RAJKOT MUNICIPAL CORPORATION

E-Tender No.: RMC/AMRUT 2.0/DRN PROJECT/2023/SPS-MUNJAKA

Bid Documents
For
Construction of Sewage Pumping Station with providing, lowering, laying, jointing, testing and commissioning of Rising main pipeline including supply, installation, testing & commissioning of pumping machinery with allied accessories including O & M for 2 years at F.P. No. 26/7 in TP-42 of Munjaka in Rajkot

Volume-II
Technical Specifications & Drawings

DECEMBER-2023

Milestone Dates for e-tendering is as under	
1. Downloading of e-Tender documents	06-12-2023 To 27-12-2023 up to 18.00 Hrs.
2. Pre-bid meeting in the O/o City Engineer at **Central ZONE**	12-12-2023 at 11:00 hrs
3. Online submission of e - Tender	28-12-2023 up to 18.00 Hrs.
4. Physical submission of EMD, Tender fee and other documents required as per Financial and Experience criteria by Regd. Post. A.D. / Speed Post ONLY	04-01-2024 up to 18.00 Hrs.
5. Opening of online tender (Technical Bid)	06-01-2024 at 10.30 Hours onwards
6. Verification of submitted documents (EMD, e - Tender fee, etc.)	09-01-2024 up to 18.00 Hrs.
7. Agency to remain present in person along with original documents for verification	09-01-2024 up to 18.00 Hrs.
8. Opening of Price Bid (If possible)	16-01-2024 at 11.00 Hours onwards (If possible)
9. Bid Validity	180 Days
For further details, pre-qualification criteria etc. visit www.rmc.nprocure.com	

CITY ENGINEER
RAJKOT MUNICIPAL CORPORATION
SHRI HARISINHJI GOHIL BHAVAN
WEST ZONE OFFICE, 150' RING ROAD,
RAJKOT - 360005 (GUJARAT)

I N D E X

Sr No	Particulars
1	Technical specifications
2	Schedule of Drawings

Part 1: Specifications for Civil Works

CONTENTS

1.0 General

Sr.	PARTICULARS
1.1	Scope of work
1.2	Design
1.3	e-Tender price
1.4	Completion Schedule
1.5	General Technical Guideline
1.6	Classification of Strata
1.7	Materials in General
1.8	Sample and Tests of Materials
1.9	Standards
1.10	Orientation

2.0 Earth works

Sr.	PARTICULARS
2.1	Scope
2.2	Application Codes
2.3	General
2.4	Clearing
2.5	Excavation
2.6	Rock
2.7	Stripping Loose Rock
2.8	Fill, Back filling and Site Grading
2.9	General Site Grading
2.10	Fill Density
2.11	Timber Shoring
2.12	Dewatering
2.13	Rain water Drainage

3.0 Concrete works

Sr.	PARTICULARS
3.1	Scope
3.2	Application Codes
3.3	General
3.4	Materials
3.5	Sample and Tests
3.6	Storing of Materials
3.7	Concrete
3.8	From work
3.9	Reinforcement workmanship
3.10	Tolerances
3.11	Preparation Prior to Concrete Placement

3.12	Transporting, Placing and compacting Concrete
3.13	Mass Concrete Works
3.14	Curing
3.15	Construction Joints and Keys
3.16	Foundation Bedding
3.17	Finishes
3.18	Repair and Replacement of Unsatisfactory Concrete
3.19	Vacuum Dewatering of Slabs
3.20	Hot Weather Requirements
3.21	Cold Weather Requirements
3.22	Liquid Retaining Structures
3.23	Testing Concrete Structure for Leakage
3.24	Optional Tests
3.25	Grouting
3.26	Water stops
3.27	Preformed fillers and joints sealing compound concrete Pour Card
3.28	Mode of Measurements and Payment

4.0 Structure Steel works

Sr.	PARTICULARS
4.1	Applicable codes and specifications
4.2	Steel Materials
4.3	Fabrication
4.4	Tolerances
4.5	End Milling
4.6	Inspection
4.7	Shop Matching
4.8	Drilling Holes for other works
4.9	Marketing of Members
4.10	Errors
4.11	Painting of steel works
4.12	Acceptance of Steel, its Handling & Storage
4.13	Anchor Bolts & Foundations
4.14	Assembly & connections
4.15	Erection
4.16	Inspection
4.17	Tolerances
4.18	Clean up of Work Site

5.0 General Technical Specifications for Building work

Sr.	PARTICULARS
5.1	General
5.2	Application Codes and Specifications
5.3	Brickwork
5.4	Un-coursed Random Ruble Masonry, in Foundation, Plinth and Superstructure

5.5	Coursed Rubbles Masonry (First Sort) for Superstructure
5.6	Concrete Block Masonry
5.7	Damp – Proof Course
5.8	Miscellaneous Inserts, Bolts etc.,
5.9	Wood Work in Doors, Windows, Ventilators & Partitions
5.10	Steel Doors, Windows and Ventilators
5.11	Aluminum Doors, Windows, Ventilators & Partitions
5.12	Steel Rolling Shutters
5.13	Rubbles Sub – Base
5.14	Base Concrete
5.15	Terrazzo and Plain Cement Tiling Work
5.16	In – Situ Terrazzo work
5.17	Shahabad /Tandur / Kota
5.18	Carborundum Tile Finish
5.19	Glazed Tile Finish
5.20	In – Situ Cement Concrete Floor Topping
5.21	In – Situ Granolithic concrete Floor Topping
5.22	Floor Hardener Topping
5.23	PVC Sheets / Tile Flooring
5.24	Acid Resisting Brick / Tiling work
5.25	Epoxy Lining Work
5.26	Water – Proofing
5.27	Cement Plastering Work
5.28	Cement Pointing
5.29	Water – Proofing Admixtures
5.30	Painting of Concrete, Masonry & Plastered Surface
5.31	Painting & Polishing of Wood work
5.32	Painting of steel work
5.33	Flashing
5.34	Thermal Insulation for Ceiling
5.35	Plaster of Pairs Board for ceiling
5.36	False or Cavity Floor
5.37	Fire Proof Doors

6.0 Item wise Detailed Technical Specifications for Sewage Pumping Station

7.0 Common Conditions

1.0 GENERAL:

1.1 Scope OF WORK

This tender covers construction of sewage pumping station. The schedule of quantities is given separately in tender. The broad scope of work is as follows and shall be carried out strictly in accordance with specifications and instructions of Engineer-in-charge issued from time to time. The contractor shall provide all necessary materials equipment, labour etc. for the execution and maintenance of work until completion unless otherwise mentioned in the tender documents. All materials that go with the work shall be approved by the Engineer in charge prior to procurement and use.

This sewage pumping station consist of by-pass chamber, sluice gates, inlet chamber, screen, grit chamber, wet well, pump house over wet well, incoming and by-pass sewer lines, toilet block, compound wall/retaining wall and any and all other works indicated and considered necessary for the execution of this work whether or not specifically mentioned or called for.

1.2 Design

Complete detailed structural design and all drawings shall have to be provided by contractor (A g e n c y) and must have to proof check and verify by Rajkot Municipal Corporation's project management consultant (PMC) Agency, and as per suggestions / comments by RMC's PMC Agency the contractor (Agency) shall have modified all design and drawings ad have to carry out the construction of civil components of sewage pumping station accordingly.

1.3 e-TENDER PRICE:

The rates quoted in the bill of quantities shall cover everything necessary for the due and complete execution of the work according to the drawings and other condition and stipulations of the contract including specifications of the evident, intend and meaning of all or either of them or according to customary usage and for periodical and final inspection and test and proof of the work in every respect and for measuring, numbering or weighing the same, including setting out and laying or fixing in position and the provision of all materials, power, tools, rammers, labour, tackle, platforms with impervious lapped joints for scaffolding, ranging roads, straight edged, cantering and boxing, wedges, moulds, templates, posts, straight rods, straight edged, cantering and boxing, wedges, moulds, templates, posts, straight rails, boning staves strutting, barriers, fencing lighting pumping apparatus, temporary arrangement for passage of traffic access to premises and continuance to drainage water supply and lighting (if interrupted bycontractor’s work) temporary sheds, painting, varnishing, polishing establishment for efficient supervision and stating arrangements for the efficient protective of life and property and all requisite plant and machinery of every kind.

The contractor shall keep every portion of the work clear of accumulation from time to time and shall leave every portion of the work clean, clear, perfect and at the conclusion of whole, providing at their own cost all such material implement, appliances and labour as the Engineer in charge may require to prove if it to be so.

1.4 COMPLETION SCHEDULE:

The contract period shall be **18 (Eighteen) Calendar months** from the date of notice to proceed. The Contractor shall submit his completion schedule and the program of works together with this e-Tender in conformity with completion schedule given in the documents.

1.5 GENERAL TECHNICAL GUIDELINE:

a. All the items occurring in the work and as found necessary during actual execution shall be carried out in the best worker like manner as per specifications and the written order of the Engineer in charge

b. Extra Claim in respect of extra work shall be allowed only if such work is ordered to be carried out in writing by the Engineer in charge

c. The contractor shall engage a qualified Engineer for the Execution of work who will remain present for all the time on site and will receive instructions and orders from the Engineer in charge or his authorized representative. The instruction and orders given to the contractor representative on site shall be considered as it given to the contractor himself.

d. The work order book as prescribed shall be maintained on the site of the work by the contactor and the contractor shall sign the orders given by the inspecting offers and shall carry out them properly.

e. Quantities specified in the e-Tender may vary at the time of actual execution and the contractor shall have no claim for compensation on account of such variation

f. Unexcavated lengths shall be left wherever required and so directed by the Engineer in charge during the currency of the contract and shall be tackled. If required, before completion of work.

g. Diversion of road, if necessary, shall be provided and maintained during the currency of the contract by the contractor at his cost.

h. Figured Dimensions of drawing shall supersede measurements by scale, special dimensions or directions in the specifications shall supersede all other dimensions.

i. All levels are given on drawings and the contractor shall be responsible to take regular level before actually starting the work the levels shall be commence to the G.T.S. Levels and shall be got approved from the Engineer in charge.

j. If the arrangement of temporary drainage is required to be made during any work of this Contract, this shall be made by the Contractor without claiming any extra cost.

k. All works shall be carried out strictly as per detailed specification whether actually specified or not. If not specified, as per directions of owner / Engineer-in-charge.

l. Use of I. S. Code shall mean its latest applicable version for respective items.

1.6 CLASSIFICATION OF STRATA:

1. All materials encountered in excavation will be classified in the following groups irrespective of mode of excavating the materials and the decision of the Engineer in charge in this regard shall be final and binding to the contractor.

2. Soils:
   Soils of all sorts, silt, sand, gravel, soft murrum, stiff clay, kunkar and other soft excavation not covered in the items mentioned here under.

3. Hard Murrum:
   Hard Materials comprising of all kinds of disintegrated rock or shale or indurate conglomerate interspersed with boulders, weatheredand decomposed rock, which could be removed with pick, bar, shove, wedges and hammers, though not without some difficulties.

4. Soft – Rock:
This shall include all materials which is rock but which does not need blasting and can be removed with a pick bar, wedges, pavement breakers, pneumatic tools etc.

5. Hard Rock:
This shall include rock accusing in mass or boulders which need blasting, this will also include rock to be removed by chiseling or any other method where blasting is not permissible.

1.7 Materials in General

The term "materials" shall mean all materials, good and articles of every kind whether pure, processed or manufactured, equipment, and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Excepts as may by otherwise specified for particular parts of the works the provision of clauses in "*Materials and Workmanship*" shall apply to materials an workmanship for any part of the works.

All materials shall be new, of the kinds and qualities described in the Contract, and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the works, the Contractor shall inform Engineer-in-charge of the names of the supplier from whom he proposes to obtain any materials but he shall not place any order without the approval of Engineer-in-charge, which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep Engineer-in-charge informed of orders for and delivery dates of all materials. Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the works under this contract.

1.8 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by Engineer-in-charge and shall carry out the specified tests directed by Engineer-in- charge, at the site, at the supplier's premises or at a laboratory approved by Engineer-in-charge. Representative of Engineer-in-charge shall attend the test at the appointed place within seven days of the said data on which the material are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by Engineer-in- charge to carry out such at test on a mutually agreed date in his presence. The Contractor shall in any case submit to Engineer-in-charge's representative within seven days of every test such number of certified copies (minimum six) of the test results as Engineer-in-charge may require.

Approved by Engineer-in-charge as to the placing of order for materials or as to samples or tests shall not prejudice any of Engineer-in-charge's powers under the Contract.

The provisions of this clause also apply fully to materials supplied under any nominated sub-contract.

1.9 Standards

Materials and workmanship shall comply with the relevant India Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to Engineer-in-charge, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to Engineer-in-charge.

The specifications, standards and codes listed below are considered part of this Bid specifications. All standards, specification, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Bid specification and the Standards referred to herein, the Bid Specification shall govern.

A) Materials

1.	IS : 269	Specification for 33 grade ordinary Portland cement
2.	IS : 383	Specification for coarse and fire aggregates from natural sources for concrete
3.	IS : 428	Specification for distemper, oil emulsion, colour as required
4.	IS : 432	Specification for mild steel and medium tensile steel bars and hard dpuren steel wire for concrete reinforcement (Parts
5.	IS : 455	Specification for Portland slag cement
6.	IS : 458	Specification for precast concrete pipes (With and without reinforcement)
7.	IS : 650	Specification for standard sand for testing of cement
8.	IS : 651	Specification for salt glazed stoneware pipes and fittings
9.	IS : 777	Specification for glazed earthenware tiles
10.	IS : 808	Specification dimensions for hot rolled steel beam, column, channel and angle sections
11.	IS : 814	Specification for covered electrodes for manual metal are welding of Carbon and Carbon Manganese steel
12.	IS : 1003	Specification for timber paneled and glazed shutters (Part 1 &
13.	IS : 1038	Specification for steel doors, windows and ventilators
14.	IS : 1077	Specification for common burnt clay building bricks
15.	IS : 1398	Specification for packing paper, water proof, bitumen
16.	IS : 1489	Specification for Portland pozzolana cement (Parts 1 & 2)
17.	IS : 1566	Specification for hard drawn steel wire fabric for concrete reinforcement
18.	IS : 1580	Specification for bituminous compound for water proofing and caulking purposes.
19.	IS : 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
20	IS : 1852	Specification for rolling and cutting tolerance for hot rolled steel products
21.	IS : 1948	Specification for aluminum doors, windows and ventilators
22.	IS : 1977	Specification for structural steel (ordinary quality)
23.	IS : 2062	Specification for steel for general structural purpose
24.	IS : 2185	Specification for concrete masonry units (Parts 1 & 2)
25.	IS : 2202	Specification for wooden flush door shutter (parts 1 & 2)
26.	IS : 2645	Specification for integral cement water proofing compounds
27.	IS : 2750	Specification for steel scaffoldings
28.	IS : 2835	Specification for flat transparent sheet glass

29.	IS : 3384	Specification for bitumen primer for use in waterproofing and damp roofing
30.	IS : 3502	Specification for steel chequerred plates
31.	IS : 4021	Specification for timber door, window and ventilator frames
32.	IS : 4350	Specification for concrete porous pipes for under drainage
33.	IS : 4351	Specification for steel door frames
34.	IS : 4990	Specification for plywood for concrete shuttering work
35.	IS : 8112	Specification for 43 grade ordinary Portland cement
36.	IS : 9862	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
37.	IS : 10262	Recommended guidelines for concrete mix design
38.	IS : 12269	Specification for 53 grade ordinary Portland cement
39.	IS : 12330	Specification for sulphate resisting Portland cement
40.	IS : 12709	Glass fiber reinforced plastics (GRP) pipes, joint and fittings for use for potable water supply

B) Tests

1.	IS : 516	Method of test for strength of concrete
2.	IS : 1182	Recommended practice for radiographic examination of fusion welded butt joint in steel plates
3.	IS : 1199	Methods of sampling and analysis of concrete
4.	IS : 2386	Methods of test for aggregates for concrete (Parts 1 to 8)
5.	IS : 2720	Methods of test for soils (Parts 1 to 9)
6.	IS : 3025	Methods for sampling and test (Physical and Chemical) for water and wastewater (Parts 1 to 44)
7.	IS : 3495	Methods of test for wire flux combination for submerged are welding
8.	IS : 3613	Acceptance tests for wire flux combination for submerged are welding
9.	IS : 4020	Methods of test for wooden flush doors Type tests
10.	IS : 4031	Methods of physical tests for hydraulic cement (Part 1 to 15)
11.	IS : 5807	Methods of test for clear finishes for wooden furniture (Part 1 to 6)
12.	IS : 7318	Approval tests for welders when welding procedure approval is not required (Part 1 and 2)

C) **Codes of Practice**

1.	IS : 456	Code of practice for plain and reinforced concrete
2.	IS : 783	Code of practice for laying of concrete pipes
3.	IS : 800	Code of practice for general construction in steel
4.	IS : 816	Code of practice for use of steel tubes in general building construction
5.	IS : 817	Code of practice for training and testing of metal arc welders
6.	IS : 875	Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)
7.	IS : 1081	Code of practice fox fixing and glazing of metal (steel and aluminum)
8.	IS : 1172	Code of practice for basic requirements for water supply, drainage and sanitation.
9.	IS : 1477	Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
10.	IS : 1597	Code of practice for construction of stone masonry (Part 1 & 2)
11.	IS : 1742	Code of practice for building drainage
12.	IS : 1893	Criteria for practice earthquake resistant design of structures

13	IS : 2065	Code of practice for water supply in buildings
14.	IS : 2212	Code of practice for brickwork
15.	IS : 2338	Code of for finishing of wood and wood based materials (Parts 1 & 2)
16.	IS : 2394	Code of practice for application of lime plaster finish
17.	IS : 2395	Code of practice for painting, concrete, masonry and plaster surface (Parts 1 to 2)
18.	IS : 2470	Code of practice for installation of septic tanks (Parts 1 to 2)
19.	IS : 2502	Code of practice for bending and fixing of bars for concrete reinforcement
20.	IS : 2571	Code of practice for laying in situ cement concrete flooring
21.	IS : 2595	Code of practice for radiographic testing
22.	IS : 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
23.	IS : 2974	Code of practice for design and construction of machine foundations (Parts 1 & 4)
24.	IS : 3114	Code of practice for laying of cast Iron pipes
25.	IS : 3370	Code of practice for concrete structures for the storage of liquids (Parts 1 & 4)
26.	IS : 3414	Code of practice for concrete for design and installation of joints in buildings
27.	IS : 3558	Code of practice for use of immersion vibrators for consolidating concrete
28.	IS : 3658	Code of practice for use of immersion vibrators for consolidating concrete
29.	IS : 3935	Code of practice for composite construction
30.	IS : 4000	Code of practice for High strength bolts in steel structure
31.	IS : 4014	Code of practice for steel tubular scaffoldings (Parts 1 & 2)
32.	IS : 4111	Code of practice for ancillary structures in sewerage system (Parts 1 to 4)
33.	IS : 13920	Code of practice for laying of glazed stoneware pipes
34.	IS : 4326	Code of practice for Earthquake Resistant Design and Construction of Buildings
35.	IS : 4353	Recommendations for submerged are welding of mild steel and low alloy steels
36.	IS : 5329	Code of practice for sanitary pipe work above ground for building
37.	IS : 5334	Code of practice for magnetic particle flaw detection of welds
38.	IS : 5822	Code of practice for laying of welded steel pipes for water supply
39.	IS : 7215	Tolerances for fabrication of steel structures
40.	IS : 9596	Recommendations for metal arc welding of carbon and carbon manganese steels
41.	IS : 10005	SI units and recommendations for the use of their multiples and of certain other units

D) Construction Safety

1.	IS : 3696	Safety code for scaffolds and ladder (Parts 1 & 2)
2.	IS : 3764	Safety code for Excavation work
3.	IS : 7205	Safety code for erection of structural steel work

1.10 Orientation

The works shall be laid out within the confines of the site in order to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground service requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of Engineer-in-charge be relocated by the Contractor.

2.0 EARTHWORKS

2.1 SCOPE

This specification covers the general requirements of earth work in excavation for well, foundations and trenches, dewatering, form work etc. in different materials, filling in areas as shown in drawing, filling back around foundations trenches, conveyance and disposal of surplus soils or stacking them properly as directed by Engineer-in-charge and all operations covered within the intent and purpose of this specification.

2.2 Applicable Codes

The following Indian Standard codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

a) IS 783 – 1985 - Code of practice for laying of concrete pipes

b) IS 3764 – 1992 - Excavation work – Code of Safety

c) IS 2720 - Methods of test for soils:

(PART – 01)-1983	Preparation of dry soil samples for various tests.
(PART – 02)-1986	Determination of Water content.
(PART – 04)-1985	Grain size analysis
(PART – 05)-1985	Determination of liquid and plastic limit
(PART – 07)-1980	Determination of work content–dry density relation using light compaction
(PART – 09)-1971	Determination of dry density–moisture content by constant weight of soil method
(PART – 14)-1983	Determination of density index (relative density) of cohesion less soils.
(PART – 22)-1978	Determination of organic matter.
(PART – 26)-1987	Determination of total soluble sulphates.
(PART – 27)-1987	Determination of dry density in place by the ring and water replacement
(PART – 28)- 1974	Determination of PH value
(PART – 33)- 1971	Determination of the density in place by the ring and water replacement method.
(PART – 34)- 1972	Determination of density of soil in place by rubber balloon method.
(PART – 38)- 1976	Compaction control test (Hilf Method).

2.3 General

The Control shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary. Whether or not such items are specifically stated herein for completion of the work in accordance with the Owner's Requirements.

The Contractor shall survey the site before excavation and set our all lines and establish levels for various works such as grading, basement, foundations, plinth fillings, roads, drains, cable, trenches, pipeline etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavations shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, riprap with regular slopes within the lead specified and leveling the same so as to provided natural drainage. Rock/soil excavated shall be stacked properly as approved by the Engineer-in-charge. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

Top soil shall be stock pilled separately for later re-use.

2.4 Clearing

The area to be excavated / filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The materials so removed shall be disposed off as approved by Engineer-in-charge. Where earth fill is intended the area shall be stripped of all loose/soft patches, top soil containing objectionable matter / materials before fill commences.

2.5 Excavation

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Engineer-in-charge the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths depths and profiles as are shown on the DRAWINGS provided by the Contractor and approved by the Engineer-In-Charge or such other lines and grades as may be agreed with the Engineer- in-charge. Rough excavation shall be carried out a depth of 150 mm above the final levels. The balance shall be excavated with special care. Soft pocks shall be removed below the final level and extra excavation filled up with lean concrete as approved by the Engineer-in-charge. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and backfill later, outside the lines shown on the Drawing provided by the Contractor as agreed with the Engineer-in-charge. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with concrete of the same class as in the foundation resting thereon, up the required elevation at no cost to the Owner.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer-in-charge shall be obtained by the Contractor in each individual's case, for the method proposed for the excavation, including dimensions side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safety for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope?

2.6 Rock

2.6.1 General

"Rock" means a natural aggregate of mineral crystals which for its excavation would normally require the use of heavy pneumatic / hydraulic breaker and / or cutting equipment or explosives. The term shall exclude any material that can be removed by ordinary excavating machinery means a hydraulic backhoe with rated output of 50 KW or less.

Before classification of material as rock, the Contractor shall demonstrate to the satisfaction of the Engineer-in-charge, his inability to excavate it without resort to heavy percussion tools completed with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted except for pipeline.

Material shall not be classified as rock unless the Engineer-in-charge has agreed to such classification based on such a demonstration before its excavation. Excavation where rock has been encountered and classified as such shall not be back filled before examination of the excavated faces by the Engineer-in-charge, to enable the extent of the excavation to be determined.

2.6.2 Excavation by Use of Explosives

Unless otherwise stated herein, IS Specification "IS: 4081: Safety Code for Blasting and related Drilling Operations" shall be followed. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer-in-charge, shall be taken during the blasting operations, care shall be taken during the blasting operations, and care shall be taken that no damage is caused to adjoining buildings or structures because of blasting operations. In case of damage to permanent to temporary structures, Contractor shall repair the same to the satisfaction of Engineer-in-charge at his cost. An excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

The Contractor shall obtain a valid Blasting license from the authorities concerned. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as away as possible from the area to be blasted. Engineer-in-charge's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 meters to any structure or to locations where concrete has just been placed. In the latter case, the concrete must be at least 7 days old.

For blasting operations, the following points shall be observed.

1. Contractor shall employ a competent and experienced supervisor and licensed blaster in–charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

2. Before any blasting is carried out, Contractor shall intimate Engineer-in-charge, and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charge, the nature of explosive to be used and the precautions taken for ensuring safety.

3. Contractor shall ensure that all workers and the personnel at site are excluded from an area within 200m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

4. The blasting of rock near any existing buildings, equipment's or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by MS plates with adequate dead weight over them. Blasting shall be done with small charges. Only and where directed by Engineer-in-charge; a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

5. The firing shall be supervised by a Supervisor and more than 6 holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

6. A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

7. Contractor shall preferably detonate the explosives electrically.

8. The explosive shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.

9. In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

10. Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will suitable for handling without secondary blasting.

11. When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer- in-charge, with concrete of strength not less than M10. Stopping in rock excavation shall be done by hand trimming.

12. Contractor shall be responsible for any accident to workers, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observation of rules, laid by inspector of explosives, or any other Authority duty constituted under the State and / or Union government as applicable at the place of excavations.

2.7 Stripping Loose Rock

All loose bounders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Engineer-in-charge, to fall or otherwise

endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion, which was originally sound and safe.

Any material not requiring removal in order to completed the permanent works but which in the opinion of Engineer-in-charge, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

2.8 Fill, Back filling and Site Grading

2.8.1 General

(a) All fill material shall be subject to the Engineer-in-charge's approval. If any material is rejected by Owner' Representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited / disposed off as directed by Engineer-in-charge after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Engineer- in-charge.

2.8.2 Material

To the extent available, selected surplus spoil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulder shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pit. The material and source shall be subject to the prior approval of the Engineer-in-charge. The approved borrow pit area shall be cleared of all bushes, roots of trees, plant etc. Top soil containing foreign material shall be removed. The material so removed shall be disposed of as directed by Engineer-in- charge. The Contractor shall provide the necessary access roads to borrow area and maintain the same if such roads do not exist.

2.8.3 Filling in pits and trenches around foundation of structures, wall etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm. Each layer being watered rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer-in-charge. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer-in-charge is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be termed and leveled to a proper profile to the approval of the Engineer-in-charge.

