bonded epoxy (FBE) conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. Exterior surfaces shall be coated with a minimum of 150 microns of FBE conforming to the applicable requirements of ANSI/AWWA C116/A21.16.

Measurement and Rate

Dismantling joints will be enumerated in numbers. Cost of supply, installation, fitting, fixtures of such joints will be included in the supply and laying of pipeline including labour all complete to the satisfaction of the Engineer.

Mechanical Coarse Screens

1.43 "J" Type Trash Rack Bar Screens

General:

"J" type Trash Rake Screens shall be capable of performing the screening duties in sewage pumping stations and sewage treatment plants. These screens shall be suitable for operation in an inflow mixed up with large and medium-sized undefined floating waste. The screens shall be so constructed that there is no undue wear or deterioration during their operative life and so designed that repair and maintenance is kept to a minimum.

These screens shall be supplied along with accessories such as screen segments, guide frames, hand scraper assembly and all fasteners as required for the erection /installation of the screen guide frame, and an Electric Hoist for taking out and putting in the screen.

Design & Construction Details:

The screen segment consists of its sides, top & bottom frame members, back support stiffeners & vertical rectangular flats/bars of stainless steel.

i. The screen shall move vertically up or down in SS side guide channels that are either "securely fixed to the two vertical side walls of the inlet chamber by means of suitably sized and spaced anchoring plates & mechanical anchor fasteners" or "embedded in the two vertical side walls and bottom floor of the channel using grout" as per actual site requirement.

ii. Side guide frame length shall be from the invert of bottom level of the screen channel, up to the top of the screen channel floor level.

iii. The bottom member of the guide frame shall remain flush with the bottom level of the channel embedded in the bottom floor of the channel using grout as per actual site requirement.

iv. Screen Segment shall be provided with 2 Nos. SS lifting pins/rods at top, replaceable wear shoes of gunmetal (as required) & Stainless-steel rollers (2 Nos. at 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.

v. The Vertical rectangular flats/bars for screens shall be of dimensions 50x10 i.e. 50 mm deep x 10mm thick spaced at 50 mm clear average bar spacing at an inclination angle of 90º to the horizontal plane.

vi. "J" type perforated tray/bucket shall be bolted to the bottom of the screen segment.

vii. One no. manual cleaning rake/comb shall be offered for screen for each screen to manually clean the screen while the screen segment is brought up/lifted, at the top of the channel level.

viii. A mild steel epoxy-painted lifting beam shall be provided to lift/lower down screen segments for screens having the same size at each location to move smoothly in the side guide channels.

ix. The provision of an EOT crane/monorail/tripod & arrangement, hoist supporting

arrangement, any kind of mechanical cleaning/raking mechanism, collection bins/portable screen container, water jetting arrangements & trolley etc shall be provided.

General Material & Equipment Requirements:

The screens should be made of Stainless-Steel material to withstand the corrosive and abrasive sewage Environment. The screen manufacturer shall follow the proven manufacturing practice mentioned here under, to eliminate the possibility of corrosion. The manufacturer must have a quality system i.e. ISO: 9001-2015 in place to ensure the quality of the product.

i. The screens shall be manufactured in a stainless-steel clean area, in a plant, where no ferrous material is cut, welded, or handled. This is required to ensure that no ferrous contamination/pick-up takes place leading to corrosion of the stainless-steel screens.

ii. To ensure the best workmanship, the screen manufacturer must have welding PQR, WPS & Qualified welders as per ASME Section 9. The manufacturer shall be required to provide workers' welding certification. The welding is to be done in such a way that corrosion, especially fissure corrosion, is avoided. Intermediate seam-welding and open fissures are not permitted.

iii. The manufacturer shall ensure that the entire welded joints are tested by Dye penetration test, by qualified inspectors.

iv. As an additional precaution the manufacturer shall 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.

v. Since the corrosion-resistant property of stainless steel gets reduced when exposed to heat while cutting by plasma, all the cutting of stainless-steel material shall be done using heat less water jet cutting procedure.

vi. All the stainless-steel material used on the assembled product shall be checked for correct chemical composition using Positive Material Identification equipment. This shall be re-verified at the time of inspection.

Material Of Construction:

The materials of construction of important components of "J" type removable trash rack screen shall be as stated below:

1	Screen Structure & Support Stiffeners	Stainless Steel ASTM A240 type 316
2	Screen Bars	Stainless Steel ASTM A276 type 316
3	Screen Lifting Pin/Lifting Rod	Stainless Steel ASTM A276 type 316
4	Guide Frames (at Two Sides & Bottom)	Stainless Steel ASTM A240 type 316
5	Replaceable wear shoes	Leaded Gun Metal
6	Roller Assembly	UHMWPE / Stainless Steel 316
7	"J" type perforated Tray	Stainless Steel ASTM A240 type 316
8	Screen Assembly Fasteners	Stainless Steel ASTM A276 type 316
9	Manual cleaning rake/comb/hand scrapper	Stainless Steel ASTM A276 type 316
10	Lifting Beam	Epoxy Painted Mild Steel IS 2062 Gr. E250 A

		/ Br

Shop Testing:

The screen must be completely manufactured and subsequently offered for inspection at the manufacturer's works only. 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 the following tests at the manufacturer's premises before dispatch:

a	Dimensional Check	Important Dimensions shall be checked with reference to the approved GA drawing. Variations in dimensions, if any, shall be within the permissible limits as per the applicable Indian/international standards.
b	Operational Test	The complete screen shall be offered for vertical up or down / horizontal movement in SS guide channels (only in the lower part of the guide frame) and tested in dry condition to verify interference-free movement and satisfactory operation.
c	Dye penetration test	A dye penetration test to be conducted at random to check the soundness of welding joints during the inspection. Both, the Procedure as well as a person conducting the dye penetration test should have been certified by the outside agency as per relevant standards.
d	Positive Material Identification Test	To ensure that Screens are made of Stainless Steel of specified grade positive material identification (PMI) test to be conducted for all important components like Bars and frames during inspection and PMI reports to be submitted to the client/corporation along with joint inspection report.
e	Review of test certificate:	Material test report/certificate shall be offered for review during the inspection.
f.	Review of WPS, PQR & Welder's qualification certificate	To be offered for review during the inspection and copy of same to be submitted to client / corporation along with joint inspection report.
g	Review of Material Test Certificates	Material test certificates for all important components of the assembly are to be furnished for review at the time of inspection.

Standard Finishing & Painting:

Stainless steel components shall be shot blasted after fabrication and then pickled and passivated on all surfaces to remove any ferrous contamination taking place during the process of welding, cutting, machining, and handling.

Miscellaneous:

Packing of screens and allied accessories shall be transit-worthy to avoid any possibility of damage during transportation to the site(s).

If required, the following shall be arranged: -

i. Collection bins & wheeled trolley, water jet sprayer to clean the screen,

ii. Chequered plate to cover the opening /cut-out on top of the channel as required.

iii. The provision of overhead Electric hoist/Manual Hoist with starter panel & all

accessories & Hardware/EOT crane/Monorail/Tripod arrangement, Rope/Chain pulley block, any sort of lifting arrangement & Hoist supporting Arrangement.

1.44 Mechanical Front Rake Coarse Bar Screen

Scope:

The scope includes supplying, installing, testing, and commissioning mechanically cleaned bar screens with multiple rake blades manufactured from SS 304 stainless steel. The screen should include bars rake, dead plate, discharge chute, side frames, covers, rake blades, drive chains, sprockets and bearings, scraper assembly, drive motor, gear reducer, anchor bolts, controls and all accessories and appurtenances, etc. required for complete and proper operation with all accessories and hardware.

The mechanical coarse screen is to be installed in the screen chamber to arrest large and medium floating or similar materials from sewage entering a pumping station.

The screen shall be installed in a suitable size screen chamber and shall be capable of operating as and when the liquid level difference between upstream and downstream levels reaches to pre-set value and should stop as the level difference decreases. An adjustable timer should also be provided to operate the screen periodically, should the level not reach the pre-set value. The screen shall be equipped with a torque protection switch, to avoid any damage to the screen mechanism.

The screen shall be manufactured from AISI 304 stainless steel shapes (rods, angles, and channels), pipes and sheets. Side frames and guides, bar rack, rake assembly, scraper assembly, shafting, discharge chute, fasteners and anchor bolts shall be made of this material.

All stainless-steel components and structures shall be chemically pickled to remove any residues that may be present on the material, as a result of forming, manufacturing, or handling. After pickling, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer, which is critical to the long life of the stainless steel.

Chains and sprockets shall be made of SS304 material. Chain rollers shall be made of polyamide.

The lower sprocket bearing shall have a stainless-steel casing including a shaft made of white cast iron and a ceramic (calcium carbide) friction bushing.

Upper sprocket bearings shall have a paint-coated cast iron casing and include ball bearings that are greased for life and shall be double-sealed with Nylon rings.

1.1.10.1 Performance & Design Requirements:

The Mechanical coarse screen is to be installed in the screen chamber for separation of floating, settling and suspended material from sewage by means of an inclined bar rack installed within the channel. There shall be multiple cleaning elements (rakes) depending on the depth of channel to clean the bar rack. Both ends of the cleaning elements shall be connected to drive chains.

Each chain shall be driven by a sprocket on a common shaft and a flange-mounted gear motor. The design will ensure proper meshing of the cleaning rakes with the bar rack to

ensure high operating reliability.

The cleaning elements, attached to the chain system, shall be easily adjustable to different requirements. The cleaning elements, consisting of the rake and comb plate shall be screwed and replaceable.

The Mechanical Coarse Screen shall consist of:

i. Screen with bars, including head and foot connection profiles.

ii. Screenings apron, with discharge chute on top of the rack screen, equipped with a removable stainless-steel covering.

iii. The cleaning elements, consisting of the rake and comb plate, are screwed and thus independently replaceable.

iv. Bushed conveyor chains each deflected by two upper and lower chain wheels and guided in lateral profiles.

v. Guide tracks with connecting profiles for the reception of the bushed conveyor chains.

vi. Drive motor with overload protection.

vii. Screen frame with plate cover to support the cleaning mechanism including the plates required to fix and adjust the screen.

viii. An electromechanical torque control to reliably protect the screen against damage caused by overload and in addition emitting an electric signal.

ix. Chain wheel bearings.

x. Re-greaseable upper flange bearings.

xi. Water-resistant, maintenance-free lower ceramic bearings.