2.8.4 Plinth Filling

Plinth filling shall be carried out with approved material as described here in before in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer-in-charge, may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and

then surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of the plinth fill shall be carried out by means of 12-ton rollers smooth wheeled, sheep-foot or woobly wheeled rollers. In case of compaction of granular material such as sands and gravels, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer-in-charge. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer-in-charge obtained prior to commencing filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfied of Engineer-in-charge, but in no case, less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/areas, it may not be possible to use roller because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

2.8.5 Sand Filling in plinth and other places

Where back filling is required to be carried out with local sand, it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structure on sand fill shall not be started until the ENGINEER-IN-CHARGE, has inspected and approved the fill.

2.8.6 Filling in Trenches

Filling in trenches for pipes and shall be commenced as soon as the joints of pipe and drains have been tested and passed. The back filling material shall be properly consolidated by watering and ramming, taking due care so that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling up to a level 30 cm above the top of the pipe shall be done with fine material such as earth, murrum, etc. the filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm where as the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available

to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

2.9 G e n e r a l site Grading

Site grading shall be carried out as indicated in the DRAWINGS and as approved by the Engineer-in-charge. Excavation shall be carried out as specified in the Owner's Requirements. Filling and compaction shall be carried out as specified under Clause 2.7 and elsewhere unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and leveled. If the fill has to be compacted, it shall be placed in layers not exceeding 255 mm, leveled uniformly, and compacted as indicated in Clause 2.7 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur the Contractor should remove the affected material and make good the slip.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicated grades without further breaking .In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material is not washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12-ton roller. Not less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

2.10 Fill Density

The compaction, under the plant road area and building plinths shall comply with minimum 95% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that specified density has been obtained. In other areas, the soil should be backfilled and compacted suitably as specified by the Engineer.

2.11 Timber Shoring

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "Polling boards". These shall be of minimum 25 cm x 4 cm sections or as approved by the Engineer-in-charge. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of

strong wood at maximum 1.2 meter spacing, strutted with ballies or as approved by the Engineer-in-charge. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of trench or pit shall remain exposed, to render the earth liable to slip out.

Timber shorting shall be" close" or "open" type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by the Engineer-in- charge. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits etc. from collapsing.

Timbering shoring may also be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer-in-charge.

The with pureal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Engineer-in-charge. In all other respects, the Engineer-in-charge for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

2.12 Dewatering

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Engineer-in-charge, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of concrete. The Contractor shall, however, ensure that no damage to the structure result on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Engineer-in-charge to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer-in- charge. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in opinion of the Engineer-in-charge obstructs the progress of the work, ideas to in sanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structure and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Engineer-in-charge, to be large, a well point system single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer-in- charge, details of his well point system including the stages, the spacing number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

2.13 Rain water Drainage

Grading in the vicinity of excavation shall be such as to exclude rain/surface water draining into excavated areas. Excavation shall be kept clean or rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Engineer-in-charge.

3.0 CONCRETE WORKS

3.1 SCOPE

This Specification covers the general requirements for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; form work; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for complete works.

It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all work shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by Engineer from time to time. The decision of Engineer as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on Contractor and no claim whatsoever will be entertained on this account.

3.2 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments / revisions and other specifications and codes referred to therein, should be considered a part of this specification. In all cases the latest issue / edition / revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

3.2.1 Material

1.	IS :269	Specification for 33 grade ordinary Portland cement.
2.	IS :455	Specification for Portland slag cement.
3.	IS :1489	Specification for Portland-pozzolana cement (Part 1 & 2).
4.	IS :8112	Specification for 43 grade ordinary Portland cement.
5.	IS :12269	Specification for 53 grade ordinary Portland cement.
6.	IS :12330	Specification for sulphate resisting Portland cement.
7.	IS :383	Specification for coarse and fine aggregates from natural sources for concrete.
8.	IS :432	Specification for mild steel and medium (tensile steel bars and hard drawn steel) wires for concrete reinforcement. (Part 1 & 2).
9.	IS :1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
10.	IS :1566	Specification for hard drawn steel wire fabric for concrete reinforcement.
11.	IS :9103	Specification for admixtures for concrete.
12.	IS :2645	Specification for integral cement water-proofing compounds.
13.	IS :4990	Specification for plywood for concrete shuttering work.

3.2.2 Material Testing

1.	IS :4031	Methods of physical tests for hydraulic cement (Parts 1 to 15).
2.	IS :4032	Methods chemical analysis of hydraulic cement.

3.	IS :650	Specification for standard sand for testing of concrete.
4.	IS :2430	Methods for sampling of aggregates for concrete (Parts 1 to 8).
5.	IS :2386	Methods of test for aggregates for concrete (Parts 1 to 8).
6.	IS :3025	Methods of sampling and test (physical and chemical) for water used in industry.
7.	IS :6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

3.2.3 Material Storage

1	IS : 4082	Recommendations on stacking and storing of construction material at site**.**

3.2.4 Concrete Mix Design

1.	IS : 10262	Recommended guidelines for concrete mix design
2.	SP : 23 (S & T)	Handbook on Concrete Mixes

3.2.5 Concrete Testing

1.	IS: 1199	Method of sampling and analysis of concrete.
2.	IS: 516	Method of test for strength of concrete.
3.	IS: 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test
4.	IS: 8142	Method of test for determining setting time of concrete by penetration resistance.
5.	IS: 9284	Method of test for abrasion resistance of concrete.
6.	IS: 2770	Method of testing bond in reinforcement concrete.

3.2.6 Equipment's

1.	IS: 1791	Specification for batch type concrete mixers.
2.	IS: 2438	Specification for roller pan mixer.
3.	IS: 4925	Specification for concrete batching and mixing plant.
4.	IS: 5892	Specification for concrete transit mixer and agitator.
5.	IS: 7242	Specification for concrete spreaders.
6.	IS: 2505	General requirement for concrete vibrators: Immersion type.
7.	IS: 2506	General requirement for screed board concrete vibrator
8.	IS: 2514	Specification for concrete vibrating table.
9.	IS: 3366	Specification for pan vibrators.
10.	IS: 4656	Specification for form vibrators for concrete.
11.	IS: 11993	Code of practice for use of screed board concrete vibrators.
12.	IS: 7251	Specification for concrete finishers.
13.	IS: 2722	Specification for portable swing weigh batchers for concrete (Single and double bucket type).
14.	IS: 2750	Specification for steel scaffoldings.

3.2.7 Codes of Practice

1.	IS: 456	Code of practice for plain and reinforced concrete.
2.	IS: 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

3.	IS: 3370	Code of practice for concrete structures for storage of liquid (Part 1 to 4)
4.	IS: 3935	Code of practice for composite construction.
5.	IS: 2204	Code of practice for construction of reinforced concrete shall roof.
6.	IS: 2210	Criteria for the design of reinforced concrete shall structures and folded plats.
7.	IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
8.	IS: 5525	Recommendation for detailing of reinforcement in reinforced concrete work.
9.	IS: 2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
10.	IS: 9417	Specification for welding cold worked bars for reinforced concrete construction.
11.	IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
12.	IS: 3414	Code of practice for design and installation of joints in buildings.
13.	IS: 4326	Code of practice for earthquake resistance design and construction of building.
14.	IS: 4010	Code of practice for steel tubular scaffolding (Part 1 & 2)
15.	IS: 2571	Code of practice for laying insitu cement concrete flooring.
16.	IS: 7861	Code of practice for extreme weather concreting : Part I. Recommended practice for hot weather concreting.

3.2.8 Construction Safety

1.	IS: 3696	Safety code for scaffoldings and ladders.(Part 1 & 2)
2.	IS: 7969	Safety code for handling and storage of building materials.
3.	IS: 8989	Safety code for erection of concrete framed structures.

3.3 General

The Engineer-in-charge shall have the right at all times to inspect all operations including, the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer-in-charge approval obtained prior to starting of concrete work. This shall, however not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Material should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer-in-charge and after establishing suitability based on previous data, experience or tests.

3.4 Materials

3.4.1 Cement

All cement for use on the works except otherwise stated shall be the ordinary Portland cement (OPC) manufactured in India and shall confirm to the IS: 269,

IS: 8112, IS: 12269 or latest versions. It shall be of the make and quality approved by the Engineer.

(For this work, approved makes are Ambuja, Sidhi, L&T, Sanghi, Lotus, Hathi or equivalent make approved by Engineer-in-charge. Mini cement plant cement shall not be allowed).
The cement shall be stored in weather proof godown or cement store specially constructed for the purpose in such a manner as to prevent deterioration due to moisture of instruction of foreign matters.

The weather proof godown shall have a soil impervious floor raised 300mm above the general ground level so that the cement stored thereon shall not come in direct contract with sub soil moisture. The passage and the general construction shall be such that it offers full protection from weather effects. Large stocks of cement shall not be kept at the works but only sufficient quantities should be kept to maintain continuity of the work.

3.4.1.1 Storage of Cement:
No cement that has been stored for more than 90 days shall ordinarily be allowed to be used in the works Cement stored for longer period than 90 days shall be used only after approved by the Engineer-in-charge who shall ascertain its quality before giving such permission.

The Contractors shall offer every facility to the Engineer for inspection of cement. The cement go down shall be so arranged by the contractor that each consignment could be stacked separately and in such a manner so as to allow counting of bags in each row with ease.

The cement, used in any type of concrete shall always be measured by weight and one cubic meter shall be taken as weighing 1440kgs. (Table 30 of A.C.C. hand-book)

3.4.2 Aggregates:
All the aggregates shall confirm to the latest IS : 383 The aggregates shall consist of naturally occurring sand and gravel or stones crushed or uncrushed or a combination thereof. They are classified broadly under two categories viz.(i) sand of fine aggregates and (ii) coarse aggregates, depending, upon their sizes. The fine aggregates, those which pass through Is sieve No.480 and the coarse aggregate are those which are retained on the IS sieve No.480.

3.4.2.1 Storage of aggregate:
The fine and coarse aggregate shall be stored separately and in such a manner that segregation of the various sized particles shall not occur, the stock piles shall be formed on platform of weak concrete timber of similar approved hard standing and aggregate shall be kept clean and free from foreign substances. Storage piles of aggregate shall be arranged with proper drainage and protection from rainfall in order to prevent excessive changes in moisture content taking place during concreting.
The aggregate both fine and coarse shall be hard, strong, durable, clean, free from veins and adherent coatings. The use of flaky and elongated pieces of aggregates shall be prohibited.
The aggregates shall not contain deleterious materials such as iron pyrite, coal mica, shale or similar laminate material, clay, alkali, soft fragment sea shells, organic impurities etc in such quantity as to effect the strength of durability of concrete or the reinforcement embedded in such reinforced concrete.

3.4.2.2 The maximum quantities of deleterious materials that may be permitted shall conform to the following limits by weights.

Deleterious Substances	Fine P.C. by weight		Coarse aggregate P.C. by weight	
	Uncrushed	Crushed	Uncrushed	Crushed
1) Coal and lignite	1.00	1.00	1.00	1.00
2) Clay lumps	1.00	1.00	1.00	1.00
3) Soft fragments	---	---	---	---
4) Materials passing through 75 micro sieve	3.00	3.00	3.00	3.00
5) shale	1.00	---	---	---

The total of various deleterious materials in any sample shall in on case exceed 5 percent. If the aggregate supplied is unclean, it shall be washed. If it is not properly graded, it shall be screened by hand or by mechanical means and the various sizes proportioned to get the required grading.

Storing of aggregates on dusty, muddy and grassy sports shall be avoided. They shall be stored on the works in such a manner as to prevention of foreign matter and protected from exposure to dust. They shall be placed in stock piles in individual units of suitable sizes and in suitable layers to prevent segregation. They shall no be allowed to run down slopes.

3.4.2.3 Sand or fine aggregates:

All fine aggregates shall consist of clean, hard strong durable uncoated siliceous gritty materials consisting of well graded particles obtained from rock, fragments If shall be free from clay lumps, injurious amounts of dusts, mica shells, soft or flaky particles shale, alkali, organic matter, lead or other deleterious substances.

The sand shall be taken from source approved by the Engineer. The sand or fine aggregates shall confirm to the latest IS No.383
If the Engineer considers it necessary, it shall be washed and or screened before use, all the expense of the contractors.

The sand shall have a fineness modules of not less than 2.5 and not more than 3.0 and the grading shall confirm as far as possible to the following analysis :

I. S. Sieve No.	Percent passing Natural sand or Crushed gravel.	Crushed Stone.
180	95 - 100	90 - 100
240	70 - 95	60 - 90
120	45 - 85	40 - 80
60	25 - 60	20 - 50
30	5 - 30	5 - 30
15	0 - 10	0 - 15

The specific gravity of sand shall not be less than 1.6. In on case shall fine aggregate be accepted containing more than 2 per cent by dry weight, not more than 2 ½ % by dray volume, not more than 5 percent by wet volume of clay, loam or silt,

any sample of fine aggregate shows more than 5 per cent of clay, loam or silt, in one hour's settlement after shaking in an excess of water the lot represented by the sample shall be rejected.

The following two field tests are recommended for ascertaining the percentage of clay lumps and impervious organic material and the contractor shall carry out the same if the Engineer-in-charge deems necessary.

(1) Test for determining silt in sand :

Fill a calibrated tumbler with same to half its volume and add water there to until the fill a calibrated tumbler is three quarter full shake up the mixture vigorously and allow it to settle for about an hour. The volume of silt visible on top of the sand shall be measured. If the volume of the it's standing over the sand exceeds 5 per cent of the total volume of sand same shall be rejected.

(2) Colorimetric test for organic impurities :

The sample of sand shall be mixed with equal volume of 3p.c. solution (about one ounce in a quarter of water) of caustic soda / sodium hydroxide taken in a plain glass an the mixture shall be allowed to stand for 24 hours. The liquid standing above the sand shall not be darker than lights straw (pale yellow) colour. If the color is marked yellow of brown, then test would indicate presence of organic materials in excessive amount.

In case suitable sand is not available in adequate quantities within a reasonable and economical limit, the contractors may be allowed the use of crushed or pulverized stone of gravel either along or mixed with natural sand in parts. The stone or gravel shall be clean, sharp and free from dust etc. and shall conform to the latest I.S. 383. In this case, approval of Engineer-In-Charge shall be obtained.

The percentage of crushed stone to be mixed with sand shall be such as to obtain the fineness modulus of the blended sand within the limits specified above, and or approved by the Engineer after Laboratory tests.

3.4.2.4 Coarse Aggregates:

All coarse aggregate used in concrete works shall consist of crushed rock gravel or other approved inert materials.

Broken or crushed rock from sound blue basalt or black trap zeolite shall be used in concrete as coarse aggregate. The particles of aggregate shall be clean hard, tough, durable free from deleterious substance and shall contain no soft flat or elongated pieces. The coarse aggregate shall have specific gravity not less than 2.6 and the water absorption measured after being immersed for 24 hours in water shall not be more than 6 percent by weight. The maximum percentage of deleterious materials in the coarse aggregate shall not exceed 5 per cent by weight in the aggregate when tested in conformity with IS No. 363

The nominal size of the coarse aggregate for reinforced concrete work shall be 10 to 20 mm. Larger coarse aggregate up to 40mm size may be used if approved by the Engineer in plain concrete work. The maximum size of coarse aggregate shall be large as possible within the limits specified but in no case shall be greater than one quarter of the minimum thickness of the member, provided that the concrete can be placed in the form work without difficulty so as to surrounded to reinforcement thoroughly and to fill the corners of the form-work. The minimum size of coarse aggregate shall be as mentioned earlier such as to retain most of the material (90 per cent, 95 per cent maximum) on IS sieve No. 480.

Aggregating shall be screened and, if necessary blended to give the required grading when tested in the Laboratory at Contractor's cost by means of standard mesh sieves, the grading shall fall within the following limits:

Sieve size.	**Percentage retain by weight**	
	Plain C.C.	R.C.C.
40 mm	----------	----------
25 mm	10 to 15	----------
20 mm	35 to 40	15 - 0
10 mm	37 to 80	100 - 80
No.480	98 to 100	100 - 95

The percentage given above are for guidance and the Engineer-in-charge reserves the right to modify the same to any other lower of higher value if considered necessary by him, according to the requirements of the work.

In the event of undesirable segregation occurring in coarse aggregating in two or more suitable fractions as directed.
The grading so specified shall be such as to give a dance, water tight concrete of specified proportion and strength and required consistency. The Engineer shall have the right and authority to carry out routine control tests and analyses of the broken rock at any stage of the work processing and / or concerting operations and the contractors shall give necessary facilities in respect of such testing. The sampling and testing shall be carried out, as per standard IS practice entirely at the cost of the contractors.

3.4.3 Water

Water used for both mixing and curing shall conform to IS: 456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

The water used for the preparation of concrete, for washing sand etc. and for curing shall be clean and free from objectionable quantities of silt, organic materials, acid, alkali, salts, oil and other deleterious impurities and it shall be obtained from the source approved by the engineer. Potable water shall be obtained from the source approved by the Engineer. Potable water shall generally be found fit for preparation of concrete. The quantity of water to be added for making concrete shall be properly measured and controlled.

3.4.4 REINFORCEMENT

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill sealers, rust, dirt, dust, or any other substance that will destroy or reduce bond.

3.4.4.1 MILD STEEL BARS :

Mild steel bars reinforcement for R.C.C. work shall conform to I.S. 432 (Part-II) 1966 and shall be tested quality. It shall comply with relevant part of I.S.456-1978.

All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose of thick rust at the time of placing.

For the purpose of payment the bar shall be measured correct upto 10 mm length and weight payable shall be worked out as per the weight specified below:

1. 6 mm 0.22 Kg./Rmt.
2. 8 mm 0.39 Kg./Rmt.
3. 10 mm 0.62 Kg./Rmt.
4. 12 mm 0.89 Kg./Rmt.
5. 16 mm 1.58 Kg./Rmt.
6. 20 mm 2.47 Kg./Rmt.
7. 25 mm 3.85 Kg./Rmt.
8. 28 mm 4.83 Kg./Rmt.
9. 32 mm 6.31 Kg./Rmt.
10. 40 mm 9.86 Kg./Rmt.

3.4.4.2 TMT FE-415 or FE-500 STEEL BARS FOR REINFORCEMENT :

All reinforcement steel shall be of TMT bars confirming to IS: 1786 of Make TATA, VIZAG, SAIL, ELECTROTHERM, GALLANT, NEELKANTH or equivalent make approved by Engineer-in-charge and welded wire fabric to IS: 1566 for water retaining structure.

Reinforcement bars shall conform to IS-432, IS-226 or IS-1786 and welded wire fabrics to IS : 1566. Only TMT bars for reinforcement in RCC work shall be used which shall be clean, free from pitting, oil, grease, paint, loose mill scale, rust, dirty dust or any other such substance that will destroy or reduce bond.
If permitted by the Engineer-in-charge reinforcement shall be done in accordance with IS-2751 or IS-9417 as applicable.
Other provision and requirements shall conform to specification No. 3.4.4.1 for mild steel bars.

3.4.4.3 MILD STEEL BINDING WIRE :
The mild steel wire shall be of 1.63 mm or 1.22 mm (16 or 18 gauge) diameter and shall conform to I.S. 280-1972.

The use of black wire will be permitted for binding reinforcement bars. It shall be free from rust, oil paint grease, loose mill scale or any other undesirable coating which may prevent adhesion of cement mortar.

3.4.5 Admixtures
Accelerating, regarding, water-reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixtures to IS: 2645.
Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer-in-charge. An admixture's suitability and effectiveness shall be trail mixes with the other materials used in the works. If two or more admixture is to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete work, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

Wastage
Wastage allowance for cement and steel shall be considered in the item rate and

no extra payment shall become payable to the Contractor on any account.

3.5 Samples and Tests

All materials used for the works shall be tested before use.
Manufacture's test certificate shall be furnished for each batch of cement / steel and when directed by the Engineer-in-charge. Samples shall also be got tested by the Contractor in a laboratory approved by the Engineer-in-charge at no extra cost of Owner. Engineer-in-charge may appoint separate third party inspection for the material testing to ensure the quality of work. The Contractor shall replace the defective material as an outcome of these tests.

Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer-in- charge.

Water to be used shall be tested to comply with requirements of IS: 456.

The Contractor shall furnish manufacturer's test certificate and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

3.6 Storage of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirement of IS: 4082 shall be complied with.

The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the materials shall be rejected. Cement bag shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by Engineer-in-charge. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

3.7 Concrete

3.7.1 General

In concrete grade M15, M20, M25, M30 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq. mm as per IS: 456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5 and M10 shall be NOMINAL MIX CONCRETE whereas all other grades, M15 and above, shall be DESIGN MIX CONCRETE.

3.7.2 Design Mix Concrete

(a) Mix Design & Testing

For design mix concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition to such that it is cohesive and does not segregate and should result in dense and durable concrete and also capable of giving the finish as specified. For water retaining structure, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the workers to achieve the desired result.

Unless otherwise specially mentioned, the minimum cement content and maximum water cement ratio for Design Mix Concrete shall be as given below :

Grade of Concrete	**Minimum cement Content in**	**Maximum W/C ratio**
M20	360	0.55
M25	380	0.50
M30	410	0.45

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR in this account. Even in the case where the quality of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be the Contractor's sole responsible to carry out the mix designs at his own cost. He shall furnish to the Engineer-in-charge at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

Grade of Concrete	**Minimum compressive strength N/Sq.mm**	**Specified characteristic compressive**
M15	10.0	15.0
M20	13.5	20.0
M25	17.0	25.0
M30	20.0	30.0
M35	23.5	35.0
M40	27.0	40.0

A range of slump which shall generally be used for various types of construction unless otherwise instructed by the Engineer-in-charge is given below:

Structure/Member	**Slump in**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	100	25
Slabs, Beams and reinforced walls Pump & miscellaneous	75	25
Foundations	100	25
Building Column	50	25
Pavements	50	25
Heavy mass construction	50	25

(b) Batching & Mixing of Concrete

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. There proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value. Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water-cement ratio specified for use by the Engineer-in-charge shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional comment to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer-in-charge. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 3370.

(c) Ready Mix Concrete

Minimum cement consumption shall be as specified in tender document. However, necessary computer print out for consumption of all materials an admixtures if permitted shall be made available as and when required in any frequencies as directed by Engineer –in-charge.

Necessary slump requirements at the pouring places shall be made available with ready mix concrete.

Concrete mix shall be design for 33% higher strength than the grade of concrete specified. The proportions for ingredients chosen shall be such that concrete has adequate workability for condition prevailing on the work in question and can be properly compacted with the means available. Use of cementacious material like Fly ash etc. shall not be permissible.

Except where it can be shown to the satisfaction of the Engineer-in-charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes shall be stocked in separate stock piles. Required quality of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples use din the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water

shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

If is most important to keep the specified water – cement ration constants and its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates,

IS: 2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The special Conditions / Specification regarding **Ready Mix Concrete** are as follows.
The details like locations, capacity, experience, delivery schedule etc. of the **Ready Mix Concrete** agency shall be submitted by the successfully tenderer for prior approval of the undersigned.

The **Ready Mix Concrete** shall be conforming to IS :4926 with its latest amendments.
All the responsibility of **Ready Mix Concrete** i.e. procurement for all materials, operation of plant and machinery, transit mixers, pumping machineries relevant piping etc. shall be on the account of the contractor.
The Rajkot Municipal Corporation shall not be held responsible for any delay / damage / loss due to deployment of **Ready Mix Concrete** for this project.

The octroi for the **Ready Mix Concrete** shall have to be borne by the contractor as per prevailing rates.

Ready Mix Concrete process shall be fully automatic and computerized When a transit mixer is used for transportation of concrete, no extra water should be added to the concrete from else where after initial introduction of mixing water from the batch, except when on arrival at the site of the work, the slump of the concrete is less than that specified : such additional water to bring the mixer under such pressure and direction of flow that requirements for uniformity are met.

Records and certificates : The contractor shall keep from the manufacture batch records of the quantities by mass of all mixing and of the results of all tests. If required by the Rajkot Municipal Corporation, the contractor shall furnish certificates, at agreed intervals, giving this information.

The contractor shall supply the following information for guidance of the manufacturer :

The type of cement to be used Details Specification of aggregates to be used. Type of admixture to be used. If specified.
Min. acceptable strength Slump of concrete or compaction factor

Ages at which the test cubes or beams are to be tested and the frequency and number of test to be made. Any other requirement.

Tolerance : Unless otherwise agreed to between the Rajkot Municipal Corporation (RMC) and the contractor, the concrete shall be deemed to comply with the

requirements of this, if these results of testes where applicable lie with in the tolerance specified below.

Consistency of workability : The slump average of two tests shall not differ from the specified value by + 10 mm for a specified slump of 75 mm. The compacting factor average of two tests shall be within + 0.03 of the value specified. If any other method of determining consistency to be used a suitable tolerance shall be agreed to be between the purchaser and the manufacture. The tests for consistency or workability shall be complete within 15 minutes of the time of receipt of the ready mix concrete at the site.
Aggregate : When tested in accordance with IS 2386 (Part-I) 1963, the quantity of aggregate larger than the max size specified by the purchaser shall not exceed 5% of the qty. of coarse aggregate and all such pass sieve of next higher size.

3.7.3 Nominal Mix concrete.

(a) Mix design and testing

Mix design and preliminary test are not necessary for Nominal Mix concrete. However works test shall be carried out as per IS : 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 3 of IS : 456. However it will be the Contractor's role responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

(b) Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only.

3.8 Formwork

formwork shall be all inclusive and shall consist of but not be limited to shores, bracing's sides of footing , walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, false work, wedges etc.

The design and engineering of the formwork as well its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer-in-charge the DRAWING and calculating for the design of the formwork shall be submitted to the Engineer-in-charge for approval.

Formwork shall be designed to fulfill the following requirements:

(a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the method of placing and compacting.
(b) Made of suitable materials.
(c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
(d) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamics effect arising from construction and compacting activities, wind and weather forces.
(e) Capable of easy striking out without shocks, disturbance or damages to the concrete.
(f) Soffit forms capable of imparting a camber if required.
(g) Soffit forms and supports capable of being left in position if required.
(h) Capable of being cleaner and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these

purposes and to facilitate the preparation of construction joints.
The formwork may be of timber, plywood, steel, plastic or concrete depending upon the approval of the Engineer-in-charge. Timber of formwork shall be well seasoned, free sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, sailings, sawdust, wire pieces dut etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.
Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer-in-charge. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be property anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spelling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm X 20 mm size.