Construction:

i. The bar Screen shall remove floating materials from the incoming wastewater by means of a positively cleaned bar rack that is installed in a concrete channel. The screen shall retain floating materials at the bar rack. A multitude of rake blades shall remove and lift the floating materials to a discharge mechanism. The bar rack shall be cleaned by serious rakes engaging the bar rack from the upstream side at the bottom of the channel and then moving up along the bar rack. The floating materials shall be lifted above the channel and dropped on a discharge chute at the downstream side of the screen. Screens with single rakes shall not be approved.

ii. The bar rack shall consist of equally spaced, straight bars that are inclined from the horizontal with the inclination angle specified above. The lower ends of the bars shall be provided with a minimum 4 mm thick curved base plate such that the rakes positively remove all screenings from the bottom of the bar rack. The bar rakes shall be securely fastened to the frame of the screen and be readily removable.

iii. Bars shall have a Tapered bar profile with a cross-section of 10x5x50 mm.

iv. The bar screen shall be provided with a dead plate extending from the bar rack to the

discharge chute. The dead plate shall be made of a minimum of 4 mm thick stainless-steel plate and shall be stiffened by structural members so that it is flat without undulation so that the tips of the rake's teeth ride at a distance between 1 to 2 mm over the dead plate. The dead plate shall be securely fastened to the side frames.

v. A Discharge chute shall be provided that fully encloses the discharge section of the screen. An access hatch with hinges and a handle shall be provided in the chute permitting easy access. The discharge chute shall be mounted to direct screenings into the appropriate receiving container or conveyor. The chute shall have a slope of a minimum of 45 degrees. The discharge chute shall be made of a minimum 2.5 mm thick stainless-steel plate.

vi. The frame shall be provided supporting all required loads. Side frames shall be made of at least 4 mm thick 304 stainless steel plates with a minimum of four axial edges. The side frames shall be connected with each other, through channels having a minimum thickness of at least 4 mm and a minimum cross- section of 108 X 49 mm. The side frames shall be connected to support frames. The support frames shall be securely anchored onto the operating floor.

vii. The screen shall be provided with easily removable, sufficiently, stiffened covers made of 1.5 mm thick stainless-steel plates with edges on all sides. The covers shall be provided with turn locks and handles.

viii. Each side frame shall include separate roller tracks to guide the rakes. The roller tracks shall be bolted to the frame so that they can easily be replaced. The roller tracks shall be made of 4 mm thick L-profiles.

ix. The 4 mm thick neoprene strips shall be fastened to the side frames to seal the lateral gaps between the side frames and the channel walls.

x. Drive chains for the rakes shall be roller-type chains and be made of SS 304. The drive chains, chain guides, sprockets and their bearings shall be replaceable without removing the screen from the channel.

xi. Each screen shall be provided with four sprockets with a reference diameter of 327 mm.

xii. Rakes shall include rake bars made of 6 mm thick channel profile having a cross section of 110 x 86 mm

xiii. The rake blades shall have teeth matching and engaging the bars of the bar rack. The rake blades shall each consist of several pieces with teeth such that only one piece needs to be replaced in case that a tooth should be damaged.

xiv. A pivoting scraper mechanism shall be positioned at the point of discharge and shall be attached to the side frames. The scraper shall clean the rake on each pass and return to its resting position with minimal shock. The scraper shall be designed such that screenings do not wrap around the rake or scraper. The scraper shall be provided with a scraper bar made 3 mm thick channel profile with a minimum cross section of 40 x 70 mm and an adjustable 10 mm thick wiper made of polyethylene. The scraper shall be connected with the frame through a pair of minimum 500 mm long scraper arms that shall be made of at least a 4 mm thick channel profile with a minimum cross-section of 68 x 59 mm.

xv. A pair of shock absorber elements made of neoprene shall be provided.

xvi. The drive shaft shall have a diameter of a minimum of 80 mm and a wall thickness of a minimum of 4.8 mm.

xvii. The drive shaft includes an integral rocker arm assembly on the drive end that flexes if the screen rakes get jammed.

xviii. The rocker arm assembly shall consist of a drive unit mounted to a stainless-steel arm. The stainless-steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy-duty tension springs. The flange bearing shall be connected to the rocker's arm by four bolts. The rocker arm shall be maintained in the standard operating position by the two tension springs. If the screen rakes experience a jam, the force will cause the rocker arm to rotate around the drive shaft, compressing one of the tension springs. This motion shall be limited by a rocker guide. When the rocker arm rotates out of the normal operating position a proximity sensor will send a signal to the PLC causing the motor to enter a self-cleaning mode. If the self-clearing mode should prove unsuccessful then the system shall initiate an alarm signal

xix. All stainless-steel parts must be completely passivated and submerged fully in the Pickling Bath.

xx. The motor can be equipped to run on frequency converters; therefore, can adjust the speed of the rakes to meet the necessary screenings conveying capacity.

xxi. Rake screens must use stainless steel covers as a standard.

xxii. The rake screen bar rack is put together with segments. A segment has a higher stiffness instead of a single bar. In case of damage, only the damaged segment must be changed, not the whole bars rack.

xxiii. The rake screen should be with the front rake system with a number of rakes considering channel depth.

xxiv. The rake-assembly shall be driven by an electric motor. The motor shall be rated for operation in a 50- degree Celsius environment. The motor should be of IP 65 protection type.

xxv. Screen construction should be such that, it should mount only on top of the channel wall. The frame will rest on the special supports installed on the wall along the depth of the channel. In case of maintenance, the screen should be able to be lifted out from the top with a crane. No personnel should go inside the screen chamber for any type of maintenance or repair work.

General

i. Mechanical Bar Screens should be fixed bar types that capture the debris with a minimum clear spacing between the bars no greater than 50 mm for the Coarse Screen, 10 mm for Intermediate Screen and 6 mm for fine screens.

ii. The Screen should be mechanically operated and suitable for installation in the screen channel, for removal of floating wastes coming along with sewage. The screens should be capable of screening out most of the medium and large floating

materials such as plastic bags, floating debris, weeds, paper wastes, clothes, and rags etc. which are generally clogging the impellers of the pumps/equipment installed downstream of the screens.

iii. The mechanical screen should be sturdy against full blockage from waste and high force of water acting on the complete mechanical screen, the design of the mechanical screen should withstand all conditions.

iv. The operation of the screen shall be automatic through the timer. An ultrasonic-type differential level sensor shall also be provided to sense the head loss through the bar and give the signal to the travelling raking mechanism to start/stop its operation.

v. 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 feedback from the level controller.

Fabrication and design features

i. Use a power grinder to dull and produce smooth edges.

ii. Use bolted field connections. Field welding will not be allowed.

iii. Design all components for continuous 24 hours per day service.

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

v. The screen shall have protection against overload conditions, which otherwise might damage the equipment.

vi. All screens shall be constructed and shipped as an integrated product comprising of frame structure and guides, rakes, dead plate, cog wheels/sprockets and chains, discharge chute & drive unit.

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

viii. Upon receipt at the site the screen 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.

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

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

The screens should be of Stainless-Steel material to withstand the corrosive and aggressive sewage environment hence the screen manufacturer is expected to follow the best manufacturing practice mentioned hereunder to further eliminate the possibility of corrosion of the screen in such a corrosive atmosphere:

i. The manufacturer must have a quality system i.e. ISO: 9001-2015 in place to ensure the quality of the end-product.

ii. The screens should be manufactured in a stainless-steel clean area i.e. in a plant where no ferrous material is cut welded or handled. This is required to ensure that no ferrous contamination/pickup takes place because the stainless-steel surfaces subjected to ferrous pick-up get corroded.

iii. Further to this as an additional precaution the manufacturer of the screens must have the facility for Pickling and Passivation to remove any ferrous contamination that might have taken place during the manufacturing/handling/movement of raw and fabricated material.

iv. As screens are fabricated items hence to ensure the best workmanship. The screen manufacturer must have welding PQR, WPS & Qualified welders as per ASME Section 9.

Material of Construction & Specification:

All parts of the screen including fixed bars, rakes, screen frame, guide rails, dead plate, link type roller chains & sprockets, Cogwheel/sprocket, and discharge chute shall be constructed from stainless steel material grade Minimum SS 316 for long life in aggressive sewage environment. Suitable measures shall be taken to ensure the long life of the parts.

i. The bars shall be of flat profile having minimum 10 x 50 mm size with an average bar spacing of 10 mm.

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

iii. The rake shall be made of Stainless-Steel SS 316.

iv. The complete screen frame shall be constructed with 4mm plate stainless steels of suitable grade.

v. The drive chain for the rakes shall be a link-type roller chain with a minimum breaking load of 63kN and made of stainless-steel grade AISI 316. This is very essential considering the highly corrosive sewage atmosphere.

vi. Drive chains, chain guides, sprockets and their bearings shall be replaceable without removing the screen from the channel.

vii. To effectively remove the debris from the bottommost portion of the screen, the screen shall be provided with a curved structure at the bottom of the screen.

viii. The dead plate shall be a of minimum 2 mm thick in stainless steel and shall be suitably braced to ensure rigidity and prevent caving/bending due to increased water flow in monsoon.

ix. The upper sprocket bearing shall be re-greaseable and flange-type.

x. Lower bearings shall be made of non-re-greaseable special ceramic bushes or better.

xi. The screen should have an integrated scraper for discharging the screenings to the discharge chute. The scraper/wiper shall be cushioned during travel to the rest position.

xii. The rake mechanism should be operated by a geared motor and suitable for automatic operation, controlled by a level sensor and an electric control cabinet.

xiii. A torque switch should be provided to protect the screen from damage resulting from excessive torque.

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

Level Sensor

The level sensor shall be of ultrasonic differential type shall be provided.

Electrical motor

The drive shall be a Geared motor and the motor shall be of TEFC type with IP 55 protection & Class F insulation and be suitable for operation on 3 phase, 415V+/- 10%, frequency of 50 Hz+/- 5% and IE3 class efficiency as a minimum.

Control Panel

The control panel shall have IP 65 protection, be powder coated and shall be comprised of

- Mushroom head emergency stop.
- Overload relays for motor protection.
- PLC Circuitry to operate the screen with differential type ultrasonic level sensor.
- Selector switch to operate the screen in Auto, off and JOG mode.
- Provision to run the screen on a timer in case of failure of the level sensor.