Form for substructure may be omitted when, in the opinion of the Engineer-in-charge, the open excavation is firm enough (in hard non-porous soils) to act as a form, such excavation shall be larger, as approved by the Engineer-in-charge that required as per DRAWING to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structure.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering .If the shuttering for a column is erected for the full height of the column, one side shall be build up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0 m or as approved by the Engineer-in-charge. The Contractor shall temporarily and securely fix items to be cast (embodiment's/inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new

concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirement:

a) Development of adequate concrete strength;
b) Permissible deflection at time of striking form work;
c) Curing procedure employed-its efficiency and effectiveness;
d) Subsequent surface treatment to be done;
e) Prevention of thermal cracking at re-entrant angles;
f) Ambient temperatures;
g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20^{O} C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by Engineer-in-charge, it is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

3.9 Reinforcement Workmanship

Reinforcement bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5^{O}C. Local warming may be permitted if steel is kept below 5^{O}C.

All bars shall be accurately bent gradually and according to the size and shapes shown on the DRAWING schedules or a directed by Engineer-in-charge.
Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer-In-Charge.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer-in-charge prior to concrete placement. Spacers shall be of such materials and design as will be durable, not lead to corrosion of the reinforcement and not cause spelling of the concrete cover.

Binding wire shall be 16 gauges soft annealed wire. End of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement; laps/splices not shown on Drawing shall be subject to Engineer-in-charge's approval.

3.10 Tolerances

Tolerance for formwork and concrete dimensions shall be as per IS: 456 unless specified otherwise.

Tolerances specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

The formwork shall be designed and constructed to the shapes, lines and

dimensions shown on the Drawings within the tolerances given below:

(a)	Deviation from specified dimensions of cross section of columns and beams	-6 mm
(b)	Deviations from dimensions of footings (tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel	+12 mm
1.	Dimension in plan	-12 +50 mm
2.	Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
3.	Thickness	+0.05 times the specified thickness

3.114 Preparation Prior to Concrete Placement
Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, insert and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provide.

All arrangements formwork, equipment and proposed procedure, shall be approved by the Engineer-in-charge, Contractor shall maintain separate Pour card for each pour as per the format enclosed.

3.12 Transporting, Placing and Compacting Concrete
Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or cause to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0 m

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by termites or by pipeline from the mixer and shall never be allowed to fall freely through the water.

Concreting under water :
When it is necessary to deposit concrete under water, the methods, equipments, and materials of the mix to be used shall be got approved from the Engineer-in-charge before any work is started. Such concreting be considered as controlled concrete i.e. design mix.

Concrete shall not be placed under temperature below 50 degree centigrade. The temperature of concrete, when deposited, shall be however not less than 50 centigrade nor more than 40 degree centigrade.

Concrete to be placed under water shall contain ten percent more cement than that required for the same mix placed in the dry.

The slump shall not be less than 100 mm nor more than 180 mm. The slump shall be tested as per I. S. 516.

Coffer-dams or forms shall be water tight to ensure still water conditions if practicable and in any case to reduce the flow of water to less than 3 meters per minute through the space into which concrete is to be deposited. The forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter.

Concrete shall continue to be deposited until it has been brought to the required height. The top surface shall always be kept as wet as far as possible and formation of seems avoided. For concrete any one of the following methods may be used.

(a) Tremie :

When concrete is to be deposited under water by means of tremie, the top section of the tremie shall be a hopper large enough to hold one full batch mix or the entire contents of the transporting bucket. The tremie pipe shall not be less than 200 mm dia. and also shall be large enough to allow a free flow of concrete and strong enough to with stand the external pressure of water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wedging by use of gunny sacks or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end. Thus establishing a continuous stream of concrete. It will be necessary, to raise slowly the tremie in the order to allow a uniform flow of concrete, but it shall not be emptied so that water enters above the concrete in the pipe.

At all times after the placing of concrete is started and until all the requirement quantity has been placed, the lower end of the tremie pipe shall be kept below the top surface of the plastic instead of flowing out over the surface, and thus avoid formation of layers of laitance. If the charge in the tremie is lost while depositing, the tremie shall be raised above the concrete surface, and unless sealed by a check valve it shall be re-plugged at the top end, as at the beginning before refilling for depositing further concrete.

(b) Drop Bottom Bucket :

The top of the bucket shall be closed. The bottom doors shall move freely downward and outward when tripped. The bucket shall be filled completely and lowered slowly to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

To minimize the formation of laitance, great care shall be exercised to disturb the concrete as far as possible while it is being deposited.

While placing concrete the Contractor shall proceeds as specified below and also ensure the following.

a) Continuously between construction joints and pre-determined abutments.
b) Without disturbance to forms or reinforcement.
c) Without disturbance to pies, ducts, fixing and the like to be cast in: ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
d) Without dropping in a manner that could cause segregation or shock.
e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
f) Do not place if the workability is such that full compaction cannot be achieved.
g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the lining progressively as concrete is placed.
h) If placed directly on to hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.;
i) Ensure that there is no damage or displacement to sheet membranes.
j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration blending and melting of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer-in-charge. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had to settle as approved by the Engineer-in-charge. Concrete shall be protected against damage until final acceptance.

3.13 Mass Concrete Works

Sequence of pouring for mass concrete works shall be as approved by the Engineer-in- charge. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

3.14 Curing

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

a) Premature drying out, particularly by solar radiation and wind;
b) Leaching out by rain and flowing water;
c) Rapid cooling during the first few days after placing;

d) High internal thermal gradients;
e) Low temperature or frost;
f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Engineer-in-charge shall be cured by use of continuous sprays or pounded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Engineer-in-charge, the same shall be of a non-wax bas and shall not impair the concrete finish in any matter. The curing component to be used and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be sealed and fastened.

3.15 Construction Joints and Keys

Construction joints will be shown on the DRAWING or as approved by the Engineer-in- charge. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed, construction joints shall be made with the approval of the Engineer-in-charge.

Dowels for concrete work, not likely to be taken to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the DRAWINGS or as approved by the Engineer-in-charge.

Before resuming concreting on a surface which has not fully hardened, all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and horizontal layers.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

3.16 Foundation Bedding

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer-in-charge. The surfaces of absorptive soils shall be moistened.
Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

3.17 Finishes

3.17.1 General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified. Defects due to bad workmanship

(e.g. damaged or misaligned forms, defectives or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and meet the requirements of the design and to produce finished concrete to required dimension, plumbs, planes and finishes.

3.17.2 Surface Finish Type F1
The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas filling all form tie holes and cleaning up of loose or adhering debris. For surface below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

3.17.3 Surface Finish Type F2
The appearance shall be that of a smooth dense, well-compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

3.17.4 Surface Finish Type F3
This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discoloration, blemishes, arises, air holes etc. only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

3.17.5 Integral Cement Finish on Concrete Floor
In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer-in-charge shall be supplied and used as recommended by the manufacturer.

3.18 Repair and Replacement of Unsatisfactory Concrete
Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches and holes left by form bolts etc. shall be inspected by the Engineer-in-charge who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contactor at no additional cost of the Owner.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer-in-charge.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer-in-charge as to the method of repair to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:1 cement sand mortar. The use of epoxy for rebinding fresh concrete shall be carried out as approved by the Engineer-in-charge.

3.19 Vacuum dewatering of Slabs

Where specified floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, flatting and trowelling as per equipment manufacturers recommendation.
The equipment to be used shall be subject to the Engineer-in-charge.

3.20 Hot Weather Requirements

Concrete during hot weather shall be carried out as per IS: 7861(Part I).

Adequate provisions shall be made lower concrete temperatures which shall not exceed $40^{O}C$ at the time of placement of fresh concrete.

Where directed by the Engineer-in-charge, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

3.21 Cold weather Requirement

Concreting during cold weather shall be carried out as per IS: 7861(Part II).

The ambient temperature during placement and up to final set shall not fall below 5 deg.C. Approved antifreeze/accelerating additives shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripped period shall be closely monitored.

3.22 Liquid Retaining Structures

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

The Contractor shall make all arrangement for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer-in-charge. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the Engineer-in-charge at no extra cost to the OWNER.

3.23 Testing Concrete Structures for Leakage

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the Engineer-in-charge as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the

requirements of the test shall be deemed to satisfied if the external forces show no sign off leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested .The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Engineer-in-charge shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation looses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water , after curing as specified ,and subjecting to the specified test pressure for specified period .If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

3.24 Optional Tests

If the Engineer-in-charge feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer-in-charge as per relevant IS Codes. Contractor shall have to pay for these tests.

In the event of any work being suspected of faulty material or workmanship requiring is removal or if the works cubes do not give the stipulated strengths, the Engineer-in- charge reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure ,etc. The Engineer-in-charge also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Owner. Alternately Engineer-in-charge also reserves the right to ask the COTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

3.25 Grouting

3.25.1 Standard Grout

Grout shall be provided as specified on the DRAWINGS.

The proportion of Standard grout shall be such as to produce a flow able mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by the Engineer-in-

charge. The grout proportions shall be limited as follows:

Sr no	Use	Grout Thickness	Mix Proportions	W/C Ratio
a)	Fluid mix	Under 25 mm	One part Portland Cement to one part sand	0.44
b)	General mix	25 mm and over but less than 50 mm	One part Portland Cement to two part sand	0.53
c)	Stiff mix	50 mm and over	One part Portland Cement to 3 part sand	0.53

3.25.2Non-Shrink Grout
Non-shrink grout where required shall be provided in strict accordance with the manufacturer's instructions/specifications on the DRAWINGS.

General
Inspection
All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer-in-charge. Material rejected by Engineer-in-charge, shall be expressly removed from site and shall be replaced by Contractor immediately.

Clean-up
Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

Acceptance Criteria
Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) Properties of constituent material;
b) Characteristic compressive strength;
c) Specified mix proportions;
d) Minimum cement content;
e) Maximum free-water/cement ratio;
f) Workability;
g) Temperature of fresh concrete;
h) Density of fully compacted concrete;
i) Cover to embedded steel;
j) Curing;
k) Tolerances in dimension;
l) Tolerance in levels;
m) Durability;
n) Surface finishes;
o) Special requirements such as;
    i) Water tightness
    ii) Resistance to aggressive chemicals
    iii) Resistance to freezing and thawing
    iv) Very high strength
    v) Improved fire resistance vi) Wear resistance
    vii) Resistance to early thermal cracking

The Engineer-in-charge decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

For work not accepted, the Engineer-in-charge may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer-in-charge shall in that case direct the Contractor to undertake and execute the remedial measures.

These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the contractor by the Owner for executing the remedial measures.

3.26 Water stops

3.26.1 Material

The material for the PVC water stops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS: 12200. Testing shall be in accordance with IS: 8543.

a)	Tensile strength	3.6 N/mm^2 minimum
b)	Ultimate elongation	300% minimum
c)	Tear resistance	4.9 N/mm^2 minimum
d)	Stiffness in flexure	2.46 N/mm^2 minimum
e)	Accelerated extraction I) Tensile strength II) Ultimate elongation	 10.50% N/mm^2 minimum 250% minimum
f)	Effect of Alkali i) Weight increase ii) Weight decrease iii) Hardness change	7 days 0.10% maximum 0.10% maximum ±5 points
g)	Effect of Alkali i) Weight increase ii) Weight decrease iii) Dimensions change	28 days 0.40% maximum 0.30% maximum ±1 %

PVC water stops shall be either of the bar type, serrated with centre bulb and grips for use within the concrete elements or of the surface (Kicker) type for external use.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Engineer-in-charge before procurement for incorporation in the works.

3.26.2 Workmanship

Water stops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Water stops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of water stops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Water stops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the water stops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting water stops shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

3.27 Preformed Fillers and Joint Sealing Compound

3.27.1 Materials

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibers conforming to IS: 1838(Part I). Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to is: 3384

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade "A" as per IS: 1834

3.27.2 Workmanship

The thickness of the preformed bitumen filler shall be 25 mm for expansion joints and 50 mm for isolation joints around foundation supporting rotatory equipments. Contractor shall procure the strips of the desired thickness and width in length as manufactured. Assembly of small pieces/thickness of strips to make up the specified size shall not be permitted.

The concrete /masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS: 702 shall be applied by brushing at the rate of 1.20Kg/sq.m. When the bitumen is still hot the performed bitumen filler shall be pressed at held in position till completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20Kg/sq.m.
Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100 mm wide x 4 mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the performed joint filler dislodging. This plate shall be welded to an edge angle of IS A 50x50x6 mm/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

CONCRETE POUR CARD

POUR NO: DATE:
DRG NO: STRUCTURE:
CONCRETE GRADE QUALITY: MAX. AGGREGATE SIZE:
START/COMPLETION TIME:

Sr no.	Item			Remarks if any
1.	BEFORE CONCRETIN	Centerlines checked	Yes/No.	
2.		Form work and Staging checked for accuracy, strength & finish	Yes/No.	
3.		Reinforcement checked	Yes/No.	
4.		Cover to reinforcement checked	Yes/No.	
5.		Verified test certificate for cement/steel	Yes/No.	
6.		Adequacy of materials/equipment for pour	Yes/No.	
7.		Embedded parts (location & plumb)	Yes/No.	
8.	SOFFIT(S) & POUR TOP (T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT		S(B) T(B) S(B) T(B)	
9.	CONSTRUCTION JOINTS LOCATION & TIME (IF NOT AS PER DRAWING)			
10.	CEMENT CONSUMPTION IN KGS.			
11.	NUMBER OF CUBES AND IDENTIFICATION			
12.	TEST CUBE RESULTS (7 DAYS/28 DAYS)			
13.	CONCRETE CONDITION ON FORM REMOVAL		Very good/ good/fair / poor	

Notes: - Each pour to have separate cards, in triplicate one each for Owner/client, Contractor & site office.

Under remarks indicate deviations from drawings & specifications, congestion in reinforcement if any, unusual occurrences such as failure of equipment's, sinking of supports/Props, heavy rains affecting concreting, poor compaction, improper curing, other deficiencies, observation etc.

3.28 MODE OF MEASUREMENT AND PAYMENT

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the schedule of quantities. No extra claim shall also be entertained due to change in the number, position and / or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing insets in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete

quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sq.m in areas where concrete is measured in sq.m and 0.010 cu.m where concrete is measured in cu.m.

Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the understide of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slab / beams.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Engineer shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rates for reinforcement shall include lap chairs, spacer bars etc.

4.0 STRUCTURAL STEEL WORKS

4.1 Applicable Codes and Specifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless others wise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1	IS:800	Dimensions for Hot Rolled Steel sections
2	IS:814	Covered Electrodes for Manual Metal Arc welding of Carbon and Carbon Manganese steel
3	IS:800	Code of practice for General Construction in steel
4	IS:801	Code of price for Use of Cold Formed Light Gauge Steel Structure Members in General Building construction
5	IS:806	Code of Practice for Use of Steel Tubes in General Building Construction
6	IS:7205	Safety Code for Erection of Structural Steel Work
7	IS:7215	Tolerances for Fabrication of steel Structure
8	IS:4000	High Strength Bolts in steel structure-Code of Practice
9	AISC	Specifications for Design, Fabrication and Erection of Buildings
10	IS:1161	Steel tubes for structural purpose.
11	IS:102	Ready mixed paint, Brushing, Red Lead, Non-setting, Priming.
12	IS:110	Ready mixer paint, Brushing, grey filler for enamels for use over primers.
13	IS:117	Ready Mixer paint, Brushing, Finishing, Exterior Semi gloss for general purposes, to Indian Standard colours.
14	IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, alkali and heat resisting.
15	IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16	IS:341	Black Japan, Types A,B and C
17	IS:2339	Aluminium paint for general purposes, in Dual container
18	IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) undercoating (b)Finishing
19	IS:2933	Specification for enamel, synthetic, exterior, type 2, (a) undercoating (b)Finishing
20	IS:5905	Sprayed aluminum and zinc coatings on Iron and Steel
21	IS:6005	Code of practice for phosphating of Iron and Steel
22	IS:9862	Specification for ready mixed paint, brushing, bituminious, black, lead free, acid, alkali, water & Chlorine resisting.
23	IS:13183	Aluminum paint, Heat resistant. SIS-05-5900 (Swedish
24	IS:1239	Mild steel tubes, tubular and other Wrought steel fittings Part 1-Mild Steel tubes Part 2-Mild steel tubular and other wrought steel pipe fittings
25	IS:1363	Hexagon Head Bolts, Screws and Nuts of Product Grade C (Size range 15 to M 64) (Part 1 to 3)
26	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
27	IS:1977	Structural Steel (Ordinary Quality)
28	IS:2062	Steel for General Structure Purpose
29	IS:2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and
30	IS:3502	Steel Chequered Plate
31	IS:3757	High Strength Structure Bolts
32	IS:5369	General Requirements for Plain Washers and lock Washers
33	IS:5372	Taper Washers for Channels

34	IS:5374	Taper Washer for I beam
35	IS:6610	Heavy washer for steel Structure
36	IS:8500	Structural Steel-micro alloyed (medium and high strength
37	IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
38	IS:816	Code of practice for use of Metal Are Welding for general construction in Mild Steel
39	IS:822	Code of Procedure for Inspection of Welds
40	IS:1182	Recommended Practice for Radiographic examination of Fusion Welded Butt joints in Steel Plates
41	IS:1200	Method of Measurement in Building Civil Works
42	IS:1477	Code of practice for Painting of (part 1 &2) Ferrous Metal in
43	IS:2595	Code of practice for Radiographic Testing
44	IS:3658	Codes of Practice for Liquid Penetrate Flaw Detection
45	IS:5334	Code of Practice for Magnetic Particle Flaw Detection
46	IS:9595	Recommendations for Metal Are Welding of Carbon and Caron Manganese Steel

4.2 Steel Materials

Steel materials shall comply with the referred in Sub-Clause 4.1
All materials used shall be new, unused and free from defects. Steel conforming to IS:1977 shall be used only for the following

Fe 310-0 (St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural
Fe 410-0 (St42-0)	For structure not subjected to dynamic loading other then the loads such as: Platform roofs ,foot over bridges Building, Factory
Fe 510-0 (St 42-0)	Grade Steel Shall not be used a)If welding is to be employed for fabrication b)If site is in severe earthquake zone

4.3 Fabrication

4.3.1 General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machine/ground smooth true and square where so specified where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Engineer-in-charge, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

4.3.2 Connections

Shop/field connections shall be as per approved fabrication DRAWING.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever the turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical; the unthreaded portion of bolt shall bear on the member assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rain water shall have drain holes provided.

4.3.3 Straightening

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the approval of the Engineer-in-charge, in writing.

4.3.4 Rolling and Forming

Plate's channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the DRAWINGS. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

4.3.5 High Strength Friction Grip Bolting

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

4.3.6 Welding

Welding procedure shall be submitted to the Engineer-in-charge, for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS: 7310 (Part I) and IS: 7318 (Part-I)

While fabrication plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Engineer-in-charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately penned with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overweening.

No welding shall be done on base metal at a temperature below-5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 32 mm and above.

All welds shall be inspected for flaws by any of the methods described under Sub-clause 4.6.3. The choice of the method adopted shall be agreed with the Engineer-in-charge.

The correction of defective welds shall be carried out in a manner approved by the Engineer-in-charge, without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means approved by the Engineer-in-charge shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed. The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

4.4 Tolerances

The dimensional and weight tolerances for rolled shapes shall be accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS: 7215.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

4.5 End Milling

Where compression joints are specified to be designed for bearing, the bearing surface shall be milled true and square to ensure proper bearing and alignment.

4.6 Inspection

4.6.1 General

The Contractor shall give due notice to the Engineer-in-charge, in advance of the works being Made ready for inspection. All rejected material shall be promptly removed from the shop the replaced with new material for the Engineer-in-charge's inspection. The fact that certain material has been accepted at the Contractor’s shop shall not indivalidate final rejection at site by the Engineer-in-charge, if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Owner may make because of defective or unsatisfactory materials and/or workmanship.

No material shall be painted or dispatched to site without inspection and approval by the Engineer-in-charge, unless such inspection is waived in writing by the Engineer-in- charge.

The Contractor shall provide all the testing and inspection service and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer-in-charge.

Inspection and tested on structure steel members shall be as set forth below.

4.6.2 Material Testing

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Engineer-in-charge's satisfaction to demonstrate conformity with the relevant specification.

4.6.3 Tests on Welds

(a) Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Engineer-in-charge.

(b) Liquid Penetration Inspection

In the case of welds examined by Liquid Penetrate Inspection, such tests shall be carried out in accordance with relevant IS code. All defects shown shall be repaired and rechecked.

(c) Radiographic Inspection

All full strength butt welds shall be radio graphed in accordance with the recommended practice for radiographic testing as per relevant IS code.

4.6.4 Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the fabrication Drawings

4.6.5 Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the
Contractor shall notify the Engineer-in-charge. The Contractor must obtained permission from the Engineer-in-charge, before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Engineer-in-charge.

The Engineer-in-charge, has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Owner, only in case of successful testing.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer-in-charge.

4.7 Shop matching

For structure like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as column along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Engineer-in-charge. All these shop assemblies shall be carried out by the Contractor.

4.8 Drilling Holes for other works

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other Contractor shall be drilled by the VENDOR/CONTRACTOR at no extra cost of the OWNER. The information for

such extra holes will be supplied by the OWNER/ Engineer-in-charge.

4.9 Marking of Members

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approval erection DRAWINGS and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt hole. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be identical locations. Members having lengths of 7.0 and more shall have the erection mark at both ends.

4.10 Errors

Any error in stop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Engineer-in-charge, as defective workmanship. Where the Engineer-in-charge, rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to the Specification's by the Contractor, at no cost to the Owner.

4.11 Painting of Steel Work

All fabricated steel material, except those galvanized shall receive protective paint coating as specified in specification, which is describe below.

4.11.1 Materials

Rex-oxide-zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932. Aluminum paints shall conform to IS: 2339.
All the materials shall be the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer-in-charge, for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

4.11.2 Workmanship

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paints for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS; 1477(Part 2)

The type of paint, number of costs etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling, primer and finish paint shall be from the same manufacture.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc, shall be as per IS : 1477 (Part-I) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surface; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry. A second coat of primer shall be applied by brushing to obtain a film free from "holidays"

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, talking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be adequately by brushing and allowed to hard-dry. The gloss form the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hr shall elapse between the application of successive coats each coat shall very slightly in shade and this shall be got approved by the ENGINEER-IN-CHARGE.

4.12 Acceptance of steel, its handling and storage

The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the ENGINEER-IN- CHARGE.

No dragging of steel shall be permitted. All steel shall be stored 300 mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepaid and maintain by contractor. Steel shall not stored in the vicinity of areas where excavation for grading will be done and, is so stored temporarily, this shall be removed by the contractor well before such excavation and/or grading commences to a safe distance avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with the specifications for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also damage.

4.13 Anchor Bolts & Foundations

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundation constructed, to ensure that the structure can be properly erected as shown on the DRAWINGS. Any discrepancy in the anchor bolts/Foundation shall be reported to the Engineer-in-charge.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other location shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of foundation and preparing the area in considered normal and shall be carried out by the Contractor at no extra cost.

4.14 Assembly & connections.
Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection DRAWINGS.

All field connection work shall be carried as per the DRAWINGS. All bolts, nuts, washers, rivets, electrodes required for filed connections shall be supplied by the Contractor at free of cost.

All assembling shall be carried on a level platform.

Drifts shall be used only for DRAWING the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Engineer-in-charge.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock form rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the Engineer-in-charge.

4.15 Erection
All structural steel shall be erected as shown on the Drawings Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structure, foundation, etc., unless so permitted by the Engineer-in-charge, in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and /or derrick without damaging the basement walls or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in pace as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant DRAWINGS and/or as approved by the Engineer-in-charge. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/vertical stiffening ribs.

(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/ or cable to pass through.

(c) Splicing as shown in relevant DRAWINGS.

(d) Smoothening of edges.
(e) Fixing of chequered plates by tack welding or by countersunk bolts. (f) Providing lifting hooks for ease of lifting.

As erection progresses the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Engineer-in-charge. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Engineer-in-charge.

Test certificates shall be furnished by the Contractor.

4.16 Inspection

The Engineer-in-charge shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erection required will be at the Contractor cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Engineer-in-charge.

4.17 Tolerances

4.17.1 General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

4.17.2 Columns

Deviation of column axes at foundation top level with respect to true axes:

(a)	In longitudinal direction	± 5 mm
(b)	In lateral direction	± 5 mm

	Deviation in the level of bearing surface of columns at foundation top with respect to true level ± 5 mm	
	Out of plumpness (verticality) of column axis from true vertical axis, as measured at column top:	
(a)	For columns up to and including 15 meters in height	± 1/1000 of column height in mm or ± 15 mm whichever is less
(b)	For columns exceeding 15 meters in height	± 1/1000 of column height in mm or ± 20 mm whichever is less
Deviation in straightness in longitudinal and transverse planes of column at any point along the Height		± 1/1000 of column height in mm or ± 10 mm whichever is less
Difference in erected position of adjacent pairs of columns along length or across width of building		± 10 mm

prior to connecting trusses/beams with respect to true distance.	
Deviation in any bearing or seating level with respect to true level with respect to true level.	± 5 mm
Deviation in difference in bearing level of a member on adjacent pair of columns both across and along the building.	± 10 mm
4.17.3 Trusses and Beams Shift at the center of span of top chord member with respect to the vertical plane passing through the center of bottom chord	± 1/250 of height of truss in mm or ± 15 mm whichever is less
Lateral shift of top chord of truss at the center of span from the vertical plane passing through the center of supports of the truss	± 1500 of span of truss in mm or ± 15 mm whichever is less
Lateral shift in location of truss from its true vertical position	± 10 mm
Lateral shift in location of purlin true position	± 5 mm
Deviation in difference of bearing levels of trusses or beams from the true difference	i) ± 20 mm for trusses ii)For beams : depth < 1800 mm : ± 6 mm depth > 1800 mm : ± 10 mm
Deviation in sag in chords and diagonals of truss between node points	1/1500 of length in mm or 10 mm whichever is smaller.
Deviation in sweep of trusses, beams etc. in the horizontal plane 4.17.4 Crane Girders & Rails	1/1000 of span in mm subject to a maximum of 10 mm
Shift in the centre line of crane rail with respect to centre line & web of crane girder	± 5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	± 5 mm
Difference in alignment of crane rail in plan measured between any two points 2 meters apart along rail	
Deviation in crane track with respect to Time gauge (a) For track gauges up to and Including 15 meters	± 5 mm

(b) For track gauges more than 15 meters	± [5 + 0.25 (S-15)] where S in meters in true gauge
Deviation in the crane rail level at any point from true level	± 1/1200 of the gauge distance or + 10 mm

Difference in the crane rail actual levels between any two points 2 meters apart the rail length	
Difference in levels between crane track Rails at (a) Supports of crane girders (b) Mid span of crane girders	 ± 15 mm ± 20 mm
Relative shift of crane rail surface at a joint in plane and elevation	2 mm subject to grinding of surfaces for smooth transition
Relative shift in the location of crane of crane stops (end buffers) along the crane tracks with track gauge S in mm	1/1000 of track gauge S in mm subject to maximum of 20 mm

Painting

After steel has been erected, all bare and abraded sports, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

4.18 Clean up of Work site

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Engineer-in- charge.