Shop Testing

The screen must be completely manufactured and subsequently offered for inspection at the plant of the manufacturer only. 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 the following tests at the manufacturer's premises before dispatch:

1. **Dimensional Check:** Important dimensions of the screens are to be verified with respect to the approved G.A. drawing.
2. **Operational Test:** The complete screen including its carriage, rake, drive system and motor shall be mechanically operated and tested in dry condition to verify interference-

free movement and satisfactory operation.

3. **Positive Material Identification (PMI) test:** To ensure that Screens are made of Stainless-Steel Grade SS 316 positive material identification (PMI) test is to be conducted for all important screen components like Bars, Frame, Dead Plate during inspection and PMI reports to be submitted to client/corporation along with joint inspection report.
4. **Dye Penetration test:** Dye penetration test to be conducted at random to check the soundness of welding joints during the inspection. Both the Procedure as well as person conducting the dye penetration test should be certified by the outside agency as per relevant standards.
5. **Review of test certificate:** Material test report/certificate, Motor certificate, and Control Panel certificate are to be offered for review during the inspection.
6. **Review of WPS, PQR & Welder's qualification certificate:** To be offered for review during the inspection and a copy of same is to be submitted to the client/corporation along with a joint inspection report.

1.45 Mechanically Operated Fine Bar Screen (Dip & Drop Type)

Mechanical Bar Screens should be fixed bar type, that captures the debris with a minimum clear spacing between the bars no greater than 6 mm for Fine Screens. The Screen bars should be selected/designed such that the deflection of the bar under normal operating force does not exceed 1.5mm. The bars should extend to at least 300mm above the liquid depth at peak flow in clean condition. Above this height, a dead plate of no less than 3mm should be provided up to the debris discharge height.

Debris accumulated on the bars should be carried to the discharge point with the help of a CAM-actuated, spring-loaded, bucket-mounted, polymer comb which will actively engage with the parallel bars and comb out the lodged debris. The Raking Mechanism should be driven by Transmission Roller Chains conforming to ASTM B29.1 or ISO 606. No part of the chain, sprocket, shafts, or bearings should under any circumstance get submerged while the Liquid depth in the screening channel is equal to or less than the designed peak flow when the screen is in clean condition.

Use of Rollers, Conveyors, and Chains should be avoided under all circumstances since they are highly prone to fibrous material pick-up, which leads to frequent breakdowns, due to chain breakage, caused by jammed rollers, and adding unnecessary torque to the screen mechanism.

The Movement of the raking comb should be such that the comb descends in an open condition with the teeth of the comb always pointing towards the bar and upon reaching the bottom of the screen bars, the comb should close shut with a force of no less than 300 N/m of channel width while commencing the upward stroke.

On reaching the discharge point, the debris should be unloaded from the bucket, preferably without using a scraper mechanism that tends to malfunction when larger, rigid debris is present in the bucket/comb. The collected debris should be dumped into a fully enclosed discharge chute. The raking comb should continue to the next combing cycle without reversing. This sequence of motion should be performed by the screen with mechanical

means, such as fixed-setting cams and linkages.

The screen should be fully enclosed such that no damage can be caused to the screen by rogue debris. Motors, gearbox and bearing blocks should be contained within the enclosed screen while offering them easy access for maintenance.

The screen should be operated by a PLC-based local control panel with the following features.

1. Three primary operation modes should be present.
    a) OFF mode, where the screen will be shut and will not operate under any circumstances.
    b) Manual Mode, where the screen operates continuously without stopping unless there is an error detected in the system.

1. Auto Mode where the screen stops in the parking position after each combing cycle and moves to the standby mode for the duration of the pre-set time unless the High Liquid level is detected, in which case the screen automatically shifts to the Manual Mode described above until the error is resolved. However, if errors are detected in the system in this mode, the screen will shut down.
2. Maintenance mode, which is activated by a separate maintenance key which hands motor control to a push button. This is required so that the screen can be inched into an ideal position for lubrication during maintenance.
3. An emergency stop mushroom switch is provided.
4. Warning hooters and status indication LED lights should be provided and programmed to function as described in the operation manual.
5. The PLC can detect and report malfunctions such as

a) Motor Overload

b) Input Power Error

c) Emergency Stop Activation.

d) Limit switch error.

The LCP can communicate using SCADA with the MCP and communicate the status of the screen, errors if any. The MCP will be able to communicate with the LCP and override the primary operation modes required.

1.46 Manual Bar Screens

The screen shall be fabricated from rectangular section stainless steel grade 316L of minimum section 50mm x 10mm. The bar spacing shall be less than 40 mm. The bars shall extend to at least 500mm above the maximum water level and a stainless steel plate provided up to the screening's disposal level.

The bar screen shall comprise a number of screens of equal width placed in position over the width of the wet well to provide the overall screen width shown on the drawing. The end sections of the bar screen shall provide a spacing between the bar and the wall of not greater than 100 mm.

The screen shall be inclined at an angle of not more than 60 degrees and arranged so that screenings can be drawn up the upstream face of the screen.

Handrakes shall be fabricated from stainless steel grade 316L and shall be sized to enable one operator to remove screenings from the screen. The handrake shall be fitted with a rubber handgrip.

Material

a) frame stainless steel SS316L

b) Fit and shop assemble the various items of work insofar as possible.

c) Fabricate the work true to dimensions, square, plumb, level and free of defects. Accurately fit joints and intersecting members with adequate fastening.

d) Construct the work free from distortion and defects detrimental to the appearance and performance.

e) Provide mechanical fastenings of the same material and finish as the base material on which they occur unless required otherwise for structural or safety reasons.

f) Conform to the chemical composition and mechanical properties as outlined in the appropriate ASTM Specification for the stainless steel 316L.

g) Use with sea/brackish water sea water resistant material for machine frame, filter element.

h) All 316L Stainless steel –sizes to suit.

Execution

a) Delivery, Storage and Handling: Deliver, store and handle all material in a manner which prevents damage to its fabricated form.

b) Examination: Before installing any work of this Section, carefully inspect the work of all civil sub-contractor and verify that all such work is complete to the point where this installation may properly commence.

c) Discrepancies: In the event of discrepancies, notify the Engineer immediately. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

Surge Control Installation

The Contractor shall arrange for a surge analysis to determine whether or not surges will occur in the discharge line due to pump stoppage or power failure and this analysis shall be submitted to the Engineer. If the analysis establishes that surge will occur then the Contractor shall provide surge protection equipment, as specified herein.

The Contractor shall carry out a computer based comprehensive hydraulic transient analysis showing the performance of the surge control system installed in the piping system under various normal operating modes such as power failure, pump trip and sudden valve closure. A report discussing the analysis and fully explaining the data used and results obtained shall be submitted for the Engineer's approval. The cost of analysis shall be deemed to have been included in the cost of the surge protection equipment.

The surge control system shall be designed to limit maximum pressures in the pipeline, and to limit the minimum system pressure (cavitation) and thus ensure that no liquid column separation occurs. The surge control system shall eliminate and reduce pressure fluctuation in the system and to be designed to protect the system at a maximum flow, taking into account any derating for temperature. Assume no assistance from the inertia of the pumps, and air valves in the system. Surge control system performance will be verified by field tests at pumping rates defined above.

In all instances the recommendations of the pipeline manufacturer with respect to positive and negative pressures must be followed if they limit the surge to limits beyond those specified.

The surge vessel (if required) capacity and type shall be confirmed upon the finalization of the pipeline/network profile, pump selection details, valves and all associated equipment.

The surge vessel shall be designed in accordance with IS 2825, or BS 5500, or equivalent European or American Standards. It shall withstand full positive and vacuum pressure and be tested in accordance with the design code to the same pressures as the pipeline.

For a bladder type surge vessel, if required, the vessel to be vertical / inclined mounted type and the final size of the vessel shall be in accordance with the final approved hydraulic study. The bladder type air vessel shall be supplied with iso-butyl rubber bladder or approved equal. This shall have a guaranteed life of three years in contact with the liquid pumped at the specified temperature. Bladder pressurization valve and gauge shall be provided for recharging the bladder. Access ladder or platform shall be provided as necessary.

It will be noted that in the Bills of Quantities provision is made for the surge study, the supply and installation of the surge suppression equipment. The price quoted should be the maximum expected for the proposed installation and the Contractor shall provide and install all surge suppression equipment found to be necessary including all pipe work and civil works. The cost of all ancillaries, civil works, etc. that are necessary to provide adequate surge suppressors shall be provided to the same standards as specified for the pumping station works and will be deemed to be included in the price quoted for the surge suppression equipment. No claim will be considered for extra payments due to under estimation or insufficient of the requirements.

The surge analysis study shall include the minimum following features:

1. Wave velocity shall be calculated for all modeled piping segments. It is recommended that this operation provided by the software automatically with reasonable assumptions. (i.e. manual calculation for one segment then assumption by the user to propose the same for all other modeled pipes is not acceptable unless this choice is

justified in the report).

2. Pump stoppage time for fixed speed pumps shall be calculated based on pump-set moment of inertia. (i.e. not assumed time by the user), while if controlled pump stoppage speed is considered then the same shall be explained in the report.
3. Check valve data shall be input to the program based on the data of the proposed NRV. Check valve performance shall be verified by the program including slam calculation in order to confirm that the check valve is suitable for the proposed application. Check valve closing time shall be outcome from the calculation (user input for this parameter is not acceptable). Using ideal check valve (i.e. without considering check valve input data) shall be not acceptable.
4. All valves characteristic curves shall be input to the program. Control valve cavitation calculation and curves shall be output from the program. Opening percentage / valve action shall be programmable.
5. Surge vessel (vertical – Horizontal) type vented or non-vented and concept of operation as mass balance or level control shall be specified in the report and considered in the program. The water level, in/out flow, air pressure charts for the surge vessel shall be output from the program.
6. Air valve as being (single, double) action with air into/out from the pipeline shall be calculated during surge. Air vent slam calculation shall verify the suitability of air vent type used. Air management inside the piping system shall be explained in the report.
7. Discharge chambers as a standalone weir or with discharge nozzle to another chamber can be modeled in the system. Representing the same by programming tricks shall be explained in the report and proven by showing all necessary equations that comply with the function of the boundary condition.
8. Pump protection controls for trip pre-set Hi/Lo pressure – Flow shall be available (if required) in the software.
9. Pump operation control for Flow / Pressure control shall be available (if required) in the software.
10. Surge towers and water shafts shall be available (if required) in the software.
11. Orifice plates shall be available (if required) in the software
12. Pipeline equation for head loss shall be Colebrook white, fitting loss can be input to the program.
13. The piping system charts such as head gradient and pressure envelope shall be produced by the hydraulic study software and provided in the report.
14. The program output results shall be provided with respect to time. A minimum simulation time of 1000s shall be considered.
15. Simulation of the hydraulic system as per the design control philosophy shall be possible by implementing a control layer (if required).