5.0 GENERAL TECHNICAL SPECIFICATIONS FOR BUILDING WORKS

5.1 GENERAL :

In the specification "as directed"/"Approved" shall be taken to mean "as directed"/approved by the Engineer-in-charge.

Wherever a reference to any Indian Standard appears in the specifications, it shall be taken to mean as a reference to the latest edition of the same in force on the date of agreement.

In "Mode of Measurement" in the specification wherever a dispute arises in the absence of specific mention of a particular point or aspect, the provisions on these particular point or aspects in the relevant Indian Standards shall be referred to.

All measurements and computations, unless otherwise specified, shall be carried out nearest to the following limits :

(i) Length, width and depth (height) ..... 0.01 Mt.
(ii) Areas ..... 0.01 Sq.Mt.
(iii) Cubic Contents ..... 0.01 Cu.Mt.

In recording dimensions of work.

The sequence of length, width and height (depth) or thickness shall be followed.

The distance which constitutes lead shall be determined along the shortest partical route and not necessarily the route actually taken. The decision of the Engineer-in-charge in this regard shall be taken as final.

Where no lead is specified, it shall mean "all leads". Lift shall be measured from plinth level.

Definite particulars covered in the items of work, though not mentioned or elucidated in its specifications shall be deemed to be included therein.

Approval of the samples of various materials given by the Engineer-in-charge shall not absolve the contractor from the responsibility of replacing defective material brought on site or materials used in the work found defective at a later date. The contractor shall have no claim to any payment or compensation whatsoever on account of any such materials being rejected by the Engineer-in-charge.

The contract rate of the item of work shall be for the work completed in all respects.

No collection of materials shall be made before it is got approved from the Engineer-in- charge.

Materials shall be stored in such a manner as to prevent damage, deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

Materials, if and when rejected by the Engineer-in-charge, shall be immediately removed from the site of work.

No material shall be stored prior to, during and after execution of a structure in such a way as to cause or lead to damage on overloading of the various components of the structure.

All works shall be carried out in a workmanlike manner as per the best techniques for the particular item.

All tools, templates, machinery and equipment for correct execution of the work as well as for checking lines, levels, alignment of the works during execution shall be kept in sufficient numbers and in good working condition on the site of the work.

The mode procedure and manner of execution shall be such that it does not cause damage or over-loading of the various components of the structure during execution of after completion of the structure.

Special modes of construction not adopted in general Engineering practice, if proposed to be adopted by the Contractor, shall be considered only if the contractor provides satisfactory evidence that such special mode of construction is safe, sound and helps in speedy construction and completion of work to the required strength and quality. Acceptance of the same by the Engineer-in- charge shall not, however, absolve the contractor of the responsibility of any adverse effects and consequences of adopting the same in the course of execution of completion of the work.

All installations pertaining to water supply and fixtures thereof as well as drainage lines and sanitary fittings shall be deemed to be completed only after giving satisfactory tests by the Contractor.

The contractor shall be responsible for observing the rules and regulations imposed under the "Minor Minerals Act", and such other laws and rules prescribed by Government from time to time.

All necessary safety measures and precautions (including those laid down in the various relevant Indian Standards) shall be taken to ensure the safety of men, materials and machinery on the works as also of the work itself.
The testing charges of all materials shall be borne by the Contractor.

Approval to any or the executed items for the work dose not in any way relieve the contractor of his responsibility for the correctness, soundness and strength of the structure as per the drawings and specifications.

5.2 Applicable codes and Specifications

The following codes and standards are included in this section, as part of these specifications. However, respective IS codes for the works not mentioned here shall also be applicable for those particular items of work.

1.	IS : 110	Ready mixed paint, brushing, grey, filler, for enamels for use over primers
2.	IS : 269	Specification for 33 grade ordinary Portland cement
3.	IS : 280	Specification for mild steel wire for general engineering purpose
4.	IS : 287	Recommendations for maximum permissible moisture content of timber used for different purpose.
5.	IS : 304	High Tensile Brass Ingots and Castings.
6.	IS : 337	Varnish, finishing interior

7.	IS : 348	French polish
8.	IS : 383	Specification for coarse and fine aggregates from natural sources for concrete
9.	IS : 412	Expanded metal steel sheets for general purposes
10.	IS : 419	Specification for putty for use on window frames
11.	IS : 428	Distemper, Oil emulsion, colour as required
12.	IS : 459	Specification for un-reinforced corrugated and semi-corrugated asbestos cement sheets
13.	IS : 702	Specification for industrial bitumen
14.	IS : 710	Specification for marine plywood
15.	IS : 712	Specification for building limes
16.	IS : 730	Specification for hook bolts for corrugated sheet roofing
17.	IS : 733	Wrought aluminum and aluminum alloys, bars, rods and sections for general engineering purposes
18.	IS : 777	Specification for glazed earthenware tiles
19.	IS : 1003	Specification for timber paneled and glazed shutters (Part 1 & 2)
20.	IS : 1038	Specification for steel doors, windows and ventilators
21.	IS : 1077	Specification for common burnt clay building bricks
22.	IS : 1081	Code of practice for fixing and glazing of metal (steel & aluminum)
23.	IS: 1124	Method of test for determination of water, absorption, apparent specific gravity and porosity of natural building stones
24.	IS :1237	Specification for cement concrete flooring tiles
25.	IS : 1322	Bitumen felts for water proofing and damp proofing
26.	IS : 1346	Code for practice for water proofing of roofs with bitumen felts
27.	IS : 1361	Specification for steel windows for industrial buildings
28.	IS : 1397	Specification for Kraft paper
29.	IS : 1443	Code of practice for laying and finishing of cement concrete flooring tiles
30.	IS : 1477	Code of practice for painting of ferrous metals in buildings (Parts 1
31.	IS : 1542	Specification for sand for plaster
32.	IS : 1580	Specification for bituminous compounds for water-proofing and caulking purpose.
33.	IS : 1597	Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
34.	IS : 1659	Specification for black boards
35.	IS : 1661	Code of practice for application of cement and cement - lime plaster finishes
36.	IS : 1834	Specification for hot applied sealing compound for joint in
37.	IS : 1838	Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part
38.	IS : 1948	Specification for aluminum doors, windows and ventilations
39.	IS : 1949	Specification for aluminum windows for industrial buildings
40.	IS : 2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming
41.	IS : 2098	Asbestos cement building boards
42.	IS : 2114	Code of practice for laying in - situ terrazzo floor finish
43.	IS : 2116	Specification for sand for masonry mortars
44.	IS : 2185	Specification for concrete masonry units (Part 1, 2 & 3)
45.	IS : 2202	Specification for wooden flush door shutters (Solid core type) : Part
46.	IS : 2212	Code of practice for brickwork
47.	IS : 2250	Code of practice for preparation and use of masonry mortars
48.	IS : 2338	Code of practice for finishing of wood and wood based materials

49.	IS : 2339	Aluminum paint for general purposes, in dial container
50.	IS : 2395	Code of practice for painting concrete, masonry and plaster surfaces (Part 1 & 2)
51.	IS : 2402	Code of practice for external rendered finishes
52.	IS : 2571	Code of practice for laying in - situ cement concrete flooring
53.	IS : 2572	Code of practice for construction of hollow concrete block
54.	IS : 2645	Specification of integral cement waterproofing compounds
55.	IS : 2690	Specification for burnt clay flat terracing tiles : Part 1 Machine made
56.	IS : 2691	Specification for burnt clay facing bricks.
57.	IS : 2750	Specification for steel scaffoldings
58.	IS : 2835	Flat transparent sheet glass
59.	IS : 2932	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
60.	IS : 3007	Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets
61.	IS : 3036	Code of practice for laying lime concrete for water -proofed roof finish.
62.	IS : 3067	Code of practice of general design details and preparatory work for damp proofing and water-proofing of buildings.
63.	IS : 3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
64.	IS : 3384	Specification for bitumen primer for use in water-proofing and damp proofing.
65.	IS : 3461	Specification for PVC asbestos floor tiles
66.	IS : 3462	Specification for unbaked flexible PVC flooring
67.	IS :3495	Method of test for burnt clay building bricks : Part 1 to 4
68.	IS : 3536	Specification for ready mixed paint, brushing, wood primer, pink
69.	IS : 3564	Specification for door closures (hydraulically regulated)
70.	IS : 3614 (Part	Specification for fire checks doors : Part -1 Plate metal covered and rolling type
71.	IS : 3614 (Part	Specification for metallic and non-metallic fire check doors : Part -
72.	IS : 3696	Safety code of scaffolds and ladders (Part 1 & 2)
73.	IS : 4020	Methods of test for wooden flush door : Type test
74.	IS : 4021	Specification for timber door, window and ventilator frames
75.	IS : 4351	Specification for steel door frames
76.	IS : 4443	Code of practice for use of resin type chemical resistant mortars
77.	IS : 4457	Specification for ceramic unglazed vitreous acid resisting tile
78.	IS : 4831	Code of practice for laying epoxy resin floor toppings
79.	IS : 4832	Specification for chemical resistance mortars (Part II)
80.	IS : 4860	Specification for acid resistance bricks
81.	IS : 4948	Specification for welded steel wire fabric for general use
82.	IS : 5318	Code of practice for laying of flexible PVC sheet and tile flooring
83.	IS : 5410	Cement paint, colour as required
84.	IS : 5411	Specification for plastic emulsion paint (Part 1 & 2)
85.	IS : 5437	Wired and figured glass
86.	IS : 5491	Code of practice for laying of in-situ granolithic concrete floor topping
87.	IS : 6041	Code of practice construction of autoclaved cellular concrete block masonry
88.	IS : 6042	Code of practice construction of light weight concrete block masonry
89.	IS : 6248	Specification for metal rolling shutters and rolling grillers
90.	IS : 7193	Specification for glass fiber base coal tar pitch and bitumen felts
91.	IS : 7452	Specification for hot rolled steel sections for doors, windows and ventilators

92.	IS : 8042	Specification for white Portland cement
93.	IS : 8543	Methods of testing plastics
94.	IS : 8869	Specification for washers for corrugated sheet roofing
95.	IS : 9197	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
96.	IS : 9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
97.	IS : 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams
98.	BS : 476 (Part	Methods for determination of the fire resistance of elements of construction (General Principles)
99.	BS : 476 (Part	Methods for determination of the fire resistance of load bearing elements of construction
100.	BS : 476 (Part	Methods for determination of the fire resistance of non-load bearing elements of construction
101.	Part - IV Fire Protection	National Building code of India

5.3 Brick work

5.3.1 Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of approved by the Engineer-In-Charge.

The nominal size of the modular brick shall be 200 mm x 100 mm x 100 mm with the permissible tolerances over the actual size of 190 mm x 90 mm x 90mm as per IS : 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mm x 115 mm x 75 mm with tolerance up to $\pm$ 3 mm in each dimension, one brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, and homogenous in texture, well burnt in kiln without being vitrified, hand/ machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaw and nodules of free line. Hand moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 kg./sq. cm. unless otherwise specified in the items of approved by the Engineer-In- Charge.

The average water adsorption shall not be more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under bunt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the Engineer-in-charge, for approval and bricks supplied shall conform to approved samples. If demanded by Engineer-in-charge, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by Engineer- in-charge, shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1: 6 for brickwork of thickness one

brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of approved by the Engineer-In-Charge. Sand for masonry mortar shall conform to IS: 218. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer-in-charge; sand shall be screened and washed till it satisfies the limits durable particles. Sand shall be approved by Engineer-in-charge; sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer-in-charge. The mortar thus mixer shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances. The Contractor shall arrange for test on mortar samples if so directed by the Engineer-in-charge.

5.3.2 Workmanship

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of approved by the Engineer-In-Charge. Brick work 200 mm/230 mm thick and over shall be laid in English Bond unless otherwise specified. 100 mm/115 mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilized only as closers to make up required wall length or for bonding. Bricks shall be laid with frogs on top.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one meter. Brick work shall not be raised more than one meter per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joint shall not be less than 6 mm and not more than 10 mm. the face joints shall be raked to a minimum depth of 10 mm/ 15 mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering / pointing respectively to bed one later. When plastering or pointing is not required to be done, the joints shall be uniform is thickness and be struck flush and

finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar-being washed away by rain.
Brick work shall be kept constantly moist on all the faces for at least seven days after 24 hrs of lying. The arrangement for curing shall be got approved from the Engineer-in- charge.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS : 2750 and IS : 3696 (Part I) Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer-in-charge. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural measures shall be adopted.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished don top with 12 mm thick cement mortar 1 : 3 and provided with 2 layers of Kraft paper Grade I as per IS : 1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC / steel beans resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50 mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade I as per IS : 1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in the half brick partition walls.

Where the drawings indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surface at the point of entry into the brick masonry.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the Drawing and all facing brickwork shall be well bounded to the backing /RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.
Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works. The pattern of laying the bricks shall be as specifically indicated in the Drawing and approved by the Engineer-In-Charge. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

5.4 Uncoursed Random Rubble Masonry, in Foundation, Plinth and Superstructure

5.4.1 Materials

Stones for the works shall be of the specified varieties which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part - I). The percentage of water adsorption shall not exceed 5 percent as per test conduct in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer-in- charge, for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1: 6 Materials and preparation of mortar shall be as specified in clause 5.3.1.

5.4.2 Workmanship

For all Works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hummer dressed stones with squared quoins at corners.

The brushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or heating stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and

to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spells and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm. by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-third into the wall and a set of two or more bond stones over lapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be racked back (and not saw toothed) at an angle not exceeding 45 deg. Masonry work shall not be raised by more than one meter per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 5.3.2

5.5 Coursed Rubble Masonry (First Sort) for Superstructure

5.5.1 Materials

The Material specification for the work shall be as per clause 5.4.1

5.5.2 Workmanship

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least $1/3^{rd}$ the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project the surface of bed and side joints.

No spalls or pinning's shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stone shall be as specified in clause 5.4.2 with the further stipulation that these shall be provided at 1.5 m to 1.8 m apart clear in every course but staggered at alternate course.

The quoins which shall be of the same height as the course, in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their bed, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a
minimum uniform chisel draft of 25 mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 5.3.2 Requirements of execution of the work and curing shall be as stipulated in clause 5.4.2.

5.6 Concrete Block Masonry

5.6.1 Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part I).

Masonry units of hollow and solid light -weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

Masonry units of autoclaved cellular concrete block shall conform to the requirement of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under. Length 400, 500 or 600 mm Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in length of 200, 250 or 300 mm to correspond to the full length block.

Actual dimension shall be 10 mm sort of the nominal dimensions.

The maximum variation in the length of the units shall not be more than $\pm$ 5 mm

and maximum variation in height or width of the units shall not be more than $\pm$ 3 mm.
Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks. Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.

The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the value of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of Engineer-in-charge.

5.6.2 Workmanship
The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.
The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete block shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 5.3.1.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joints. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be racked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollows concrete block is greatly affected by variations of moisture content in the units. Only well dried block should be used for the construction. Block with moisture content more than 25 % of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/ studs, joints reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS: 280 or welded wire fabric/high strength deformed basis.

For jambs of doors, windows and opening, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of door/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall laid up at the same time with a true masonry bond between at least 50 % of the concrete blocks. The sequence for construction of partition walls are treatment at the top of load bearing walls for the RCC slab be as detailed under clause 5.3.2 for the brick work.

Curing of the mortar joints shall be carried out for at least 7 days. The walls should be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 5.3.2 shall be adopted for execution o block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.
Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

5.7 Damp - Proof Course

5.7.2 Materials and Workmanship

Where Specified, all the walls is a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water -proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacture. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick work/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

5.8 Miscellaneous Insert, Bolts etc.

All the miscellaneous insert such as bolts, pipes, plate embedment's etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction DRAWINGS.

Contractor shall prepare and use templates for this purpose, if so directed by the Engineer-in-charge. In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the Engineer-in-charge.

5.9 Wood work In Doors, Windows, Ventilators & Partitions

5.9.1 Materials

Timber to be used shall be first class teak wood as per IS: 4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required size. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50 mm and above in thickness and 8 to 14 percent of timber less than 50 mm in thickness for different regions of the country as stipulated in IS : 287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part I) and with particle board/hard board face panels shall conform to IS: 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS: 2835. Wires and figured glass shall be as per IS: 5437.

Builder's hardware for fittings and fixtures shall be of the best quality form approved manufacturers.

5.9.2 Workmanship

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the details Drawings and / or as directed by the Engineer-in-charge.

All members of the door, windows, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces the right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutters shall be 15 mm. The size of the frames shall be as specified in the respective items of approved by the Engineer-In-Charge. The workmanship shall generally conform to be requirements specified in IS: 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and windows frames, one at the center and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber paneled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the Drawings. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutters shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutters shall be checked by measuring the diagonals and the difference shall not be more than ±3 mim. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Part 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirements of the thickness, core, face panels, viewing glazed panel, ventilation louver opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710. Flush door shutters shall be from reputed manufactures and Contractor shall submit test results as per IS: 4020, if so desired by the Engineer-in- charge.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of "B" quality as per IS: 710. Flush door shutters shall be from reputed manufactures and Contractor shall submit test results as per IS: 4020, if so desired by the Engineer-in-charge.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of "B" quality as per IS: 2835. The thickness and type of glazing to be provided shall be as specified.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidized or anodized aluminum shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.

Woodwork shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the Engineer-in-charge. The type of finish and the number of coats shall be as stipulated in the respective items of approved by the Engineer-In-Charge. Preparation of the wood surfaces and application of the finishes shall be in accordance with clause 7.3.2 Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the Drawings

The frame work of the partitions with mullions and transoms shall be with the sections of dimensions as specified. Panels of double/single glazing plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/ beams including provisions of necessary shims for wedging

etc. Finished work shall be of rigid construction. Erected truly plumb to the lines and levels, at locations as per the construction Drawings

Any carpentry work which shows defects due to inadequate seasoning of the timber of bad workmanship shall be removed and replaced by Contractor with work as per Specifications.

5.10 Steel Doors, Windows and Ventilators

5.10.1 Materials

Hot rolled steel sections for the fabrications of steel doors, windows and ventilators shall conform to IS L 7452, which are suitable for, single glazing.

Pressed steel door frames for steel flush doors shall be out of 1.25 mm thick mild steel sheets of profiles as per IS L 4351.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS L 5437.

Builder's hardware of fittings and fixture shall be of the best quality from the approved manufactures.

5.10.2 Workmanship

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work and of sizes as indicated in the Drawings Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS: 1038. Steel windows shall conform to IS: 1361, if so specified.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and metered. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS: 1038.
Tolerance in overall dimensions shall be within [1] $\pm$ 1.5 mm. The frames and shutters shall be free from wrap or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the Engineer-in- charge, before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and/or as shown in the Drawing for single or composite units.

For windows with fly proof mesh as per the item of work, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock- strike plate, mortar guards, angle threshold, shock-absorbers of rubbers or similar material as per the requirements of IS : 4351. Pressed steel doorframes shall be fixed as 'built in' as the masonry work proceeds. After placing it plumb at the specified location, masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the doorframe, without leaving any voids. Temporary struts across the width shall be fixed, during erection to

prevent bow/sag of the frame.
Door shutters of flush welded construction shall be 45 mm thick, fabricated with two outer skills of 1.25 mm thick steel sheets, 1 mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge beveled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/ or Drawings Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25 mm thick steel sheets, mild steel angles and stiffeners as per the Drawings Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be "Built-in" as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10 mm clearance around the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired/ figured glass of the thickness as specified in the items of works. All glass panels shall have properly squared corner straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS: 419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beds with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings

The material of the Builders hardware of fittings and fixture of chromium plated steel, cast brass, brass copper oxidized or anodized aluminum shall be as specified in the items of approved by the Engineer-In-Charge. The number, size and type of fitting and fixtures shall be as in the DRAWINGS / items of works.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS : 1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation workmanship expected is of a high order for efficient and smooth operation of the units.

5.11 Aluminum Doors, Windows, Ventilators & Partitions

5.11.1 Materials

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, and ventilators shall conform to designation HE9-WP OF is 733.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings & fixtures shall be of the best quality form approved manufactures.

5.11.2 Workmanship

All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS: 1948.
Aluminum windows shall conform to IS: 1949, if so specified.
All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be on an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mired and welded at the corners to a true right angle conforming to the requirements of IS: 1948. Tolerance in overall dimensions shall be within $\pm$ 1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminum swing type doors, aluminum sliding windows, partitions shall be as specified.

IS : 1948 and IS : 1949 referred to incorporates the size, shapes, thicknesses and weight per running meter of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such the sections of the various components of the unit proposed by the Contractor will be reviewed by the Engineer-in- charge, and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.

The framework of the partitions with mullions and transoms shall be with anodized aluminum box sections. Anodized aluminum box sections shall be in -filled with timber of class 3 (Silver oak or any other equivalent) as per IS: 4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the DRAWINGS approved by the Engineer-In-Charge. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction DRAWINGS approved by the Engineer-In-Charge.

Specific provisions as stipulated for steel doors, windows ventilators under clause 5.10.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works. A layer of clear transparent lacquer shall be applied on aluminum sections to protect then form damage during installation. This lacquer coating shall be removed after the installation is completed.

5.12 Steel Rolling Shutters

5.12.1 Materials and Workmanship

Rolling shutters shall be of an approved manufactures, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self coiling type (manual) for clear areas up to 12 sq.m gear operated type (mechanical) for clear areas up to 35 sq.m and electrically operated type for areas up to 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the Drawings

Shutters shall be built up of interlocking laths 75 mm width between rolling centers formed from cold rolled steel strips. The thickness of the steel strip shall not be less

than 0.90 mm for shutters up to 3.50 m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS: 6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.
Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS: 2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of works. Painting shall be carried out as per clause 5.32.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanized with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be at least 610 gms/sq.m.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

5.13 Rubble Sub-Base

5.13.1 Materials

Stone used for rubble packing under floors on grade, foundation etc. shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects.
Stones shall generally conform to the requirements stipulated in IS L 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of $\pm$ 10 mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer-in-charge.

5.13.2 Workmanship

Stone shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breading joints and in close contact with each other. All interstices between the stones shall be wedged -in-by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling- in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stone shall be in filled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

5.14 Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of works.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly taped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

5.15 Terrazzo and Plain Cement Tilling Work

5.15.1 Materials

Terrazzo tile and cement tiles shall generally conform in all respects to standard stipulated in IS: 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm^2.

The type quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as specified.

The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble power by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1 mm to 6 mm and 1.50 parts by volume if the chips are between 6 mm to 25 mm.

The minimum thickness of wearing layer of terrazzo tiles shall be 5 mm for tiles with chips of size varying from 1 mm up to 6 mm or from 1 mm up to 12 mm. This shall be 6 mm for tiles with chips varying from 1 mm up to 25 mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5 mm. This shall be 6 mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

5.15.2 Workmanship

Laying and finished of tiles shall conform to the requirements of workmanship stipulated in IS: 1443.

Tilling work shall be commenced only after the door and window frame are fixed and plastering of the walls/ceiling is completed. Wall plastering shall not be carried out up to about 50 mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45 mm below the level of finished floor. Before the tilling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25 mm average thickness of cement mortar consisting of one part of

cement to 6 parts of sand shall be provided as bedding for the tile over the base concrete. The thickness of bedding mortar shall not be less than 10 mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5 mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5 mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or Grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for at least 14 days after fixing of the tiles.

About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tile adjoining the wall shall go about 10 mm under the plaster, skirting or dado.

The skirting and dado work shall be executed only after laying tile on the door. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10 mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5 mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement past so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with beveled edged to obtain a neat and true joint. After the work has set, hand polishing with carborundum stone shall be done so that the surface matches with the floor finish.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usages of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS: 1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiles the level of the central portion shall be kept 10 mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of $\pm$ 3 mm in any 3m length is acceptable in a nominally flat floor.

5.16 In-Situ Terrazzo Work

5.16.1 Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 5.15.2

Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the center at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials shall be kept, as thoroughly mixed in the dry state; water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

5.16.2 Workmanship

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/skirting shall be as specified in the respective items of works. Laying and finished or in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

In-situ terrazzo shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix 1:2:4 using 10 mm downgraded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20 mm for dado/skirting work.

The minimum thickness of topping shall be 6 mm if chips used are between 1 mm to 4 mm, 9 mm if chips are between 4 mm to 7 mm and 12 m if chips are between 7 mm to 10 mm, if chips larger than 10 mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall be divided into panels not exceeding 2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2 m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of at least 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminum, brass or other material as indicated in the item of works. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5 mm and width not less than 25 mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before

spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and leveled to the correct height to suit the thickness of the finis. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry the under layer shall be spread and leveled with a screeding board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before, laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS : 2114.

5.17 Shahabad / Tandur / Kota Stone Slab work

5.17.1 Materials

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100 mm shall be $\pm$ 5 mm. This shall be $\pm$ 2 mm on dimensions less than 100 mm.

Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

5.17.2 Workmanship

The type, size, thickness and colour/shade etc. of the slabs for flooring /dado/skirting shall be as specified in the respective items of works.

Preparation of the concrete base, laying and curing shall be as per clause 5.15.2

Dado / Skirting work shall be as per clause 5.15.2. the thickness of the slabs for dado / skirting work shall not be more than 25 mm. Slabs shall be so placed that the back surface is at a distance of 12 mm. if necessary, slabs shall be held in position temporarily by suitable method. After checking for vertically, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab

shall be removed.

Grinding and polishing shall be as per clause 5.15. except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

5.18 Carboundum Tile Finish

5.18.1 Materials

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS: 1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm^2.

The topping shall be uniform and of thickness not less than 6 mm. The quantity of carborundum grit shall be not less than 1.35 Kg/sq.m used with cement with or without pigment. The carborundum girt shall pass through 1.18 mm mesh and shall be retained on 0.60 mm mesh.

5.18.2 Workmanship

Requirements as detailed for terrazzo/cement tile finish under clause 5.15.2 shall be applicable for carborundum tile flooring.