The following charts shall be provided with respect to time for each studied case:

a) Head Gradient/envelope for the entire piping system
b) Pressure envelope for the entire piping system
c) Check valve closing velocity chart
d) Air valve air in/out flow and volume charts
e) Surge vessel fluid level and discharge flow charts
f) Surge vessel air volume and pressure charts
g) Pressure and flow series shall be submitted at the pump station and each branch connection for each case.
h) Pumps speed and efficiency chart shall be provided for pump start / stop operation.

16. All cases brief explanation and results shall also be provided in summary table and included in the report.
17. The report shall be prepared according to the standard and shall include the following chapters:
    a. Introduction
    b. System description
    c. Software used in the study brief description
    d. Steady State Objectives
    e. Steady State Design Criteria
    f. Steady State cases description (sensitivity checks) to confirm pump head
    g. Surge Analysis Objectives
    h. Surge Analysis Design Criteria
    i. Surge Analysis cases description (As per system control philosophy)
    j. Model Input Data
    k. Steady State sensitivity check result
    l. System Curve
    m. Surge Analysis cases Results
    n. Conclusion & Recommendations
    o. Attachments shall include, Model, input/output data, time series charts, equipment vendor catalogues…etc.
18. Pump station required minimum cases shall be as follows:
    a. FPT (Full Pump Trip) with and without surge protection
    b. One pump trip standby pump start
    c. Pump start / stop operation (allow min. time between staring / stopping the next pump(s) for lifting pump stations that starting the pump operation shall be based on the fluid level in the wet well while the time considered for other type of pump stations shall be as per the control philosophy)
    d. Closing line valve(s) (if applicable).
19. Modeling the pump station shall be in accordance with the mechanical drawings. All equipment shall be considered. Combined components such as pumps with imbedded check valves shall not be acceptable.

Spare Parts

The contractor's scope of work shall cover all obligations for the supply of spare parts, tools, test equipment’s/instruments, chemicals, consumables, lubricants and fuels.

The mechanical equipment supplied to the project site shall include for the supply of spares, the contractor shall submit detailed item list of spare parts including quantity supplied, address of local suppliers and manufacturer, recommendation for Client approval.

All spare parts, tools, etc. supplied under the contract shall be strictly interchangeable with the parts

they are intended to replace and from the same manufacturer as that of the original part.

Warranty

All materials and components furnished, and installed under this contract, shall be guaranteed against defects in design, material and workmanship for the full warranty period which is standard with the manufacturer, but in no case less than one year from the date of PAC, unless specified elsewhere in the specification for any equipment / material.

Contractor/ Manufacturer shall provide complete guarantee for the design, material selection and performance of the equipment in accordance with this specification and requisition.

Contractor shall guarantee all work and material in his supply against defective material, poor workmanship, improper design, improper packing and/or failure in normal use.

The equipment shall be warranted against design/manufacturing defects for a period from the date of commissioning as specified in the contract.

If any such defect is detected during this period, Contractor/ Manufacturer shall either repair or replace the defective component without any charge, within the specified guarantee period.

All mechanical equipment shall ensure reliable and maintenance free operation and supplied with two years warranty.

During the guarantee period, a warranty check of each system required to be validation tested shall be performed twice by qualified technical representatives of the various system manufacturers, including manufacturers of equipment components within systems. Checks shall be detailed and complete, requiring not less than 8 hours at the site, and shall be performed under the observation and to the satisfaction of engineer and Client representative. All costs for in-service checks shall be included in the Contract Price.

The Contractor shall notify Client in writing at least ten days prior to the start of each warranty check and obtain his approval of the proposed dates.

At the time of each warranty check, each qualified technical representative shall review the O&M Manual and the pertinent operational and maintenance problems encountered, and furnish technical advice and recommendations to Client.

The initial warranty check shall be performed approximately six months after final acceptance of the plant. The second warranty check shall be performed within thirty days of the end of the contractual guarantee period.

The Contractor shall submit a written report of each warranty check, signed by the appropriate manufacturer or his representative, to Client within ten days following the check. The report shall describe the checking procedure in detail, and shall restate all advice and recommendations given to Client.

Miscellanous Work

1.47 Ventilation Fan

Supply of exhaust fans (axial type) shall be provided at the places specifically mentioned for ventilation purpose. The cast aluminum alloy blades shall have high efficiency aerofoil section. Blades shall be directly mounted on motor shaft, dynamically balanced to avoid noise and vibration and shall conform to IS:2312. The means provided for securing the fan mounting or fan casing to the wall shall be such as to provide a secure fixing without damage to the fan or wall. The blade and its carriers shall be securely fastened to avoid loosening in operation.

The drive motors shall be TEFC, squirrel cage, induction type suitable for 240 volts ± 10%, 1phase or 415 volts ± 10%, 3 phase, 50 Hz AC supply with IP 54 enclosure and Class B insulation.

Suitably designed guards made of SS AISI shall be provided at the inlet and outlet side to prevent accidental contact. No inflammable material shall be used in the construction of exhaust fan. Moulded

parts, if used, shall be of such materials as to withstand the maximum temperature attained in the adjacent component parts.