5.19 Glazed Tile Finish

5.19.1 Materials

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tile shall be of the best quality from an approved manufacture. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

5.19.2 Workmanship

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12 mm for flooring and 10 mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.
Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar dropping etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles.

Tile shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom or the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than
1 mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10 mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of Grey cement with wire brush to a depth of at least 3 mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

5.20 In-Situ Cement concrete Floor Topping

5.20.1 Materials

The mix proportion for the in-situ concrete floor topping shall be 1:2:4 (one part cement: two parts sand: four parts coarse aggregates) by volume unless otherwise specified.

The aggregates shall conform for the requirements of IS :383.

Coarse aggregates shall have high harness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5 mm and below shall be as per IS:2571.

Grading of the sand shall be within the limits indicated in IS: 2571.

5.20.2 Workmanship

The thickness of the floor topping shall be as specified in the items of approved by the Engineer-In-Charge. The minimum thickness of the floor topping shall be 25 mm. Preparation of base concrete/structural slab before laying the topping shall be as per clause 5.14 The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer-in-charge. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.
Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap at least one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately

before depositing the concrete topping, neat cement slurry at 2.75 Kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

Finishing of the surface by trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferably to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerance is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finishes which are difficult to repair satisfactorily.

5.21 In-Situ Granolithic Concrete Floor Topping

5.21.1 Materials and Workmanship

The Requirements of materials and workmanship shall be all as per clause 5.20 for in- situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (Cement sand coarse aggregates) by volume.

The minimum thickness of granolithic floor topping on hardened concrete base shall be 40 mm.

5.22 Floor Hardener Topping

5.22.1 Materials & Workmanship

Floor Hardener topping shall be provided either as integrally finished over the structural slab/ grade slab or laid monolithically with the concrete / granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium / heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of approved by the Engineer-In-Charge.

For monolithic application with the floor finish/slab the thickness of the layer shall be 15 mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to read over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Toweling to a smooth finish shall be carried out as per clause 5.20.2. after the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

5.23 PVC Sheet / Tile Flooring

5.23.1 Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS: 3462 or homogenous PVC asbestos tiles conforming to IS: 3461.

The surface of the sheet/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the Engineer-in-charge.

Each tile/sheet be legibly and indelibly marked with the name of the manufacture or his trade mark, IS certificate mark, and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of approved by the Engineer-In-Charge.

5.23.2 Workmanship

PVC Floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the underbed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix - A of IS: 5318.

The surface of the underbed shall have trowelled finish without any irregularities, which creates poor adhesion, Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for at least 7 days. During this period the temperature range shall be between 20 deg. C and 30 deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, accordance to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface are at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one and end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5 kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/stair trends.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

5.24 Acid Resisting Brick/tilling work

5.24.1 Materials

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS: 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

5.24.2 Workmanship

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS: 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS: 1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/ Stainless steel/ chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for
the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25 % hydrochloric acid or 30 to 40 % sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin in used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furans type of resin is used for the mortar. If phenolic or cashew nut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 day respectively, if heat treatment is given with infrared lamp.

5.25 Epoxy Lining Work

5.25.1 Materials

The epoxy resin and hardener formulation for laying of joint less lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS : 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

a) Hydrochloric acid up to 30 % concentration
b) Sodium hydroxide up to 50 % concentration
c) Liquid temperature up to 60^{O} C.
d) Ultraviolet radiation
e) Alternate wetting and drying Sand shall conform to grading zone III or IV of IS: 383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic / Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the Engineer-in-charge.

5.25.2 Workmanship

The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel type of facilitate execution of the required thickness for satisfactory performance.

The concrete surface over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surface shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water of dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC / stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out obtain uniformly the specified thickness of lining.
Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

5.26 Water-Proofing

5.26.1 General

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Owners Representative.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The bricks bat coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Engineer-in-charge.

5.26.2 Modified Bituminous Membrane

Modified Bituminous Membrane shall be "SUPER THERMOLAY" 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non- woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermo fusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited. "PLYFLEX" of Bitumat Company Limited, Saudi Arabia supplied by STP limited shall also be acceptable or other equivalent specification.

5.26.3 Waterproofing of Roofs with Lime Concrete

(a) Materials

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25 mm and shall generally conform to IS: 3068.

Lime shall be class C lime (fat lime) or factory made hydrated lime conforming to IS: 712.

(b) Workmanship

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked

lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12 kg of washing soap and 4 kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

The roof surface over which the water - proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer.

The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS : 2690 (Part I) shall be as specified in the items of work approved by the Engineer-In-Charge. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work prepared by the Contractor duly considering the traffic the terrace the will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75 mm and average thickness shall not be less than 100 mm. in case, the thickness is more than 100 mm; it shall be laid in layers not exceeding 100 mm to 125 mm.
Laying of lime concrete shall be commenced form a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slops specified for effectively draining the rain-water towards the down take points.

Lime concrete fillet for a minimum height of 150 mm shall be provided all along the junction of the roof surface with the brick masonry wall/ parapet/ column projections. These shall then be finished on top with provision of clay terracing tiles / cement concrete tiles.

After the time concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surfaces and rebounds readily form it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or columns projections.

During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar than comes on the top shall be smoothened with a

trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugars solution may be prepared in any one of the following ways as directed by the Engineer-in-charge.

a) By mixing about 3 kg of Jiggery and 1.5 Kg of BAEL fruit to 100 liters of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small

pieces and allowed to soak in water), 200 gm of jiggery and 40 liters of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of stpure or hessian which shall be kept wet continuously.

Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12 mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angle to the direction of run-off gradient. Transverse joints in alternative rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by at least 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instruction. Curing shall be carried out for a minimum period of seven days.

Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

5.26.4 Waterproofing of Roofs/Terraces etc.

(a) Water proofing of Horizontal Surfaces

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85/25 shall be applied at rate of 1.45 Kg/sq.km.
A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the Engineer-in-charge, as the unrolling progress.

The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by the flame torching.

Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm.

The membrane shall be properly overlapped / terminated at all openings, rainwater down takes etc. to ensure that such junctions do not become sources of leakage.

Top of membrane finally shall be painted with antiglouse reflective paint.

(b) Waterproofing of Vertical Surfaces at Roof Level and Gutters

The water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bounded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding.

The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm.

The membrane shall be taken up to a pre-cut chase anchored and sealed.

5.26.5 Khurras and Rainwater down Pipes

Down pipes shall be isolated from RCC work with 6 mm polyethylene from fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layer of aluminum foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down the pipes.

5.26.6Testing

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond anywhere on the surface.

5.27 Cement Plastering Work

5.27.1Materials

The proportions of the cement mortar for plastering shall be 1: 3 (One part of cement to three parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer-in-charge. If so desired by the Engineer-in-charge sand shall be screened and washed to meet the specification. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Dropping of plaster shall not be re-used under any circumstances.

5.27.1Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirement's specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm/20 mm/ for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 12 mm thickness in cement mortar 1:3, with neeru finishing by neet cement/lime slurry. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out a jambs, lintel and sill faces, etc. as shown in the DRAWING and as directed by the Engineer-in-charge.

Plain Faced Ceiling plaster- This plaster shall be applied in a single coat of 12 mm thickness in cement mortar 1:3, with neeru finishing by neet cement/lime slurry. Application of mortar shall be as stipulated in above paragraph.

Exterior sand faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 12 mm thick in cement mortar 1:3. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 8 mm thick in cement mortar 1:2. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster 20 mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph exterior sand faced plaster this plaster shall be applied in 2 coats. The first coat shall be approximately 14 mm thick and the second coat shall be 6 mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be specified in the respective items of work.

Wherever more than 20 mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the Engineer-in-charge, duly satisfying requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for at least 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer-in-charge.

Where specified in the DRAWINGS approved by the Engineer-In-Charger, Rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the DRAWINGS approved by the Engineer-In-Charge.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturer's instruction while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/window etc. ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 7.2.2.

The finished plaster surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 mm length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.

c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

5.28 Cement Pointing

5.28.1 Materials

The cement mortar for pointing shall be in the proportion of 1:3 [One part of cement to three parts of fine sand]. Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer-in-charge, and if so directed it shall be washed / screened to meet specification requirements.

5.28.2 Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least
15 mm / 20 mm deep in brick/ stone masonry respectively as the work proceeds when the mortar is still green.
Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or "V" as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour require shall be added to cement in such proportion as recommended by the manufacturer and as approved by the Engineer-in-charge.

5.29 Water - Proofing Admixtures

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer-in-charge.

5.30 Painting of Concrete, Masonry & Plastered Surfaces

5.30.1 Materials

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer-in-charge.

All the materials shall be of the best quality form an approved manufacturer. Contractor shall obtain prior approval of the Engineer-in-charge for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

5.30.2 Workmanship

Contractor shall obtain the approval of the Engineer-in-charge regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for through drying of the sub-strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

Surface of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

5.30.3 White Wash

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke

from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

5.30.4 Colour Wash

Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finish dry surface shall not show any signs on peeling/powdery and come off readily on the hand when rubbed.

5.30.5 Cement Paint

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacture's instruction. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 Kg/sq.m. A minimum of 2 coats of the same colour shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second is applied.

The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

5.30.6 Oil bound Distemper

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for at least 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. At least 24 hours shall be left after the first coat to become completely dry before the applicant for the second coat. Board, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

5.30.7 Acid, Alkali Resisting Paint

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer cost shall be as per manufacturer’s instructions.

5.30.8 Plastic Emulsion Paint

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instruction. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally take about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall

present a flat velvety smooth finish and uniform in shade without any patches.

5.30.9 Acrylic Emulsion Paint

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

5.31 Painting & Polishing of Wood Work

5.31.1Materials

Wood primer shall conform to IS: 3536. Filler shall conform to IS: 110.
Varnish shall conform to IS: 337.
French polish shall conform to IS: 348.
Synthetic enamel paint shall conform to IS: 2932.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer-in-charge for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

5.31.2 Workmanship

The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc. shall be specified in the respective items of work approved by the Engineer-In-Charge.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free any free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of workapproved by the Engineer-In-Charge. Any slight irregularities of the surface shall then be made up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS: 2932. Paint shall be applied by brushing evenly and smooth by means of crossing and laying off in the direction of the grain of wood. After drying the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the applications of successive coats. Each coat shall very slightly in shade and this shall be got approved by the Engineer-in-charge. The number of coats of paint to be applied shall be as specified in the item of work approved by the Engineer-In-Charge.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS: 337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as

directed by the Engineer-in-charge. When two coats of varnish is specified, the first coat should be a hard-drying undercoat of flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated sprit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

5.32 Painting of Steel Work

5.32.1 Materials

Red-oxide - zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932. Aluminum paint shall conform to IS: 2339.
All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer-in-charge, for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

5.32.2 Workmanship

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purposes recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 1477 (Part 2).
The type of paint, number of costs etc. shall be specified in the respective items of work. Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The method to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part - 1) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from "holidays".

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface become dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard -dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall very slightly in shade and this shall be got approved by the Engineer-in-charge.

5.33 Flashing

5.33.1 Materials

Anodized Aluminum sheet shall be 1.00 thick with anodic film thickness of 0.025 mm. Galvanized mild steel sheet shall be 1.00 mm thick with zinc coating of 800 gms/sq.m. Bitumen felt shall be either Hessain base self finished bitumen felt Type -3 Grade 1 conforming to IS : 1322 or glass fiber base self finished felt Type - 2 Grade 1 conforming to IS : 7193.

5.33.2 Workmanship

The type of the flashing and method of fixing shall be as specified.
Flashing shall be of the correct shape and size as indicated in the construction DRAWINGS to be prepared by the Contractor and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100 mm.

Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/ concrete along with cement mortar
1: 4 filleting as indicated in the DRAWING approved by the Engineer-In-Charge. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats for bituminous paint at the rate of 0.10 liter/sq.m after the installation.

5.34 Thermal Insulation For Ceiling

Thermal insulation shall be 'Thermocole' TF type of similar approved or Resin bonded fiber glass boards.

5.34.1 Fixing

5.34.2 "Thermocole Boards"

Soffit of R.C.slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m^2.

Thermocole boards (T.F. variety) of 50 mm thickness shall be stuck by means of the same grade of hot bitumen.

The board shall be further secured with screws, washers and plugs. The joints of the boards shall be sealed with bitumen.

5.34.3 Fiber Glass Boards

Timber page 50 mm x 50 mm 50 mm shall be fixed to the slab at 600 mm centers with 6 mm x 65 mm long wood screws. 20 gauge G.I. Lacing wire shall be tied to the page.

"Crown" 200 fiber glass boards 50 mm thick shall be struck to the page with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

The insulation boards shall be covered with 20 mm-24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminum sheets shall be fixed over the chicken wire mesh with 50 mm overlap and secured to the timber pegs by screws.

It the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional batten are required for proper insulation, Contractor shall include its cost in the rate for insulation.

5.35 Plasters of Paris Board False Ceiling

5.35.1 Materials

(a) Plaster of Paris Boards

The plaster of Paris to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by Engineer-in-charge.

The plaster of Paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS: 2547 (Part I) However, its fineness shall be such that the residue, after drying and sieving on I.S. sieve designation 3.35 mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an over at 40^{O} Dec. C till the weight of the cubes is constant shall not be less than 84 Kg per sq.cm.

The plaster of Paris reinforced with Hessian cloth or coir shall be prepared in suitable sizes as shown on the DRAWING or as directed by Engineer-in-charge. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non- staining oil to facilitate the easy removal of the board. Plaster of Paris shall be evenly spread into the form up to about half the depth and Hessian cloth or coil shall be pressed over the plaster of Paris layer. The weight of Hessian cloth or coir in the board shall be 250 gm per sq.m. Ends of the Hessian/coir reinforcement shall be turned over at all edges to from a double layer for a width of 50 mm. the Hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give an ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly and smooth.

The size of boards shall generally be 600 mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

5.35.2 Timber Frame Work

Timber for frame work of false ceiling grid and hangers shall be of good quality and well seasoned. It shall have uniform colour, reasonably straight and close grains and shall be free from knots, cracks and sapwood. It shall be treated with approved anti termite preservative as directed by the Engineer-in-charge. Extreme care shall

be taken so that the preservative treatment does not stain the ceiling boards. In case metal hangers are used, these shall be M.S. flats or bars, having two coats of red oxide zinc chromate paint primer, as shown on DRAWINGS or as approved by Engineer-in-charge.

5.35.3 Metal Frame Work

The metal frame work may be made of section of light metal, such as anodized aluminum mild steel or as shown on the DRAWINGS. The shape of cross-section shall be such as to facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

5.35.4 Construction

Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the DRAWINGS. Contractor shall also submit a detailed DRAWING to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access, doors, etc.

Structural design of timber member for the frame for the frame shall be in accordance with IS: 883, and metal, sections shall be of appropriate size and thickness and shall be of approved manufacture, all as approved by Engineer-in-charge.

The false ceiling grid work shall be carried out as per the approved DRAWING or as directed by Engineer-in-charge. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size of 60 mm deep x 40 mm wide along one direction at 1.2 m centre to centre and secondary runners of size 50 mm deep x 40 mm wide at 60 mm centre to centre perpendicular to the main runners.

The timber grid work shall be suspended with the help of wooden hangers or metal hangers at 1.2 m centre to centre in both the directions. Wooden hangers shall be adopted for flat R.C. roof slab structures whereas metal hangers for flat R.C. roof or structural steel floors/ tresses. Metal hangers shall be fabricated from mild steel / galvanized flats of 35 mm x 6 mm size of bars of 10 mm dia, threaded at the lower end and anchored securely in the roof concrete or welded to insets provided on the underside of slabs, beams etc. All M.S. hangers shall be given two coats of red oxide zinc chromate paint primer. In case the roof work is of A.C. sheeting supported on purlins and trusses, hangers shall be suspended from roof steel work. The arrangement of metal hangers shall be such that the level of false ceiling can be adjusted during fixing of the ceiling frame work. The ceiling frame work shall be secured to hangers by means of washers and nuts. The ends of main runners shall preferably to embedded into the masonry work.

The metal frame work when it is anodized aluminum false ceiling grid system shall consist of aluminum main member of special T-Profile of 38 mm X 38 mm X 1.5 mm thick, interlocking with each other to form frames of various sizes, 600 mm X 600 mm or as shown on the DRAWING. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodized aluminum wall angles.

In the case of timber frame, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rust less screws of 2.74 mm size, 40 mm long at spacing of 100 mm to 150 mm c/c and 12 mm from the edge of the

board. Holes for screws shall be drilled and screws slightly countersunk into the board. The boards shall be fixed to wooden framework with a joint clearance of about 3 mm. The joints shall always be in perfect line and plane.

In case of aluminum grid system, boards shall be just placed into the frames formed by the main 'T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joints. The boards shall be cut with a saw, if required to any shape and size.

As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to Owner. Removable or hinged type inspection or access trap doors shall be provided at locations specified by Engineer-in-charge.

5.35.5 Finishing

It is essential the false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of Engineer-in-charge.

The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints of aluminum frame work shall be of inter- locking type so that when the cross member is in place, it cannot be lifted out.

The countersunk heads of screws and all joints shall be filled with plaster of pairs and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50 mm wide on either side of the joints and no to it shall be trowelled dry a
reinforcing scrim cloth about 10 mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

5.35.6 Fire Stopping

In case of fire protective ceiling, fire resisting barriers at suitable intervals shall be provided these shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by Engineer-in-charge, (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system for guidance).

5.36 False or Cavity Floor

5.36.1 Frame work

The false floor shall consist of a frame work of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600 mm centre to centre in both directions. The stool shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35 mm thick, 600 mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6 mm dia.

anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities up to plus or minus 15 mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

5.36.2 Floor Panels

The floor panels shall be made of 600 mm X 600 mm X 35 mm thick medium density unveneered / non-prelaminated teak wood particle boards having a density of not more than 800 Kg/cu. Bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087 specification for wood particle boards (Medium Density) for general purposes.
The thermal conductivity of the boards shall not exceed 0.12 k Cal/hr/sq.m/deg./C/m/ The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with dimensions with panel size not more than 600 mm under any circumstances. Exposed 2 mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire resistant paint from under site.

The particle boards shall be faced with 600 mm x 600 mm x 2 mm thick approved make flooring tiles conforming to IS: 3462. "Specification for unbacked flexible PVC flooring" and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the on the inner side with stickers for easy identification and reassembly whenever required.

Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.

Suitable removable covers shall be provided to serve as outlets for the cables.

5.36.3 Imposed Loading

The finished floor shall be capable of supporting a uniformly distributed load of 500 to 1000 Kg. per sq. meter of floor area as specified in data sheet. A point load of 450 Kg on 600 sq. mm on any part of the panel or a line load of 725 Kg on 100 mm strip across the panel length shall not result in a deflection greater than 2.5 mm.

5.36.4 Finish

The finished floor shall be true to lines and levels and present a neat flush surface.

5.36.5 Vender DRAWING

Vender shall prepare and submit a layout DRAWING for false floor giving all details including supporting system for approval. If so called for, vendor shall also

submit his calculations for the supporting system with all relevant data assumed, to the Engineer- in-charge, for his approval. Work shall be carried out on approved DRAWINGS only.

5.37 Fire Proof Doors

5.37.1 Material and Workmanship

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire.

The materials, fabrication and erection of fire proof doors shall confirm to IS: 3614 (Part - I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained beforehand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part - 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (confirming to IS: 304) sheet (18 G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wood in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter not be less than 35 mm for two hour fire rating and 46 mm for four hour fire rating.

The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame form zinc coated (16 G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

Signature of Contractor

City Engineer (Drainage Project)
Rajkot Municipal Corporation

6.0 ITEM-WISE DETAILED TECHNICAL SPECIFICATIONS FOR SEWAGE PUMPING STATION

Item No.

1) Excavation for well, foundations and trenches including all safety provisions including necessary dewatering, refilling, stacking, removing and spreading the excavated stuff as directed with lead upto 90mt, cleaning the site etc complete, for lifts and strata as specified.

i) In all sorts of soil and soft murrum ii)
In hard murrum
iii) In soft rock
iv) In hard rock
The relevant part of technical specifications as laid down under section-3 of this volume. The excavation shall be carried out per dimensions given in the drawings and as per instructions of Engineer-in-charge.

The rates for this item includes shoring, strutting and dewatering, if necessary.
The rate shall be for a unit of one cubic meter.

Item No.

2) Providing and casting in situ mass cement concrete in grade M-10 (approx. corresp. to prop. 1:3:6) using granite quartzite trap metal of size 12 mm to 25 mm including consolidation, curing etc. complete.

AND

3) Providing and casting in situ C.C. in grade M-30 proportions of ingredients as per mix design by weigh baching using granite, quartzite trap metal of size 12 mm to 20 mm and or 6 mm to 12 mm including scaffolding, centering, formwork, needle vibrated consolidation, curing and hydraulic testing etc. complete (excluding cost of reinforcement) for all water retaining structures.

AND

4) Providing and casting in situ C.C in grade M- 20 (proportion as per mix design or as per table-9 of IS : 456-2000 in masses by weigh baching) using granite, quartizaite trap metal of size 12 mm to 20 mm or 6 mm to 12 mm for RCC work including scaffolding, centering, formwork, needle vibrated consolidation, curing etc. complete (excluding cost of reinforcement) with centering and shuttering etc complete for structures other than water retaining.

The relevant part of technical specifications as laid down under section-3 of this volume.
The rate shall be for a unit of one cubic meter.

Item No.

5) Supplying, cutting, bending, binding and placing in position steel as per plan and design and as per IS 2502 including cost of steel and binding wire for reservoirs / structures for all diameters- by using deformed thermo mechanically treated (TMT) bars Fe- 415 or Fe-500 Grade confirming to IS: 1786-1985.

The relevant part of technical specifications as laid down under section-3 of this volume.
The rate shall be for a unit of one Metric Tonne.

Item No.

6) Providing and fixing water tight water stop at construction joints made of G.I. plain sheet of 16 to 18 gauge 20 cm wide.

Water stop shall be of G.I. Plain sheet of 20 mm width and 16 to 18 gauge and shall be bent, folded to shape and fixed as per the instructions of Engineer-in-charge to make construction joints water- tight water stop shall be accurately cut, fitted and integrally jointed at sectional joints and angular junctions to provide a continues watertight diaphragm at all joints. Water stop installation along the joints shall be

done in embedding one half of the water stop in each side joint between adjacent sections of the concrete as per direction of Engineer-in-charge. Water stop shall properly align and placed in position during embedding. To achieve continuity of water stop along the joint, water stop shall be bent and folded as per direction of Engineer-in-charge.

The rate shall be for a unit of one running meter.

Item No.

7) Water Proof Cement Plaster 20 mm thick using Water Proofing Compound and in the ratio of 1:3 with Niru finishing by cement slurry including curing etc. complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

8) Brick work using common burnt clay building bricks having crushing strength not less than 35 kg/sq.cm for superstructure above plinth in CM 1:6 including curing etc complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one cubic meter.

Item No.

9) Providing 12 mm thick cement plaster in finished even and smooth in cement 1:3 (1 cement :3 sand) with neeru finishing by floating coat of neat cement or lime slurry including curing etc complete.

AND

10) 20 mm thick sand faced cement plaster consisting of 12 mm thick backing coat of CM 1:3 (1 cement :3 sand) and 8 mm thick finishing coat of CM 1:2 (1 cement :2 sand) including spunk finishing, curing etc. complete

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

11) Providing and fixing rolling shutters of approved design and quality with top covers and necessary fittings including applying one coat of red lead primer and two coats of oil painting etc complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

12) Providing and fixing door/window made from EZ-7 section frame and using 14 gauge steel sheet including welding, fixtures fastenings, glass fixing, oil painting etc completed.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

13) Iron work / structural steel work as per instruction of Engineer In-charge by using suitable M.S. sections- angle, tees, girders, M.S.plates, flats, bars & different types of wire mesh etc. including providing, supplying, cutting, welding, jointing, hoisting, fixing in position and applying one coat of lead primer and two coats of oil painting of approved quality, etc complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one Kilogram.

Item No.

14) Providing and laying cement concrete flooring 1:2:4 (1 cement :2 coarse sand :4 graded stone aggregate 12 mm to 20mm nominal size) including consolidation, finishing, curing etc complete

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one cubic meter.

Item No.

15) Providing and laying cement concrete I .P. S. flooring 50 mm thick in 1:2:4 (1-Cement: 2- Coarse sand:4- Graded stone aggregates 12 mm to 20mm nominal size) laid in one layer finished with a floating coat of neat Cement including curing etc complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

16) Providing and laying 20 to 25 MM thick Kotah stone flooring over 20 to 25 MM (av) thick base of Lime Mortar 1:2 laid over and jointed with grey cement slurry including curing, rubbing and polishing etc complete.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one square meter.

Item No.

17) ….do….. for steps and riser by using polished kotah stone of size 0.90 to 1.45 meter length and required width.

The relevant part of technical specifications as laid down under section-3 of this volume. The rate shall be for a unit of one Running meter.

Item No.

18) Providing and fixing 50 cm wide MS ladder fabricated from M.S flats 10 mm x 75 mm with 20 mm dia steel bar steps in double rows at 30 cm C/C. This includes stays of 10 mm x 50 mm flats fixed at 3 mt. C/C with welding anchoring and three coats of anti-corrosive paint etc complete.

The M S Ladder shall be fabricated as indicated in the description of this item and as per the instructions of engineer in charge.

The relevant part of technical specifications for material and workmanship as laid down under section-3 of this volume.

The rate shall be for a unit of one Running meter.

Item No.

19) Providing and fixing safety cage for M.S. ladder by using suitable size structural steel including cutting, welding, fixing in position, anchoring and three coats of anti-corrosive etc. complete.

The safety case for M S ladder shall be fabricated by using suitable structural steel as per the instructions of engineer in charge.

The relevant part of technical specifications as laid down under section-3 of this volume.

The rate shall be for a unit of one Kilogram.

Item No.

20) Railing work - Providing and fixing 25 cm dia G.I. pipe Class-B on 75/40/5 mm channel section at 1.82 to 2.40 m interval with double coat oil paint.

For this work, ISI marked G.I. pipes of dia 25 cm of class-B shall be used. Vertical posts shall be M.S. angle 75 mm x 40 mm x 5 mm of approved quality and shall be provided at 1.82 to 2.40 mt. c/c. Vertical height of posts from finished platform surface shall be 1.15 m. Three rows of G.I. pipes shall be provided by making holes of appropriate size in the vertical posts. For vertical posts, M.S. plates of size & thickness as directed shall be provided in the fresh concrete with holdfast. Post shall be welded to the plate.
All metal sections shall be finished with single coat of primer and two coats of paint of approved quality.
The rate shall be for a unit of one running meter.

Item No.

21) Plastic Emulsion Paint (Two coats) (Asian Paint, ICI, Dulux,Nerolac, Berger etc. of approved type) (with prime coat).

The relevant part of technical specifications as laid down under section-3 of this volume.
The rate shall be for a unit of one square meter.

Item No.

22) Providing and applying Apex paint of approved quality in two coats including primer coat as per directed by Engineer-In-Charge

The paint shall be of approved quality as suggested by engineer in charge.
The relevant part of technical specifications as laid down under section-3 of this volume.
The rate shall be for a unit of one square meter.

Item No.

23) Providing, lowering, laying, and jointing ISI marked R.C..C pipes NP-3 class for Incoming and By-pass sewer line of 600mm dia with socket and spigot with rubber ring joints including all taxes, insurances , transportation , freight charges, octroi, inspection charges, loading, unloading, conveyance , stacking etc complete (Is : 458-2003)

Supply of RCC Pipes:-

For supply of RCC pipes, all the specifications mentioned in the IS Code 458:2003 and its latest revised edition shall be followed. This standard covers the requirements for reinforced precast cement concrete pipe.

Testing of RCC Pipes:

For testing of RCC pipes, all the specifications mentioned in the IS Code 3597:1998 and its latest revised edition shall be followed.

Technical requirement and procedure adopted for lowering, laying and jointing of RCC & SWG pipes:

1 Sight Rails and Boning Staves:

1.1 In laying the pipe sewers and constructing drains, center for each manhole must be marked by a peg. Or Otherwise as may be determined by the Engineer-in-charge. The contractor shall then dig holes and set up two posts (about 100mm X
1800mm) at each manhole at nearly equal distance from the center of the manhole. The distance shall be such that they shall be well clear of all intended excavation. They shall be so arranged that a sight-rail when fixed level against the posts will cross the center of the manhole. The posts shall also be so set up that the longitudinal direction of the rail may be as clear as possible to the direction of any of the lines pipes or drains converging to the manhole. If walls of buildings afford suitable means of fixing the sight-rail the post may be dispensed with. The sight-rail, must not in any

case be more than 30 M apart. If intermediate rails between two manholes be found necessary, the same shall be put up.

1.2 Construction of boning staves:

Boning staves shall be prepared by the Contractor about 75mm X 50mm of various lengths, each length being of a certain number of meter and with a fixed tee-head and fixed intermediate cross piece, each about 300mm long. The top-edge of the cross piece must be fixed at a distance below the top-edge of this tee-head, equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid. The boning staff must be marked on both sides to indicate its full length. According to the requirements of each case, a suitable length of boning staff will be fixed and the reduced level of the bed of the pip or bottom of concrete of drain at each sight-rail place added to the selected length of boning staff, and marked by a horizontal line in both posts, or on walls or fences to which the sight-rail is to be fixed.

1.3 Sight Rails:

The sight rails (about 25 mm wide and 40 mm thick) are to be screwed with the top-edge against the level marks. The center line of the pipe sewer or the drain will be marked on the rail and this mark will denote also the meeting point of the center of any converging drains or pipe sewers. Line drawn from the top-edge on rail to the top-edge of the next will be vertically parallel with the bed of the sewer or drain at any intermediate point. This could be easily determined by letting down the selected boning staff until the tee-head comes in the line of sight from rail to rail.

The posts and rail are to be perfectly square and planned smooth on all sided and edges. The rails are to be painted write on both sides, and the teak-hands and cross pieces of the boning staves are to be painted black. If the pipes or domains converging to a manhole come at different level there must be a rail fixed for every different level. When rail comes within 1.6 M of the surface of the ground a higher sight-rail shall be fixed for use with the rail over the next point. Posts and rails shall in no case be removed until the trench is excavated. The drains are constructed, the pipes are laid and permission given to proceed with the filling in.

2 LOWERING LAYING AND JOINTING OF PIPES:

2.1 Contractor to obtain permission before laying pipe, concrete or Construction of masonry:

When any portion of the excavation shall have been carried out to the necessary depth, the contractor shall obtain permission in the Engineer-in-charge before commencing the work of laying of pipes or concrete or the construction of masonry. No sewer pipe shall be allowed to be laid over and parallel to the water supply pipeline. Sewer line shall be laid below the water supply pipeline irrespective of the size of the pipeline.

2.2 Handing of pipes:

At every point of loading or unloading, pipes or fittings shall be handled by approved lifting tackle. Unloading by rolling down planks or any other form of inclined ramp shall not be allowed unless the written approval of the Engineer-in-charge is obtained regarding the same. Pipes shall be carefully stacked on site with timber packing under and between the pipes without causing nuisance or obstructions to traffic of walkway.

2.3 Laying:

The pipes shall be laid up the gradient beginning at the lowest end. No pipe shall be laid until the trench has been excavated to its required depth for a distance of 20 M in front of the pipe to be laid (This distance may vary as directed by the Engineer-in-charge). All the pipes shall be laid perfectly true, both in line and in gradient. The pipes in a trench shall be all laid and fitted previous to the jointing being commenced properly fitted temporary wooden stoppers shall be provided and constantly added to close the ends of all in-

completed pipelines. The stoppers are to be removed only when pipes are laid and jointed.

2.4 Jointing of stoneware glazed with Socket and Spigot Joints:

The laying and jointing of pipes shall conform to IS : 4127 (1967) The pipes shall have socket and spigot joints. The trench shall be checked for proper level, gradient and alignment before lowering the pipes. The laying of the pipes shall properly up-grade of slopes. The socket end shall always be facing the up-stream end of the trench.

All joints shall be filled up with hemp yarn dipped in sufficient quantity of cement slurry, cement mortar 1:1 shall be forced into joint by using cocking tools etc as directed by Engineer-In-Charge until the whole space around the spigot between it and the spigot is full so as to form a neat fillet round the pipe.

The cement mortar joints shall be cured at least for seven days.

2.5 Jointing of RCC pipe with Socket and Spigot Joints:

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings as specified in IS-458-2003, shall be used, and the manufacturer's instructions shall be deemed to form a part of these specifications.

The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

Socket & Spigot NP3 & NP4 pipe with rubber ring roll on joint for diameter upto 900 mm should be provided as per table 14 of IS 458: 2003. Socket & spigot NP3 & NP4 pipe with rubber ring confined joint for diameter 1000mm to 2600 mm should be provided as per Table -17 of IS 458:2003.

2.6 All works to be Water Tight:

The drains, manholes and all joints of pipes shall be made thoroughly sound and water tight and any joint which may be observed to be leaky at any time during the progress of the works or during the contractor's subsequent period of maintenance shall be immediately made good by the contractor at his own cost. The contractor at his own cost shall have to carry out satisfactory flow test as directed by the Engineer-In-Charge. In case of any dispute in this regard, the decision of Engineer-In-Charge shall be final and binding to the contractor.

2.7 Inspection of joints:

After the joints of any pipes in under ground work have thoroughly set the Engineer-in-charge (or any person whom he may appoint) may inspect the joints and if he has any doubt as to their soundness he may request the contractor to open out and clean the cement. Contractor shall not be required to open more than one joint in 20 M of pipe. However, if the defect is found, the Engineer-in-charge may direct him to open as many joints as he may deem necessary.

2.8 Cleansing of the pipes:

As soon as a stretch of pipeline whether of stoneware or cast iron or RCC pipes has been completed between two manhole, the contractor shall run through the pipes both backwards and forwards a double disc / solid / closed cylinder 75mm less in dia, than the internal dia of the pipes wherever required and suggested by the Engineer-In-Charge. The open end should be closed as may be directed by the Engineer-in-charge to prevent, entry of mud or silt etc. If as a result of the removal of any obstruction in the pipe line the Engineer-in-charge considers that damages may have been caused to the pipeline, he shall be competent to order the length to be tested at the expense of the contractor. Should such retest prove unsatisfactory the Contractor shall at his own expense amend the work and

carry out such further tests as may be required by the Engineer-in-charge. It shall also be ascertained by the Contractor that each stretch from manhole to manhole is absolutely clean and without any obstruction by means of visual examination of the interior of the pipeline suitable illuminated by projecting sunlight or artificial light.

2.9. Cracks in Pipes:

In the event of pipes being cracked after being properly laid either due to improper loads having been encountered or the material of refilling having been improperly selected or because of any other cause, the Contractor in every case shall be held responsible and will be called upon to replace such cracked pipes at his own cost during the expiration of period of maintenance.

Any pipe or length of pipes found to be defective shall be immediately removed and replaced at the Contractor's expense and leaking joints shall be remade. The inspections and tests shall them be repeated as often as necessary until the whole line under inspection or tests is accepted by the Engineer-in-charge.

2.10 All works to be clear, clean and perfect:

The contractor shall after completion or whenever required by the Engineer-in-charge, prove all pipes and fittings to be clear and perfect, for this purpose he shall at his own expense and in the presence of the Engineer-in-charge or his appointee, provide suitable instruments and appliances and pass them through the pipes and if required shall pass water and show that it passes freely through every portion of the work. Brick mortar and rubbish shall not be allowed to fall into the manholes of sewer lines while fixing or if fallen shall be removed by the Contractor at his own expense.

2.11 Pipe entering and leaving manholes :

Whenever a pipe enters or leaves manhole, the ends of all pipes shall be properly built-in and neatly finished with cement mortar. The pipe projections are to be cut so that the ends are flush with plastered surface of the manhole, nothing extra shall be paid for this. The rate of pipe laying includes this work also.

2.12 Fittings:

The terms fittings as used in this specification is intended to apply to any and every article used in combination with straight pipe itself.

In the areas subject to subsidence, the pipe sewer should be laid on suitable supports or concrete cradle supported on piles.

2.13 Measurement of pipe lines:

All pipelines shall be measured according to the work actually done and no allowance shall be made for sockets and any wastage in cutting to the exact length required. A bend, junction, or any other piece of fitting which may have necessarily been out for the exigencies of the work will be taken into account as if whole, provided that the cutting has been done properly and that portion used in the work is sound. This clause shall not apply to a straight pipe under any circumstances. In measuring the lengths of pipes laid, deductions shall be made for the lengths of channels between the inside faces of the walls of manholes.

The rate shall be for a unit of one running meter.

Item No.

24) Supply, erection, testing and commissioning cast iron sluice gate confirming to IS : 13349, wall thimble mounted, manually operated with required head etc complete in all respects as directed by Engineer-in-charge. (sluice gate for 600 mm dia circular opening or 600 mm x 600 mm square opening).

Thimble Mounted MANUALLY operated, FLANGE back frame cast iron sluice gate as per IS : 13349-1992 .

The Construction of sluice gate shall be in an accordance with the specification and as per IS : 13349-1992. The sluice gate shall be capable of performing the duties set out in this specification without undue wear or deterioration; they shall be constructed, so that maintenance is kept to a minimum. The sluice gate shall be rising spindle type. The item includes supply, erection, testing and commissioning of gate, along with breaking and reconstruction of R.C.C. wall / slab etc. as per site requirement and make it finish without any extra cost.

DETAILS OF CAST IRON SINGLE FACE THIMBLE MOUNTED SLUICE GATE.

1.	I.S. :	13349-1992.
2.	Size and Shape of water way opening	: 600 mm x600 mm –Square or . 600 mm dia circular
3.	Operating head a. Seating head & Unseating head	: As per design
	b. Seating head & Unseating head	: As per design

As per 350 mm size

4. Distance between centreline of water way to base of operating Platform: As pet site requirement

5. Method of operation : Ungeared manually Operated

6. Length and shape of wall thimble : As per site requirement.

7. Operating torque : As mentioned in IS :13349-1992.

8. Stem : Rising type.

9. Type of closure : Flush bottom.

10. Types of mounting : Mounting on face of wall through C.I. wall thimble.

11. Lift Mechanism : Ungear headstock, Indicator on C.I. head stock to be provided as per gate travel

12. Stem Guide : Adjustable type

13. Pipe Hood : Steel / polycarbonate material

14. Gate Opening : Providing a scale with 1 cm graduation with steel stem cover.

15. The seating face : The maximum clearance between the seating surface with the slide in the closed position shall not exceed 0.10 mm. The seating face should be fitted in dove-tailed machined grooves.

16.Test to be conducted :

SHOP TESTING : Following shop tests at manufacturers place will be conducted.

a)	Movement Test	Test Movement test should be conducted in horizontal /vertical assembled condition using stems & headstock. The gate should be operated once from full close to full open and back to full close condition with a max. force of 135 Newton-meter on the crank or hand wheel.
	Shop leakage test	Shop leakage test by applying unseating hydraulic pressure will be conducted at manufacturer's shop. A hydrostatic pressure equal to maximum seating/unseating head shall be applied to gate at centre line of gate opening from the back, ie. Unseating face of the gate in closed position, through pump. A suitable scaled calibrated pressure gauge put on the unseating face of the gate shall indicate reading equal to unseating pressure head. Water leakage through the gate under above condition shall be collected in a collection pan and measured. The leakage so measured should not exceed the limit of 2.5, 3.5 and 4.5 lpm per meter sealing perimeter for class-1, class II and class III sluice gates as stated in the IS:13349-1992. No alternate testing arrangement will be permitted in place of above method. Gates can be applied with a coat of primer to prevent rusting due to water exposure during testing.
b)	Hydrostatic Body	Body test After the leakage test Hydrostatic body test will be conducted at manufacturer's shop. A hydrostatic pressure equal to 1.5 times the maximum operating head should be applied on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.
c)	Torque test at operating Head	Torque test at operating head would be conducted at applicable head at manufacturer's shop for gates up to 2000x2000mm size
d)	Dimensional Check	Important D i m e n s i o n s shall be checked with reference to approved GA drawing.
e)	Seat clearance	With the gate in closed condition 0.1 mm thick feeler gauge should not pass through between seat facings.
f)	Material Test Certificates	Certificates Material tests certificates for all important components of gates such as Thimble, Frame, Shutter , Seat facings, Spindle, & Rubber seals etc. to be furnished at the time of inspection.

17. Fluid flowing : Raw sewage.

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

19. Make : IVC / IVI/ JASH / KIRLOSKAR OR Equivalent as approved by Engineer-in- charge

MATERIAL OF CONSTRUCTION

The materials of construction of important components of gates will be as under:

a)	Frame & Shutter Cast Iron	IS: 210 Gr. FG 200
b)	Wall Thimble Cast Iron	IS: 210 Gr. FG 200
c)	Seating Faces & Counter Sunk	Stainless Steel ASTM A240 type
d)	Wedging Device Cast Iron	IS: 210 Gr. FG 200
e)	Wedge Linings Stainless Steel	ASTM A240 type 304
f)	Stem, & Stem Coupling Stainless	ASTM A276 type 304
g)	Stem Nut Stainless Steel	ASTM A240 type 304
h)	Fasteners, Studs Anchor Bolt & Nuts Stainless Steel	ASTM A276 type 304
i)	Lift Nut Leaded Tin Bronze	IS: 318 Type LTB-2
j)	Stem Guide, Pillar, Lift Mechanism	CI IS: 210 Gr. FG 200
k)	Stem Guide Bracket	Structural steel
l)	Hand wheel	Mild Steel IS: 2062 with C.I.Hub
m)	Painting	Epoxy Paint

The unit rate shall be for a unit of one Number.

Item No.

25) Providing and fixing ISI marked 110 mm dia PVC pipe 4 kg/cm2 with couplers and necessary fittings etc. comp

AND

26) ……Do….. 63.00 mm dia PVC pipe

1.0Material

The low density polythene pipe of specified diameter with 4 kg/sq.cm working pressure shall conform to I S 3076-Latest Edition. The specifidals and fittings required shall be of best quality.

2.0Workmanship

The PVC pipes of specified diameter shall be fixed as directed. Due to thermal expansion of rigid PVC pipes, due allowance shall be made particularly in over ground pipelines for any change in length of pipeline which may occur during installation or when pipeline is in service.

Above ground installation of rigid PVC pipe should be undertaken after preparations are observed for their protection against direct sun rays and mechanical damage.

The rigid PVC pipe lines should not be kept exposed above ground when it passes through public places, railway lines, road side and footpaths.

PVC pipes shall be supported at the following intervals.

20 mm dia 500 mm 25 mm dia 750 mm 32 mm dia 900 mm

Close support spacing shall be provided if recommended by the manufacturer.
The guidelines indicated by the manufacturer regarding handling, transportation, storing, laying and jointing of pipes shall be kept in view during execution.

PVC pipes shall be fixed on wall with wooden plugs and suitable plastic clamps.

Jointing the Pipes:

The pipes and sockets shall be accurately cut. The ends of the pipes and fittings should be absolutely free from dirt and dust. The outside surface of the pipes and the inside of the fittings shall then be roughened with emery paper, and then solvent cement joint. Since solvent cement is aggressive to PVC care must be taken to avoid applying excessive cement to the inside of pipe sockets as any surplus cement cannot be wiped off after jointing. Empty solvent cement tins, brushes, rags, or paper unpregnated with cement should not be buried in the trenches. they should be gathered not left scattered about, as they can prove to be a hazard to animals, which may chew them.

If any manufacturer recommends its own methods of jointing the same shall be adopted after necessary approval from the engineer-in-charge.

Laying of pipes in trenches:
The pipes shall be laid over uniform relatively soft fine grained soil found to be free of presence of hard objects such as large flints, rocky projections, large tree roots etc. The width of the trenches shall be minimum width required for working.

The pipes laid underground shall not be less than one meter from the ground level. The pipe shall be positioned in the trenches so as to avoid any induced stressed due to deflection. Any deviation required shall be obtained by using proper type of rubber ring joints.

Mode of measurements and payment
The relevant specifications of item 2.32(A) shall be followed except that the PVC pipes of specified dia shall be paid under this item.

The unit rate shall be for a unit of one running meter.

Item No.

27) Providing, lowering, laying, and jointing ISI marked stone ware glazed pipe 100 mm dia in C:M 1:1 proportion with necessary specials, jointing materials etc complete.

Supply and testing stoneware glazed pipes:
For supply and testing of stoneware glazed pipes, all the specifications mentioned in the I S Code 651:2007 and its latest revised edition shall be followed. This standard covers the requirements for stoneware glazed pipes.
The relevant part of technical specifications for lowering, laying and jointing of SWG pipes shall be as mentioned in of RCC pipes. The rate shall be for a unit of one Running meter.

Item No.

28) Rubble masonry in foundation in C:M 1:6 with curing etc complete.

AND

29) Rubble masonry in plinth in C:M 1:6 with curing etc complete.
The relevant part of technical specifications as laid down under sections-3 of this volume.
The rate shall be for a unit of one cubic meter.

Item No.

30) Providing and fixing glaze tiles of approved 1st quality with cement slurry and filling joints with white cement including 12 mm. thick rough cast plaster in CM 1:3 etc complete.
The relevant part of technical specifications as laid down under sections-3 of this volume.
The rate shall be for a unit of one square meter.

Item No.

31) Providing and fixing standard size white porcelain Orissa Type Water Closet.

And

Item No.

32) Providing and fixing white glazed P-trap of approved quality.

Material:
The specifications of Orissa type white glazed water closet of first quality shall confirm to I S 2556 (Part-III):1981. Pan shall be with the integral squatting pan of size 580 x 440 mm with raised foot rest. Each pan shall have integral flushing. It shall also have an inlet at back or front for connecting flush pipe as directed. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and surface shall be uniform and smooth. Pan shall be provided with 100 mm dia. "P" or "S" trap approximately 50 mm water seal and 50 mm dia. vent horn.

Workmanship:
The pan shall be sunk into the floor and embedded in a cushion of average 15 cm

concrete 1:5:10 or as specified. This concrete shall be left 115 mm below the top of the pan so as to allow for flooring and its bed concrete. The floor should be suitably sloped so that the water is drained in to the pan. The pan shall be provided with 100 mm "P" or "S" trap with approximately 50 mm seal. The joints between the pan and the trap shall be made leak proof with cement mortar 1:1.
The rate shall be for a unit of one number.
The "P" or "S" trap shall be paid separately for a unit of one number.

Item No.
33) Providing and fixing stoneware gully-trap of approved quality with C.I. Jali etc complete. MATERIALS

Gully Trap:
The gully trap shall conform to IS: latest edition. It shall be sound, free from defects such as fire cracks or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.

The size of the gully trap shall be as specified in the item.

Each gully trap shall have one C.I. grating of square size correspodning to the dimensions, of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimension 300 mm x 300 mm. The cover with frame inside dimensions 300 mm x 300 mm the cover weighing not less than 4.53 kg and the frame not less than 2.72 kg. The grating cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

WORKMANSHIP
Excavation for gulley trap shall be done true to dimensions and levels as indicated on plans or as directed.

FIXING
The gulley trap shall be fixed over cement concrete 1:5:10 (1 Cement: 5 Sand: 10 Graded brick bats aggregate 40 mm. nominal size) foundation 650 mm. square and 100 mm. thick. The depth of top of concrete below the ground level shall be 675 mm. The jointing of gulley outlet to the branch drawing shall be done similar to jointing of S.W. pipe as described in Item I.1.

BRICK MASONARY CHAMBER
After fixing and testing gulley and branch drawing a brick masonry 300 x 300 mm. inside with bricks in C.M. 1:5 (1 Cement: 5 Sand) shall be built with a 100 mm. brick work round the gulley trap from the top of bad concrete up to ground level. The space between the chamber walls and the trap shall be filled with cement concrete 1:5:10. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 Cement: 3 Sand) finished with floating coat of neat cement. The corners and bottom of the chamber shall be rounded of so as to slope towards the grating.

C.I. cover with frame 300 mm x 300 mm (inside) size shall than be fixed on the top of the brick masonry with C.C. 1:2:4 (1 Cement: 2 Coarse Sand: 4 Graded stone aggregate 20 mm. nominal size) 40 mm. thick and rendered smooth. The finished top of the cover shall be left about 40 mm., above the adjoining ground level so as to exclude the surface water from entering the gully trap.
The rate shall be for a unit of one number.

Item No.
34) Providing and fixing 7.6 cm size C.I. Nahni-trap of approved quality.
1. 0 MATERIAL

1.0 Nahni trap

1.1. Nahni Trap shall be of cast iron and shall be sound and free from porosity or any defects which affect serviceability. The thickness of the base metal shall not be

less then 6.5 mm. The surface shall be smooth and free from sraze. chips and other flaws or any other kind of defect which affect serviceability. The size of Nahni trap shall be specified and shall be of self cleaning design.

1.2 The Nahni trap shall be of quality approved by Engineer in charge and shall generally conform to the relevant Indian standard

1.3 The Nahni trap provided shall be with deep seal. Minimum 50 mm expect at places where trap with deep seal can not be accommodated. The cover shall be cast iron perforated cover shall be provided on the trap of appropriate size as approved by Engineer in charge.

1.4 The Nahni trap supplied on site shall be in good condition without any damages in it and the surface shall be bright and smooth without any scratch etc.

2.0. WORKMANSHIP FITTING & FIXING

2.1. When the Nahni traps are to be fitted, the ends shall be carefully filed out so that no obstruction to bore in offered. The Nahni trap shall be fitted with pipes carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together

2.2 In jointing the Nahni trap the inside of the socket. The end shall then be tightly fixed in the socket, when Nahni trap is feted with a pipe wrench Care shall be taken that all items are free from dust, dirt and rust during fixing Burr from the joints shall be removed after fixing. After fixing, the open ends of the Nahni trap shall be temporarily plugged to prevent excess of water soil or any other foreign matter.

TESTING OF JOINTS

After fitting, the Nahni traps shall be inspected under working conditions of pressure and flow. Any joints found liken shall be redone, and all leaking Nahni traps shall be removed and replaced without extra cost.

The Nahni traps shall be tested in sections as the work laying proceeds, veeping the joints exposed for inspection during the testing.

3.0 MODE OF MEASUREMENT & PAYMENT :

3.1. The unit rate of Nahni trap shall include the cost of all materials, tools and plant required for fitting, the same to specified position as per drawings, and as directed by Engineer in charge finishing structure, etc, and all other incidental expenses for producing item of Nahni trap work to complete the structure or its components as shown on the drawings, and as directed by Engineer in charge and according to these specifications. They shall also include the cost of making, fixing and removing of all scaffolding and forms required for the work.

The rate of Nahni traps shall include the cost of all labour, materials, G I fittings as required, tools and plant scaffolding and all incidental expenses as described herein above.

3.2. The Nahni trap shall be measured for its **Number**, limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one Number.

3.3. The payment will be made on number basis of the finished work.

Item No.

35) Providing and fixing Chromium plated brass flushing valve of approved quality.

1. 0 MATERIAL Flush cock

1.1. Flush cock of specified 25 mm diameter nominal bore The Flush cock shall be best Indian make and quality of heavy Wight and shall be half turn flush cock as

approved by Engineer in charge. The Flush cock shall conform to relative Indian standard.

1.2 Flush cock shall be chromium polished of best quality as approved by Engineer in charge.

1.3 A Flush cock is a draw off tap with a horizontal inlet and outlet. A stop cock is a valve with a suitable means of connection of insertion in a pipe line for controlling or stopping the flow.

1.4 They shall be Half turn type and or brass chromium plated and of diameter as specified in the description of the item. They shall conform to I.S 781-1977 and they shall be of best Indian make. They shall be polished bright. The Flush cock supplied on side shall be in good condition without any damages in it and the surface shall be bright and smooth without any scratch etc.

1.5 The Necessary galvanized fittings like Nipple, Casing etc, of best quality and makes as approved by the Engineer-in-charge required for specified dia. bore Flush cock shall be used for fitting Flush cock as necessary .

2.0. WORKMANSHIP

Curing, Laying & Jointing

2.1. When the Flush cocks are to be fitted, the ends shall be carefully filed out so that no obstruction to bore in offered. The Flush cock shall be fitted with pipes carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together

2.2 In jointing the Flush cock the inside of the socket and the screwed end of the Flush cock shall be oiled and smeared with the white or red lead and wrapping around with a few turns of fine spun yarn round the screwed end of the Flush cock. The end shall then be tightly screwed in the socket, Tees etc with a pipe wrench Care shall be taken that all items are free from dust, dirt and rust during fixing Burr from the joints shall be removed after screwing After laying the open ends of the Flush cock shall be temporarily plugged to prevent excess of water soil or any other foreign matter.

2.3. Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anti corrosive paint to prevent corrosion

TESTING OF JOINTS

After fitting, the Flush cocks shall be inspected under working conditions of pressure and flow. Any joints found liken shall be redone, and all leaking Flush cocks shall be removed and replaced without extra cost.