The exhaust fan shall have protective insulation may be of all insulated construction or have either double insulation or reinforced insulation. Each fan shall be provided with a 10 sq mm mesh bird screen to safeguard birds from getting sucked in. The sheet used for the cowl shall be 14 gauges.

The finish shall be stove enameled glossy paint/ epoxy paint with specially pre-treated components to enhance corrosion resistance.

The number and size of exhaust fan shall be determined taking into account 12 complete changes of air per hour to the service area.

In line ventilation fan may also be used for multiple ducting system.

Ventilation system for kitchen, canteen room, toilets, pump house, booster station, chemical house, filter house, electrical panel room and staff quarters and other buildings within the plant shall be provided. Special fan shall be used in chemical house and in battery room. The temperature rise in equipment room shall not exceed 3 deg. C above the ambient temperature of 50 deg. C. Contractor has to submit all the HVAC design calculation considering desired air change per hour as per the relevant guideline for specific application.

Air required for ventilation systems in buildings below the ground level shall be supplied with proper ducting considering acoustic criterion.

All electrical room shall be provided with pressurize ventilation system.

Ducting shall be designed as per IS:655.

1.48 Fire Extinguisher and First Aid Kit

The Contractor shall provide fire extinguishers and First Aid Kit at the locations in consultation with the Engineer.

Complete first aid kits at all the sites shall be provided for the maintenance bays of the pump houses. The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns, bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc.

Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use
- Band aid stripes

Following chemicals/ medicines shall be provided in sufficient quantities:

- Tinctures iodine and mercury chrome
- Anti-inflammatory ointment
- Bottles of spirit and of antiseptic
- Toilet soaps

To be procured under medical advice:

- Tablets for bad effects of chlorine inhalation
- Skin lotions and ointments for burns, acid effects
- Eye drops for soothing effects

Fire extinguisher and first aid kits shall be provided for the end of the commissioning period

only. They shall not be used before and shall be complete.

1.49 Vendor List

Recommended vendor makes list

Sl	Equipment Description	Vendor List	Inspection Category
A	Mechanical Equipment		
1.	Submersible Pumps	Grundfos / Xylem (Flygt) / Sulzer (ABS) / KSB / KBL/ Aqua	A
2.	Horizontal Centrifugal Pumps	Grundfos / Sulzer / Wilo / KSB / Flowserve / Kirloskar	A
3.	Mechanical Bar Screens and related equipment	Huber / Jash Engineering / Bilfinger (Johnson) / Headworks / EMO / EVA / Fundamental Technologies	B
4.	Odour Control Unit and related equipment (Odour Extraction fans, prefilters etc.)	Tholander / Bioair / Likusta / PureAir / ERG / Likutech	B
5.	Agitator	Lightnin (SPX) / Chemineer / Milton Roy mixing / ABS / Sulzer / Grundfos	B
6.	Submersible Mixers	Xylem (Flygt) / ABS (Sulzer) / KSB / Wilo / Grundfos	B
7.	Electrical Chain Hoist	Demag / Kone cranes (Morris) / ElectroMech (Stahl) / Indef (Hercules) / WH Brady	B
8.	EOT Crane	Demag / Kone cranes (Morris) / ElectroMech (Stahl) / Indef (Hercules) / WH Brady	B
9.	Lifting Davit Crane	Thern / Vector Lifting / Reid Lifting	B
10.	Penstocks	Hambaker Adams / KWT/ Waterfront/ IBS Engineering / CTV / JASH	B
B	Pipes		
1.	DI	Jindal / Electro Steel Castings / Tata Kubota	A (Random samples)
2.	GRP	EPP Composites / CPP / Pacific/ Amiantit / Hobas	B
3.	HDPE	Supreme / Jain Irrigation / Georg Fischer / Dutron / Ashirvad Pipes (Aliaxis Group) / Sangir	B
4.	SS 316 / 304	Maharashtra Seamless / Jindal / Ratnamani / Navbharat / REMI	B
5.	UPVC	Georg Fischer / Astral / Jindal / Supreme / Finolex	B
6.	PVC	Georg Fischer / Astral / Jindal / Supreme / Finolex	B
C	Valves		
1.	Butterfly Valves	Kirloskar Brothers Ltd / Indian Valve Company / AVK / VAG / Tyco Valves and Controls / Weir valves & control (Batley valve) / Gaer / Audco / Hawle / Fouress	A
2.	Gate Valves	Kirloskar Brothers Ltd / Indian Valve Company / AV / VAG / Gaer / Audco / Hawle / Fouress	B
3.	Knife Edged Gate Valves	Kirloskar Brothers Ltd / Indian Valve Company / AV /VAG / Fouress / Gaer /JASH / Fouress	B
4.	Ball Valves	Valtrock / Pentair / Fluidtech valves/ Aira/ Gaer /L&T Valves / BDK / SWIMS Technologies	B

Sl	Equipment Description	Vendor List	Inspection Category
5.	Non return valves	Kirloskar Brothers Ltd / Indian Valve Company / AVK / VAG / Hawle	B
6.	Solenoid Valves	Mac / Asco numatics / Herion werke / Versa BV	B
7.	Pressure Reducing Valves	Kirloskar / JASH / VAG / CIRI Technologies / Forbes Marshall / Armstrong	B