The Flush cocks after they are fitted shall be tested to hydraulic pressure of 6 kg / sq. cm. The Flush cock shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock and water hammer. The draw off takes and stop cock shall then be closed and specified hydraulic pressure shall be applied gradually. The Flush cocks shall be tested in sections as the work laying proceeds, veeping the joints exposed for inspection during the testing.

3.0 MODE OF MEASUREMENT & PAYMENT :

3.1. The unit rate of Flush cock shall include the cost of all materials, tools and plant required for fitting, the same to specified position as per drawings, and as directed by Engineer in charge finishing structure, etc, and all other incidental expenses for producing Flush cock work to complete the structure or its components as shown on the drawings, and as directed by Engineer in chargeand according to these specifications. They shall also include the cost of making, fixing and removing of all scaffolding and forms required for the work.

The rate of Flush cocks shall include the cost of all labour, materials, G I fittings as required, tools and plant scaffolding and all incidental expenses as described herein above.

3.2. The Flush cock shall be measured for its **Number**, limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one Number.

3.3. The payment will be made on number basis of the finished work.

Item No.

36) Providing and fixing ISI marked 25 mm dia brass wheel valve of approved quality.

MATERIALS

The brass check or non return valve shall be fully cleared of all foreign matter before fixing. The fixing of valve shall be done by means of bolts nuts and 3 mm. rubber insertions with flanges of spigot and socketed till pieces, drilled to the same specification as in case of socket and spigot and with flanges in case of flanged pipes. The jointing small be done leak proof.

The ISI Marked Brass full way wheel valve of 25 mm dia shall have to fitted as per instructions of engineer-in-charge.

The rate for this work will paid per Number basis.

Item No.

37) Providing and fixing 15 mm dia brass cock/stop cock of approved quality.

MATERIALS

15 mm dia. brass chromium plated polished finish. The bib cock shall be best Indian make and quality.

WORKMANSHIP

Brass chromium plated bib cock 15 mm dia. as specified above shall be fixed as directed. The threaded portion shall be smeared with white or red-lead and around with a few turns of fine spun yarn round the screwed end of the pipe. The bib cock shall be than screwed and fixed to water tight position.

The rate shall be for a unit of one number.

Item No.

38) Providing and fixing standard size white porcelain urinal pan with waste pipe etc complete.

Material:

The white earthenware flat back or corner type urinal of size 430 mm, 260 mm x 350 mm. The lipped type urinal shall conform to I.S. 771-1979. The flat back or corner type urinal must be of 1st quality free from any defects, cracks etc.

Workmanship:

The urinal shall be fixed in position by using wooden plugs and screws and shall be at height 65 ms. from the floor level to the top of the lip or urinal, unless otherwise ducted. The wooden plugs shall be 50 mm x 50 mm at base tapering to 38 mm at top and 50 mm in length shall be fixed in wall in cement mortar 1:3 (1-cement : 3-coarse sand). The urinals shall be connected to 32 mm galvanizedmild steel waste pipe, which shall discharge in the channel or floor trap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white clad mixed with chpped hemp.

The rate shall be for a unit of one number.

Item No.

39) Providing and fixing Indian make white porcelain wash basin of size 560 x 410 mm with C.I. bracket, Chromium plated taps, plastic waste pipe, 12 mm pillar cock etc complete.

1.0: Materials :

1.1. The white glazed earthenware wash basin shall be 560 mm. x 410 mm. of 1st quality and make as approved by the Engineer-in-charge.

White glazed porcelain wash basin:

Wash basin shall be of white porcelain first quality best Indian make and it shall conform to IS: latest edition. The size of the wash basin shall be as specified in the item. Wash basin shall be of one piece construction with continued over flow arrangements. All internal angles shall be designed so as to facilitate cleaning. Wash basin shall have single tap hole or two holes as specified. Each basin shall have a circular waste hole which is either riveted or beveled internally with 65 mm diameter at top and 10 mm depth to suit the waste fitting. The necessary stud slot to receive the bracket on the under side of the basin shall be provided. Basin shall have an internal soap holder recess which shall fully drain into the bowl.

White glazed pedestal of the quality and color as that of the basin shall be provided where specified in the item. It shall be completely recessed at the back for reception of supply and wash pipe. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 750 mm to 800 mm as directed.

2.0. Workmanship :

2.1. The wash basin shall be fixed on the wall as and where directed. The wash basin shall be supported on a pair of R.S. or C.I. brackets fixed in C.M.1:3. (1 cement : 3 sand). The bracket shall conform to I.S. : latest edition. The wall plaster on the rear shall be cut to rest the top edge of the wash basin. After fixing the basin, plaster shall be made good and surface finished to match with the existing one. :

2.2. The bracket shall be painted white with ready-mixed paint.

2.3. The C.I. brass trap and union shall be connected to 32 mm. dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into an open drain leading to a gully trap. or direct in to the gully-trap on the ground floor and shall be connected to a waste pipe through a floor trap on the upper floors. C.P. brass trap and union may not be provided where the surface drain or a floor trap is placed directly under the basin and the waste is discharged into vertically.

2.4. The height of the front edge of the wash basin from the floor level shall be 80 cms.

2.5. The necessary inlet, outlet connections and fittings such as pillar cocks; CP Grass waste trap waste pipe, stop cock, chain wish rubber plug etc. shall be fixed.

2.6. The payment of fittings shall be made separately under separate items.

3.0: Mode of measurements & payment

3.1. The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item as specified in workmanship.

3.2. The rate shall be for a unit of one number.

Item No.

40) Providing and fixing uPVC pipes of Shedule-80 of any standard approved brand & quality with necessary fittings etc complete. -D- 15 mm Dia

41) ……Do….. 20 mm dia

42) ……Do….. 25 mm dia

FIXING OF THE TUBE FITTING TO WALL CEILING AND FLOORS

In case of fixing of tubes and fittings to the walls or ceilings, these shall run on the surface of the wall or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern; holder clamps keepings the pipes about 15 mm, clear of the wall. When it is found necessary to conceal the

pipes and when specified so, chasing may be adopted or pipe fixed in ducts or recesses etc. provided that there is sufficient space to work on the pipe with usual tools. The pipe shall not ordinarily be buried in walls or solid floors, where unavoidable, pipes may be buried for short distances provided that adequate protection is given against damages and where so require joints are not buries. Where required M.S. tube sleeve shall be fixed at a place a pipe is passing through a wall or floor for expansion and contraction and other movements. In case the pipe is embedded in walls or floors, it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with time mortar or lime concrete as the pipe is affected by lime. Under the floors, the pipe shall be laid in layer of sand filling.

All pipes and fittings shall be fixed truly vertical horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern clamps of required size and shape, one end of which shall be properly plugged or cemented into walls with cement mortar 1:3 (1 Cement: 3 coarse sand) and the other tighten round the pipes to hold it security. These clamps shall be spaced at regular intervals in straight length at 2 M C/C interval in horizontal run and 2.5 M. interval in vertical run. For pipe of 15 mm. dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However for bigger diameter pipes, the holes shall be carefully made of the smallest required size. After fixing the pipe the holes shall be made good with cement mortar 1:3 (1 Cement: 3 Coarse sand) and properly finished to match the adjacent surface.

TESTING OF JOINTS

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone, and all leaking pipes removed and replaced without extra cost.

The pipes and fittings as they are laid shall be tested to hydraulic pressure of 6 Kg / Sq. cm. The pipe shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock, and water hammer. The draw off takes and stop cock shall then be closed and specified hydraulic pressure shall be applied gradually. The pressure gauge must be accurate. The pipes and fittings shall be tested in sections as the work of laying proceeds keeping the joints exposed for inspection during the testing.

Mode of Measurements & Payments:

The description of each item shall, unless otherwise stated, be held to include where necessary, conveyance, and delivery, handling, unloading, storing, fabrication, hoisting, all labour for finishing to required shape and size, setting, fitting in position, straight, cutting and waste, return of packings etc.
The length shall be measured on running meter basis of finished work. The length shall be taken along the centre line of the pipe and fittings. The pipes fixed to walls, ceiling, floors etc shall be measured and paid under this item.

All the work shall be measured in decimal system as fixed in its place, subject to tolerance given below unless otherwise stated.

i) Dimension shall be measured to the nearest 0.01 metre.
ii) Area shall be worked out to the nearest 0.01 sq.metre

All measurements of cutting shall unless otherwise stated be held to include the consequent waste.

In case of fitting of unequal bore, the largest bore shall be measured for the test. Testing of pipelines, fittings and joints include for providing all plant and appliances necessary for obtaining access to the work to be tested and carrying out the tests.

The rate includes uPVC pipes with screwed socket joints, together with all fittings (such as bends, sockets, springs, elbows, tees, crosses, short pieces, clamps and plugs unions etc.) and fixing complete with clamping wall- hooks, wooden plugs etc and also cutting, screwing and waste and for making forged (or hand made) bends on piping as required. Connector shall be inserted, where

required or directed. The rate also includes cutting through walls, floors etc and their making good and painting exposed threads with anti-corrosive paint as above and testing. Where tubes are to be fixed to wall, ceiling and flooring, the rate shall not include painting of pipes, providing sleeves and sand filling under floor for which separate payment shall be made.
The rate shall be for a unit of one running meter.

Item No.

43) Supplying rotationally molded HDPE storage tank, of 1000 litres capacity, with ISI mark of approved make including all taxes, transportation, octroi etc. complete Sintex type quality storage tank (With inside lining)

Overhead water tanks of "Sintex" or equivalent of cylindrical vertical tanks with closed top with of self-supported type having approved grade of polyethylene, molded to seamless and suitable for potable water tank of capacity 1000 Liter as per company's dimensions provided with G.I. fittings of size 25mm Dia for inlet, outlet, overflow and scour connections and float valves etc. complete placed with all fittings fixing as directed by engineer in charge.
The rate shall be for a unit of one number.

Item No.

44) Construction of Inspection Chamber of size 0.30 x 0.30 meter as per type design, up to 0.45 mt. depth with C.I. frame-cover including brick masonry in C:M 1:6, foundation C:C 1:3:6, benching, Coping C:C 1:1:2, inner and outer plaster in C:M 1:3 etc complete

Construction of inspection chamber shall be carried out as per given type design and instructions of engineer in charge.
The rate shall be for a unit of one number.

Item No.

45) Filling in Plinth with Murrum brought from outside in layers of 23 cm thickness including watering, ramming & consolidating etc. Complete
EARTH FILLING (EARTH BROUGHT FROM OUTSIDE)

If the earth has to be bought from outside of the site, the rate includes the purchase cost of the earth, loading and unloading, its carting from outside to site, octroi, levy royalty or any other form of taxes as per prevailing rules, screening if necessary, spreading in 150mm to 200mm (6" to 8") layers and watering, ramming and consolidating with 10 ton roller, if it not possible then through electric compactors of adequate capacity. Each layer prior to putting next layers as per the instruction of Engineer. The earth shall be got provided prior to bring on site. The earth shall be free from trees roots, weeds, big stones, and other objectionable materials liable to decay.
The rate shall be for a unit of one cubic meter.

Item No.

46) Removing Surplus earth and disposing it with in city limit including spreading as directed by Engineer In-Charge.

After refilling all surplus excavated stuff shall have to be carted by the contractor within RMC limit including loading, transporting, unloading, spreading etc complete as directed by the Engineer-In-Charge.
Measurement: - Removal of surplus material shall be measured in Cu.m. of surplus material removed and rate will be paid per Cu.M.

Item No.

47) Anchor bars below RCC Raft slab including drilling of necessary size hole in dry or wet condition, grouting with chemical HILTI RE-500 OR EQUIVALENT in dry or wet condition, including epoxy coating, including random pull out test for 5% of total bars anchored as per drawing and instructions of Engineer-in-charge, (excluding cost of TMT bars)

Anchor bars for raft slab shall be provided after carrying out P.C.C. below the raft slab. Anchor bars shall be reinforcement bars of TMT Fe-415 or Fe-500 Grade and with diameter as specified in the drawings. Length of bars shall be length embedded in raft and PCC, as shown on the drawings, plus the length required to be embedded in the rock as per anchor grouting chemical manufacturer's specification and approved by engineer-in-charge.

To anchor a bar, bore hole of diameter and depth, as specified by the grouting chemical manufacturer and approved by the engineer-in-charge, shall be drilled and made clear using air blower. After drilling the hole, the same shall be plugged at top, until the anchor bar is grouted, to prevent the dust and other materials entering the hole. The depth of hole required shall be the depth in natural rock, measured from bottom of PCC. The holes shall be required to be drilled in dry or wet condition.

The anchor bar, as specified on the drawings, shall be grouted using Hilti RE-500 or equivalent grouting chemical as approved by the engineer-in-charge, following the grouting procedure as specified by the chemical manufacturer and approved by the engineer-in-charge. The anchor bar shall be required to be grouted with chemical for full hole depth up to top of PCC. The anchor grouting chemical should be compatible to be used in dry or wet condition and should give required pull out value, specified on the drawings, in dry or wet condition. After grouting the bar, the same shall be kept undisturbed for required chemical setting time, as specified by the manufacturer and approved by the engineer-in- charge. After the bar gets set, bar length of 25 to 50 mm, as specified by the engineer-in-charge, immediately above the PCC top, shall be painted with approved quality paint, as directed by the engineer-in-charge.

The bars shall first be anchored in straight length, without any 90 degree bend as shown on the drawing. Out of the total bars anchored, 5 % of the bars, randomly selected by the engineer-in-charge, shall be tested for pull out load. The test shall be carried out using the testing assembly as approved by the engineer-in-charge. All the bars should carry the pull out load as mentioned on the drawings. More then 90 % of the total bars tested should pass the test. In case of failure of anchor bars, more then 10 % of the total bars tested, to exhibit the required pull out load, Additional 5 % of the bars shall be tested and the procedure shall be repeated until the case when not more then 10 % of the tested bars fail the test. In case of such failures requiring more then or equal to 20 % of the total bars anchored to be tested, additional anchor bars, as decided by the engineer-in-charge, shall be required to be anchored and tested as above without any extra cost for these additional anchors.

After satisfactorily carrying out the pull out test, the bars shall be bend to required 90 degree bend as specified on the drawing.

The cost is for 1 No. of anchor bar of specified diameter, excluding the cost of reinforcement bar, which shall be paid extra, per MT, as per rates of item no. 5.

Item No.

48): RCC Pre-cast Jali of C.C. 1:2:4 reinforced with 1.6 mm Dia mild steel wire incl. Roughing, cleaning, fixing and finishing in C.M. 1:3 and curing etc. comp. of 5.0 cm. thick as per directed:

A. MATERIALS:

Water shall conform to S-1. Cement shall conform to S-3. Sand shall conform to S-6. Cement Mortar shall conform to S-11. Aggregate shall conform to S-12. Mild steel wire shall conform to S-20.

B. WORKMANSHIP:

It shall be of C.C. 1: 2: 4 (1 Cement: 2 Coarse Sand: 4 Graded stone aggregate of 6 mm nominal size), reinforced with 1.6 mm Dia mild steel wire unless otherwise specified. The thickness of Jali shall be as specified in the item. The Jali shall be set in position true to line and level before the jambs sills and soffits of the opening are plastered. It shall then be properly cemented with CM 1: 3 and rechecked for the levels. Finally, the jambs, sills and soffits shall be plastered gripping the Jali uniformly on all sides.

The rate shall be for a unit of one square meter.

Item No.

49 : Supply & Fixing of 80mm M-30 Grade cement concrete rubbermold Paving inter locking block (Grey colour) after 50 mm bedding of Bhogavo sand in line and CC on the edge in proportion of 1:2:4 with curing etc. complete

The rate shall be for a unit of one square meter.

Item No.

50 : Providing and constructing Sewer manholes as per the type design in brick masonry in C.M. 1:4 and inside and outside plastering in C.M. 1:3 necessary coping in C.C. M-25, fixing H.D.P.E. Steps and fixing manhole frame and covers (But excluding supply of manhole frame and covers) :

The said drainage manhole as per drainage type design is to carried out in brick masonry in CM 1:4 and CC in foundation in 1:3:6 including bedding, benching in 1:2:4 and the inside plaster work in niru finishing in CM 1:3 as per drainage drawing is to be carried out whereas the outer plaster in CM 1:3 is to be done with necessary fixing of HDPE reinforced plastic steps of size 385 x 165 x 0.25 mm as per given type design is to be done. Precast RCC manhole frame and cover is to be done 1:1.5:3 by filling coping and fixing work. The work shall be such that there shall not be no leakage in the manhole, in which, the rate for excavation shall be paid separately which is not included the prescribed rate. The frame and cover shall be provided by RMC Store and same shall have to be transported from Store to Site at the cost of contractor and fixing work is to be carried out accordingly, for which, the rate for only fixing work shall be paid.

The rate for manhole shall be for one number in which, the rate for frame and cover shall be paid separately where for additional depth, the rate shall be paid on one running meter basis as shown in Schedule of this tender.

THE MANHOLE AND DEPTH OF MANHOLES :-

The manholes on the sewers shall be constructed in the form and of the dimensions shown in the Drawing. The depth of the manholes shall be measured from the top of cover to the invert level of the manhole.

The manholes shall be constructed at places shown on the drawings or whatever directed by the Engineer. Type designs for these manholes are shown on the drawings but the actual type and dimensions shall in each case be determined by the Engineer as the circumstances may require.

CONSTRUCTION OF BRICK MASONRY MANHOLES :

The brick masonry shall be constructed as per the type design shown in the drawing enclosed. The various types of manholes to be adopted as per the requirement have been indicated in the L-section and sewer layout drawing in general. The manhole will be fitted with R.C.C. pre-cast medium or heavy duty manhole frame and cover as the case may be. The brick masonary manhole shall be plastered from inside and outside as shown in the drawing and as shown CM proportion and thickness.

FLOORS AND 0.80 ID CHANNEL PIPES :

The floor shall consist of cement concrete. Concrete of R.C. 0.80 ID channel pipes of the required size and curves shall be laid and bedded in cement on the concrete base to the same lines and fail as sewers unless otherwise directed. Both sides of the channel pipes shall be trenched up in concrete and rendered in cement mortar 20 mm thick and formed to a slope of not less than 1 in 12 to the channel.

STEPS :

Where the depth of the invert exceeds 0.90 M below the surface of the ground, HDPE reinforced steps of approved pattern shall be provided as per type design shown in manhole drawings.

RATE OF MANHOLES :
The rate for construction of manhole to be quoted in the bill of quantities shall include complete masonry, structure, concrete cap, plastering with cement from inside and outside, bottom concrete or channels including providing and fixing of HDPE reinforced steps and fixing of R.C.C. manhole frame & covers complete as per type design drawing and cutting the pipes flush with the inside plaster of the wall. The manholes will be paid per numbers up to the minimum depth shown in the type design and for depth beyond the specified minimum depth for a particular type of manhole, extra will be paid per running meter depth. The rates includes dewatering during all stages of construction.

The brick masonry will be paid per number excluding excavation but including masonry, bottom concrete, plastering, benching channel fixing of RCC frame and covers. (Refer R.M.C. DRG for H.C.1, H.C.2)

The rate for **Item No.50.1** shall be for a unit of one number whereas the rate for **Item No.50.2** shall be for a unit of running meter.

Item No.

51) PROVIDING & SUPPLYING RCC PRE-CAST M.H. FRAME & COVER & HOUSE CONNECTION CHAMBER FRAME AND COVER.

i) GENERAL :- The R.C.C. pre-cast manhole cover shall confirm to IS – 12592 / 2002 or its latest version and as per detailed Drawing attached herewith.

ii) SHAPES & DIMENSIONS :-
Shapes :- The shapes of pre-cast M.H. covers shall be circular only and 10 and 20 MT capacity for MHS and 5MT for HC chambers.

ii.a) DIMENSION & TOLERANCES: - length, breadth & diameter of pre-cast concrete manhole covers shall be such that the maximum clearance at top between the frame & the cover shall be 5mm. The minimum thickness of HD, MD & LD Covers shall be 90, 70 & 60 mm respectively.

ii.a.i) **GRADES AND TYPES:**
Manhole covers and frames shall be of the following four grades and types:

Grade	Grade Designation	Type/ Shape of Cover
Light Duty	LD-5	Rectangular, Square, Circular
Medium Duty	MD-10	Rectangular, Circular
Heavy Duty	HD-20	Rectangular (Scrapper Manhole), Square, Circular Lamphole
Extra Heavy Duty	EHD-35	Rectangular (Scrapper Manhole), Square and Circular

ii.a.ii) Recommended locations for placement of different grades and types/ shapes of manhole covers and frames are as given in ii.a.ii.a to ii.a.ii.c.

ii.a.ii.a) ***LD-5 Rectangular, Square or Circular Types***

Suitable for use within residential and institutional complexes / areas with pedestrian but occasional light motor vehicle traffic. These are also used for 'Inspection chambers'.

ii.a.ii.b) ***MD 10 Circular or Rectangular Types***
Suitable for use in service lanes / roads, on pavements for use under medium duty vehicular traffic including for car parking areas.

ii.a.ii.c) ***HD-20 Circular, Lamphole, Square or Rectangular (Scrapper Manhole)***

Types.

Suitable for use in institutional / commercial areas / carriageways / city trunk roads/ bus terminals with heavy duty vehicular traffic of wheel load between 50 to 100 kN, like buses, trucks and parking areas and where the manhole chambers are located in between the pavement and the middle of the road.

iii) SAMPLE:- The contractor shall get approved sample of R.C.C. pre-cast M.H. Cover & frame & house connection chamber frame and covers and shall supply materials as per approved samples from approved factory.

iv) TESTS: - The contractor / manufacturer at his own cost shall give all the required tests of RCC manhole cover and frame and all the testing facilities shall be kept open for the officers of RMC / Engineer-In-Charge at his factory.

v) RESPONSIBILITY: - The contractor shall be responsible for the materials for a period of defect liability period. After payment of final bill of the work and during this period he will be responsible for defects in the materials & for road accidents due to defective M.H. / H.C.C. Frame & covers. He shall have to replace defective materials during this period at his cost.

vi) LETTER OF COMMITMENT:- Contractor shall have to provide the letter of commitment in favour of Rajkot Municipal Corporation from the standard manufacturer of RCC Pre-cast M.H. / H.C.C. frame and covers to supply the desired quantity given in the e-Tender document in time (i.e. well in advance not to remain any manhole or chamber open at site of work after construction) with all quality control. Manufacturer shall have a long experience for preparing the RCC Pre-cast M.H. / H.C.C. frame and covers of all types i.e. HD, MD and LD as per the relevant I.S. Code of practice. A supply Schedule shall be submitted immediately on receipt of Work Order.

vii) R.C.C. MANHOLE COVERS AND FRAMES, FOLLOWING POINTS SHOULD BE CONSIDERED

Sr.	Particulars	Heavy duty manhole covers and frames	Medium duty manhole covers and frames	Light duty manhole covers and frames
1	Clear opening of the manhole	500 mm dia.	500 mm dia.	500 mm dia.
2	Type of the covers & frames	Circular	Circular	Circular

The Rate shall be paid per Number basis / pair basis.

MATERIAL:

2.1. Cement

Cement used for the manufacture of precast concrete manhole covers shall conform to IS:269 or IS:455 or IS:1489 (Part-1) or IS:1489 (Part-2) or IS:6909 or IS:8041 or IS:8043 or IS:8112 or IS:12330 or IS:12269.

2.2. Aggregates

The aggregates used shall be well graded. The nominal maximum size of coarse aggregate shall not exceed 20 mm. The aggregates shall be clean and free from deleterious matter and shall conform to the requirements of IS:383.

2.3 Concrete

The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combs, etc (See IS:456). The minimum cement content in the concrete shall be 360 kg/m^3, with a maximum water cement ratio of 0.45. Concrete weaker than grade M30 shall not be used. Compaction of concrete shall be done by machine vibration.

2.4. Reinforcement

The reinforcement steel shall conform to Grade A of IS 2062 or IS 432 (Part-1) or IS 432 (Part-2) or IS 1786.

2.4.1 Reinforcement shall be clean and free from loose mill scale, loose rust, mud, oil, grease or any other coating which may reduce or destroy the bond between concrete and steel. A slight film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.

2.5 Steel Fibers

The diameter / equivalent diameter of steel fibres where used, shall not be greater than 0.75 mm. The aspect ratio of the fibers (ratio of the length of the fibre to its diameter / equivalent diameter) shall be in the range of 50 to 80. The minimum volume of fibres shall be 0.5 percent of the volume of concrete.

In case of propriety fibres, manufacturer's recommendations shall be taken into account.

2.6. Admixtures

Where admixtures are used, they shall conform to IS 9103.

2.7. Water

The water used shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the units and shall conform to the requirements of IS 456.

2.8 SHAPES AND DIMENSIONS

2.8.1 Shapes

The pre-cast concrete manhole covers and frames shall be of any shape given in (ii.a.i)

2.8.2 Dimensions And Tolerances

The dimensions and tolerances on dimensions of frames shall be as shown in Table-1 but outside dimensions of cover at top shall match with the corresponding frame so that the maximum clearance at bottom between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and cover is in level within a tolerance of ±5 mm.

For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover (See Fig.1).

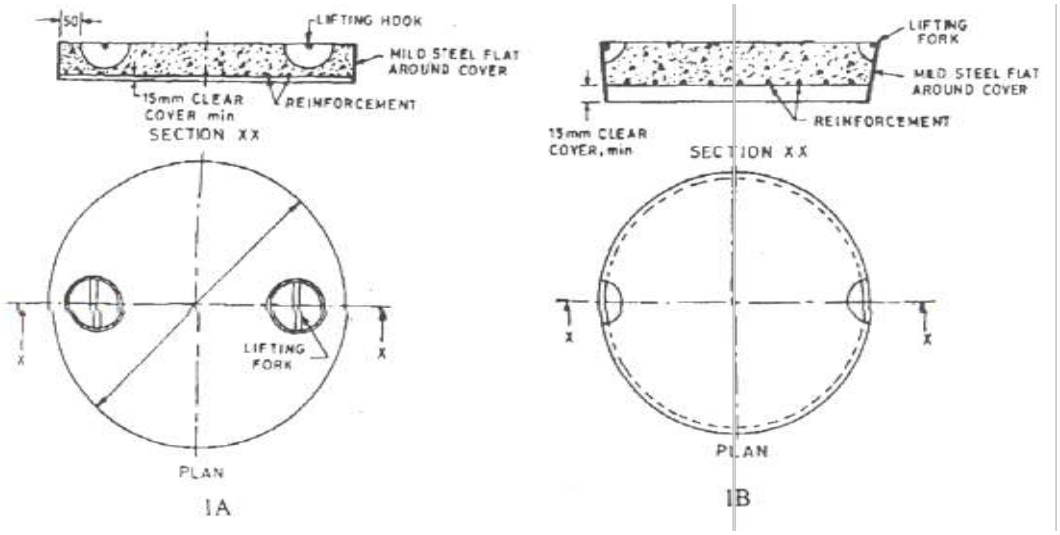


Fig.1 - Typical Illustration of Circular Precast Concrete Manhole Cover
All dimensions in millimeters

2.9 DESIGN:

The reinforced concrete manhole cover and frame shall be designed in accordance with the provisions of IS 456. If required by the purchaser, the manufacturer shall furnish the specification and drawings principle given in IS 456 may be followed.

2.10 MANUFACTURER

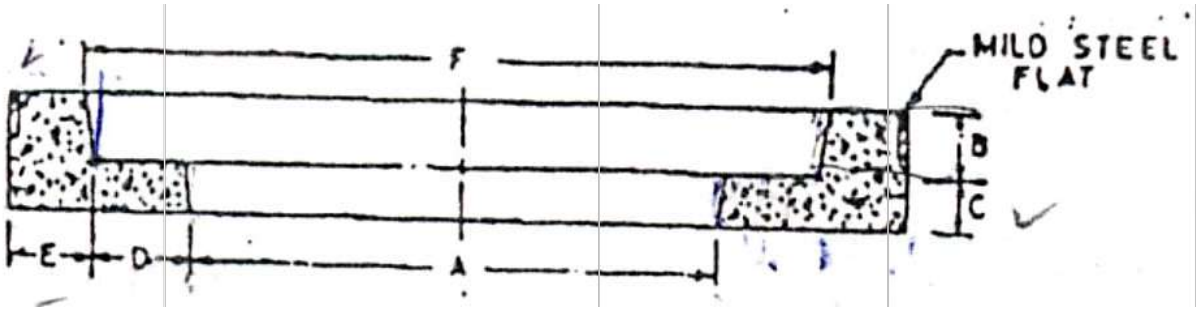
2.10.1 Mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. If steel fibres are used in addition to reinforcement, its shall be conformed to requirements given in 2.5.

2.10.2 Placing and Compaction

The reinforcement shall be placed in proper position in an appropriate mould coated with a thin layer of mould oil in case of frames and within the protective sheet (See 2 .12.1.) in case of covers. Concrete shall be filled to slightly overfill and compacted by vibration and struck off level with a trowel.

Table-1 - Dimensions of Frame
(Clause 2.8.2)
All dimensions in millimeters



Grade Designation	Description	Clear Opening in Frame	B	C	D	E	F
1	2	3	4	5	6	7	8
LD-5	Light Duty Rectangular	450 x 450	60	50	50	50	566
LD-5	Light Duty Square	450 x450 400 x400	50 50	50 50	50 50	50 50	566 x 566 516 x 516
LD-5	Light Duty Circular	370 560 500 450	50 50 50 50	50 50 50 50	50 50 50 50	50 50 50 50	486 676 616 566
MD-10	Medium Duty Rectangular	450 x 600	70	50	50	50	570 x 720
MD-10	Medium Duty Circular	450 500 560 600	70 70 70 70	50 50 50 50	50 50 50 50	50 50 50 50	570 620 680 720
HD-20	Heavy Duty Rectangular (Scrapper)	900 x 450	100	75	75	75	1080x 630
HD-20	Heavy Duty Square	560 x 560	100	75	75	75	740 x 740
HD-20	Heavy Duty Circular	450 500 560 600	90 90 90 90	75 75 75 75	75 75 75 75	75 75 75 75	630 680 740 780
HD-20	Heavy Duty Lamphole	350	100	75	75	75	530
EHD-35	Extra Heavy Duty Rectangular	900 x 560	100	75	75	75	1078x 738

EHD-35	Extra Heavy Duty Square	560 x 560	100	75	75	75	738 x 738
EHD-35	Extra Heavy Duty Circular	450 500 560 600	100 100 100 100	75 75 75 75	75 75 75 75	75 75 75 75	628 678 738 778

NOTES:

1. Tolerance on C shall be ± 5 mm, tolerance on A, B, D and E shall be +5mm 0 mm

2. For facility of removing the manhole cover suitable upward taper not more than 5^0 may be provided to the inner periphery of the frame.

3. If required for the removal of the moulds suitable taper not more than 5^0 can be given at the lower inner periphery of the frame (See figure).

2.10.2.1 Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommended since the holes left by the vibrator in the wet mix may not close after its removal owing to the interlocking of the fibres with the mix. Compaction by means of shutter or form or table vibrators is recommended. In case of extra heavy duty and heavy duty cover and frame, compaction by means of pressure-cum-vibration technique may also be employed so as to achieve dense and strong concrete.

2.10.2.2 Clear cover to reinforcement shall be not less than 15 mm.

2.10.2.3 After demoulding, cover and frame shall be protected until they are sufficiently hardened to permit handling without damage.

2.11 Curing

2.11.1.1 The hardened concrete manhole cover and frame shall be placed in a curing water tank. The period of curing shall be as given in IS456.

2.11.1.2 Steam curing of manhole cover and frames may be adopted instead of method specified in 2 .11.1.1 followed by normal curing for 7 days provided the requirements of pressure or non-pressure steam curing are fulfilled and the manhole cover and frames meet the requirements specified in this standard.

2.12 Edge Protection and Finishing

2.12.1 Cover

To prevent any possible damage from corrosion of reinforcing steel, the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.

In order to protect the edges of the covers from possible damage at the time of lifting and handling, it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anti- corrosive paint or coating.

2.12.2 Suitable arrangement may be made for fixing the manhole cover and frame in position on the manholes by mutual agreement between the manufacturer and the purchaser.

2.12.3 The manufacture of manhole cover and frame shall be such as to ensure the compatibility of their seatings. For classes HD 20 and HD 35, these seatings shall be manufactured in such a way as to ensure stability and quietness in use. This may be achieved by grinding the contact surface, if needed.

2.13 LIFTING HOOKS:

The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot dip galvanizing or any other suitable means approved by the purchaser or shall be made of naturally corrosion resistant metal rods.
The lifting arrangement shall be as agreed between the manufacturer and the purchaser. Typical arrangements of lifting devices are shown in Fig.1A and 1B.

2.14 PHYSICAL REQUIREMENTS:

2.14.1 General

All the covers and frames shall be sound and free from cracks and other defects which interferes with the proper placing of the unit or impair the strength or performance of the units. Minor chippings resulting from the customary method of handling and transportation shall not be deemed ground for rejection

2.14.2 Dimensions

The dimensions of the cover and frame shall be as specified in 2.8; the overall dimensions of the units shall be measured in accordance with Annexure-B.

2.14.3 Load Test

The breaking load of individual units when tested in accordance with the method described in Annex-C shall be not less than the values specified in Table-2. Also, the permanent set shall not exceed the requirement given in Annexure-C.

Table-2 - Test Load and Diameter of Block (Clause 2.14.3, 2.18.3 and C.1.1)

Grade of Cover	Type	Load kN	Diameter of Block mm
1	2	3	4
LD-5	Rectangular, Square or Circular	50	300
MD-10	Rectangular, or Circular	100	300
HD-20	Rectangular, Square or Circular	200	300
EHD-35	Rectangular, Square or Circular	350	300

2.15 TESTS

Tests shall be conducted on samples of covers and frames selected according to the sampling procedure given in 2.16, to ensure conformity with the physical requirements laid down in 2.14.

2.16 SAMPLING AND INSPECTION

2.16.1 Scale of Sampling

2.16.1.1 Lot

In any consignment, 500 precast concrete manhole covers and frames or a part thereof the same dimensions and belonging to the same batch of manufacture, shall be grouped together to constitute a lot.

2.16.1.2 For ascertaining the conformity of the materials in the lot to the requirements of this specification, samples shall be tested from each lot separately.

2.16.1.3 The number of covers and frames to be selected from the lot shall depend on the size of the lot and shall be according to Table-3

Table 3 - Scale of Sampling and Permissible Number of Defectives (Clause 2.16.1.3, 2.17.2. and 2.18.2)

No.of covers or frames in the lot.	Dimensional Requirements		Number of samples for load test on cover only
	Sample size	Acceptance Number	
1	2	3	4
Upto 100	10	1	2
101 to 200	15	1	3
201 to 300	20	2	4
301 to 500	30	3	5

Note:

If the number of covers in the lot is 20 or less, the number of samples for load test shall be decided by mutual agreement between the purchaser and the manufacturer.

2.16.2 Sampling Covers and Frames in Motion

Whenever practicable, samples of covers and frames shall be taken when the units are being moved as in the case of loading, unloading, etc. The batch from where the samples are to be drawn shall be divided into a number of convenient portions such that when one sample is drawn from each of these portions, the minimum number of units specified under 2.16.1.3, is provided.

2.16.3 Sampling Covers and Frames from a Stack

The number of covers and frames required for the test shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.

2.17 Number of Tests

2.17.1 All the covers and frames selected according to 2.16.1.3, shall be checked for dimensions (See 2.14.2) and inspected for visual defects (See 2.14.1).

2.17.2 The number of covers to be subjected to load test shall be according to col 4 of Table-3.

2.18 CRITERIA FOR CONFORMITY

2.18.1 The lot shall be considered as conforming to the requirements of the specification conditions mentioned in 2.18.2 and 2.18.3 are satisfied.

2.18.2 The number of covers and frames with dimensions outside the tolerance limit and / or with visual defects among those inspected shall be less than or equal to the corresponding acceptance number given in col 3 of Table- 3.

2.18.3 For load test no value shall be less than the load specified in Table-2

2.19 MANUFACTURER'S CERTIFICATE

The manufacturer shall satisfy himself that the manhole cover and frame conform to the requirements of this specification, and if requested, shall supply a certificate to this effect to the purchaser or his representative.

2.20 MARKING

2.20.1 Following information shall be clearly and permanently marked on top of each manhole cover and frame.

a) Identification of the source of manufacturer

b) Grade designation denoted by LD 2.5/ MD 10 / HD 20/ EHD 35 or 5T / 10T / 20T / 35T.

c) Any identification mark as required by the purchaser.

Item No.

52) Providing and fixing new wire for barbed wire fencing (for one raw)

For this work, 14 gauge galvanized barbed wire of approved quality as approved by Engineer-in-charge shall be used. The spacing between to rows shall keep as per instruction of Engineer-in-charge. The wire shall be fixed and tightened as directed by Engineer-in-charge.

The rate shall be for a unit of one running meter.

Asst. Engineer (Drainage Project) R.M.C.	**Dy.Executive Engineer R.M.C.**	**City Engineer R.M.C.**

COMMON CONDITIONS

(1) The Contractor at his own cost expenses shall provide necessary housing accommodation and sanitary arrangement for his staff and labour and shall pay direct to the authorities concerned all rates, taxes, royalties and other charges. The Contractor shall also comply with requirement of the Health Department as regards anti-malaria measures etc.

(2) Water required for the execution of work and for the water tightness test of the reservoir shall be supplied by the Contractor at his own cost.

(3) All materials to be used shall confirm to the relevant specifications as per latest version of Indian Standards, unless otherwise specified in the detailed specifications of item of work.

(4) Wherever a reference to any, IS appears in the specifications it shall be taken to mean as a reference to latest revision of the standard.

(5) The work under this contract also includes the supply of materials at site of work or storage's specified including Railway freight loading, carting, unloading, stacking as directed, insurance, local taxes etc.

(6) The Contractor shall be responsible for observing the laws, rules and regulations under the minor mineral acts, and such other laws and the rules prescribed by the government from time to time.

(7) The hydraulic test of water retaining structure shall have to be given by the Contractor without any extra cost. The filling of the reservoir shall be carried out gradually at the rate not exceeding 30 cm rise in water level per hour and shall preferably extend over a period of 72 hours. The records of leakage's starting at different level in the reservoir if any shall be kept. The reservoir once filled shall be allowed to remain filled for 7 days before any readings of the drop in water level are recorded. The level of the water shall be recorded again at subsequent intervals are recorded. The level of the water shall be recorded again at subsequent intervals of 24 hours over period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the reservoir, which for all practical purpose shall not exceed
40 mm.

(8) If structure does not satisfy the condition of the test and daily drop in water level is decreasing, period of test may be extended for a period of 7 days and if specified limit is the reached the structure may be considered as satisfactory.

Asst. Engineer (Drainage Project)	**Dy.Executive Engineer**	**City Engineer**
R.M.C.	**R.M.C.**	**R.M.C.**

Part-2 : Technical Specifications Rising mains

CONTENT

SR NO	PARTICULARS
A	**GENERAL**
1	Scope of Contract
2	e-TENDER Price
3	Completion Schedule
4	General Technical Guideline
5	Classification of Strata
B	**DETAILED TECHNICAL SPECIFICATION**
B1	Material specification
1	Providing and testing of GRP Pipe Line
2	Appurtenances
B2	Labour specification
1	Excavation and Refilling
2	Providing and laying Sand/Granular bedding for Pipes
3	Lowering ,laying and jointing of GRP Pipe
4	Removing surplus materials
5	Breaking of Asphalt surface
C	**GENERAL MATERIAL SPECIFICATION**
1	Concrete
2	Form Work
3	Reinforcement
4	Brick Masonry
5	Definition of Incomplete Work
6	Contractor to observe all conditions
D	**ADDITIONAL CONDITIONS**
E	**SCHEDULE OF DRAWING**

:: TECHNICAL SPECIFICATIONS::

1. **GENERAL**

SCOPE OF CONTRACT :

The works entitled "Manufacture, supply, Laying, Jointing and Testing & commissioning of Ductile iron pipeline (DI K-9) of specified size with inside cement lining and DI specials shall comprise of manufacture, supply and delivery of goods to site or work, excavation of trenches with shoring and strutting wherever required, bailing or pumping out water wherever necessary, laying of pipes, jointing of pipes including materials of jointing and testing as per specifications of various works stipulated in the tender.

2. **e-TENDER PRICE:**

The rates quoted in the bill of quantities shall cover everything necessary for the due and complete execution of the work according to the drawings and other condition and stipulations of the contract including specifications of the evident, intend and meaning of all or either of them or according to customary usage and for periodical and final inspection and test and proof of the work in every respect and for measuring, numbering or weighing the same, including setting out and laying or fixing in position and the provision of all materials, power, tools, rammers, labour, tackle, platforms with impervious lapped joints for scaffolding, ranging roads, straight edged, cantering and boxing, wedges, moulds, templates, posts, straight rods, straight edged, cantering and boxing, wedges, moulds, templates, posts, straight rails, boning staves strutting, barriers, fencing lighting pumping apparatus, temporary arrangement for passage of traffic access to premises and continuance to drainage water supply and lighting (if interrupted by contractor's work) temporary sheds, painting, varnishing, polishing establishment for efficient supervision and stating arrangements for the efficient protective of life and property and all requisite plant and machinery of every kind.

The contractor shall keep every portion of the work clear of accumulation from time to time and shall leave every portion of the work clean, clear, perfect and at the conclusion of whole, providing at their own cost all such material implement, appliances and labour as the Engineer in charge may require to prove if it to be so.

3. **COMPLETION SCHEDULE:**

The contract period shall be **18 (eighteen) Calendar months** from the date of notice to proceed. The Contractor shall submit his completion schedule and the program of works together with this e-TENDER in conformity with completion schedule given in the documents.

- **Packing and Handling:**

a. Necessary care shall be taken and required packing shall be provided to avoid damage to pipe barrels and the edges of the pipe ends in transit.

b. Where the goods are required to be dispatched at Railway risk, special packing as per IRCA rules are absolutely necessary, which would be payable by the contractor himself.

c. The contractor shall use proper handling equipment or follow suitable standard handling method for **DI pipes & DI Specials** as approved by the Engineer-in-charge to unload the materials at the delivery site to prevent damage to the goods.

4. **GENERAL TECHNICAL GUIDELINE:**

4.1 All the items occurring in the work and as found necessary during actual execution shall be carried out in the best workman like manner

as per specifications and the written order of the Engineer in charge

4.2 Extra Claim in respect of extra work shall be allowed only if such work is ordered to be carried out in writing by the Engineer in charge

4.3 The contractor shall engage a qualified Engineer for the Execution of work who will remain present for all the time on site and will receive instructions and orders from the Engineer in charge or his authorized representative. The instruction and orders given to the contractor representative on site shall be considered as it given to the contractor himself.

4.4 The work order book as prescribed shall be maintained on the site of the work by the contactor and the contractor shall sign the orders given by the inspecting offers and shall carry out them properly.

4.5 Quantities specified in the e-TENDER may very at the time of actual execution and the contractor shall have no claim for compensation on account of such variation

4.6 Unexcavated lengths shall be left wherever required and so directed by the Engineer in charge during the currency of the contract and shall be tackled. If required, before completion of work.

4.7 Diversion of road, if necessary, shall be provided and maintained during the currency of the contract by the contractor at his cost.

4.8 Figured Dimensions of drawing shall supersede measurements by scale, special dimensions or directions in the specifications shall supersede all other dimensions.

4.9 All levels are given on drawings and the contractor shall be responsible to take regular level on the approved alignment before actually starting the work The levels shall be commence to the G.T.S. levels and shall be got approved from the Engineer in charge

4.10 If the arrangement of temporary drainage is required to be made during any work of this Contract, this shall be made by the Contractor without claiming any extra cost.

5 CLASSIFICATION OF STRATA:

5.1 All materials encountered in excavation will be classified in the following groups irrespective of mode of excavating the materials and the decision of the Engineer in charge in this regard shall be final and binding to the contractor.

5.2 Soils :

Soils of all sorts, silt, sand, gravel, soft murrum, stiff clay, kunkar and other soft excavation not covered in the items mentioned hereunder.

5.3 Hard Murrum :

Hard Materials comprising of all kinds of disintegrated rock or shale or indurate conglomerate interspersed with boulders, weathered and decomposed rock which could be removed with pick, bar, shove, wedges and hammers, though not without some difficulties.

5.4 Soft – Rock:

This shall include all materials which is rock but which does not need blasting and can be removed with a pick bar, wedges, pavement breakers, pneumatic tools etc.

5.5 Hard Rock:

This shall include rock accusing in mass or boulders which need blasting, this will also include rock to be removed by chiseling or any other method where blasting is not permissible.

Signature of contractor

B-1 MATERIAL SPECIFICATION

1.0 SLUICE VALVES

1.1.1 GENERAL

This specification describes design, construction, inspection and testing features of Sluice Valves.

1.1.2 CODES AND STANDARDS

The design and manufacture of the valves shall comply with all applicable codes, standards, regulations and safety codes. Nothing in this specification shall relieve the Contractor of his responsibility. Valves shall be conforming to IS 2906 for sizes above 300 mm and IS 780 for sizes up to 300 mm.

1.1.3 DESIGN REQUIREMENTS

Valves shall be provided with back seating arrangement.
Direction of flow shall coincide with the flow direction indicated by "arrow" cast on the valve body.
Renewable body and wedge rings shall be provided.
Drain plugs of gunmetal shall be provided for all
valves. Stuffing box gland shall be of bolted type.
Valves shall be with non-rising spindle type.
Face to face dimension shall be as per IS 2906 above 300 mm. size and IS 780 up to 300 mm. size.

1.1.4 CONSTRUCTIONAL FEATURES

1.0	Standard	IS 2906 above 300 mm. size and IS 780 upto 300 mm. size
2.0	Stem	Non rising
3.0	Ends	Flanged, flat faced flanges having off center bolt holes
4.0	Bonnet	Bolted
5.0	Disc.	Solid wedge
6.0	Operation	Electrically operated / Hand wheel operated
7.0	Seat	Body - Renewable Disc - Renewable
8.0	Other requirements	Valves shall close in clockwise rotation of the hand wheel.
9.0	Body & bonnet	C.I. IS 210 GR 260
10.0	Disc	C.I. IS 210 GR 260
11.0	Stem	S.S. AISI - 410
12.0	Body seat	S.S. AISI - 316
13.0	Disc seat	S.S. AISI - 316
14.0	Stem nut	Bronze IS 318 Gr LTB2
15.0	Stuffing box	C.I. IS 210 GR 260
16.0	Gland	C.I. IS 210 GR 260
17.0	Packing	Graphited Asbestos
18.0	Bolts, studs & nuts	Carbon Steel IS 1367 Class 4.6 / 4

1.1.5 CLEANING AND PAINTING

Prior to factory inspection, all manufacturing waste such as metal chips, debris and all other foreign material shall be removed from the interior of the valve. All mill scale, rust, oil, grease, chalk and all other material shall be removed from the interior and exterior surfaces.

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and adhere perfectly to the surface.
The inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or odour to the water.

1.1.6 TESTS AND INSPECTION

Valves shall be offered for visual inspection and dimensional check. The hydrostatic testing shall be witnessed by the Employer.
Valves above 300 mm size shall be tested as per IS 2906. Valves upto 300 mm size shall be tested as per IS: 780.
Valve shall be dispatched only after owner's approval for dispatch.

1.1.7 FIXING OF VALVES:

Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pully etc. The arrangement of housing the valves with chambers and stable and firm foundations. The chamber and top roof cover with removable lid shall be provided so that it shall be possible to remove or replace or recondition the valves seats and to remove the parts without removing the valves from the pipe work. For this suitable flange adapters may be provided. Butterfly valves shall have high nitrile rubber seats, preferably metal reinforced, unless otherwise specified and shall be installed in the pipe work in such a manner that they can be removed from the line for dismantling and replacement of rubber seats.

Where the valves are required to be operated electrically, actuators shall be sized to guarantee valves closures at maximum possible differential pressure across the valve. Each actuator shall be supplied with installation, instructions and wiring diagrams and sufficient spare parts.

Valves used on pipeline shall be straight through type and non chokable. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.

The tightening of nut and bolts shall be done smoothly in such a way that no excessive strain occurs on any one side. The nuts shall be tightened on diametrically opposite site at a time.

1.1.8 INFORMATION REQUIRED

Following documents/drawings shall be submitted by Bidder along with the quotation.
Preliminary outline dimensional drawings. Typical cross section drawings.
Supplier's data sheet showing valve size, pressure rating, test pressures, list of tests to be conducted etc.
List of spares for two years operation.

1.2 DOUBLE ACTING KINETIC (H-42K) AIR VALVE WITH ISOLATION VALVE

1.2.1 GENERAL:

The double air valves shall have two ball chambers, having one outlet of large

capacity for admission and release of bulk volume of air during emptying and filling of the main and another having small outlet for escape of smaller quantities of entrapped air. This type of air valves shall be of flanged type with full conformation with IS:1538.

The ball sealed orifice always remains open while air is exhausting and is immediately closed when water rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/secs. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free set of curves showing discharge of free air valves pressure differential for all sizes of valves offered by him.
Under no circumstances shall be large orifice ball blow shut prematurely.

The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

Air valve shall be design to prevent premature closure prior to all air having been discharge 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 mixer of air and liquid. The sealing shall be design to prevent the float sticking after long period in the close position.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / for branch Di ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O.D. of the branched outlet. Plate thickness for pads will be same that of the main.

For Outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve tee's will be provided with one ½ "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 copper washed for sealing.

The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the office.

The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of glade 2 of IS:210.

Where tenderer considers necessary a suitable drain plug shall be provided.

1.2.2 JOINTING MATERIAL:

Each valve shall be supplied with all necessary joint ring, nuts, bolts and washers for completing the joints such that it will ensure effective sealing of large orifice even at low pressures. The weights of floats of the same size and type shall not differ by more than 2%.

The timber, if used in the manufacture of floats shall be seasoned and those provided in large orifice shall be ebonite coated. The float provided in high pressure chamber, if manufactured from seasoned wood, shall be coated with "ethylene propylene Rubber" (EPDM).

1.2.3 HIGH PRESSURE ORIFICE:

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working conditions by "EPDM" coated float.

The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

1.2.4 VALVE FLANGES:

All valves flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS: 1538 (part – I to XXII) – 1976 (specifications for C. I. Fittings for pressure pipes for water etc.)

1.2.5 COATING:

The casting shall be such that it shall not impart any taste or small to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when posed to a temperature of 770 C and not so brittle at a temperature of 150 C as to chip off when scratched lightly with the point of penknife.

Alternatively, two coats of black Japan conforming to type 8 of IS 341-1971 (Or latest edition) or paint conforming to type – 2 of IS 158-1969 (OR latest edition) shall be applied.

The sluice shall be provided and fixed as per specifications given in item No. 4 and as per IS-780-1980 or its latest edition.

1.2.6 TESTING:

The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be water tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

1.2.7 JOINTING MATERIAL:

The contractor shall have to provide all the jointing material like bolts, nuts, packing, branch (up to 1 Mt long) with flange, white zinc etc. at his cost.

B2 LABOUR SPECIFICATION

1. EXCAVATION AND REFILLING:

Excavation for sewer line trenches, manholes and house connection chambers etc. with shoring strutting bailing our water form trencher wherever necessary including excavation in khal kuvas or soak pits encountered in the work and making the good after the work and all safety measures and provisions such as site rails fencing lighting watching and stacking excavated stuff up to a lead of cleaning the site etc, as stipulated in the e-TENDER specifications complete for lifts and soil strata as specified below :-

(i) In all sorts of soil & soft murrum including macadam road, khal kuvas and soak pits.
(ii) In hard murrum boulders.
(iii) In soft rock, masonry structures like in C.M., L.M. or lime concrete.
(iv) In hard rock, in C.C. 1:2:4 or R.C.C. with controlled blasting and or chiseling

1.1. EXCAVATION FOR PIPELINE TRENCHES IN ALL SORT OF SOILS AND SOFT MURRRUM INCLUDING MACADAM ROAD (WBM), KHAL KUVAS AND SOAK PITS INCLUDING DEWATERING.

1.1.1. The item shall include dry or wet excavation and removal of excavated material and its stacking and disposal in a manner hereinafter specified. The water met with if any, shall be bailed or pumped out by the contractor as necessary.

1.1.2. The contractor shall provide all materials and perform all labour necessary for the excavation and completion of the work in accordance with the drawings and specifications and the intent thereof.

1.1.3. The Contractor shall provide necessary protection to labour materials, equipment etc. to ensure safety against risk and accident. The B.I.S. standard in this regard shall be followed (IS 3764 – 1966)

1.1.4. The Contractor shall be liable to pay compensation for injury to life, and damage to property, if any, caused due to any operation connected with this item.

1.1.5. The Contractor shall hand over the site of work in neat and tidy condition after completion of work and shall remove all rubbish arising out of construction work.

1.1.6. The contractor shall carry out the work of trial hole of the sizes and depths and at places as directed by the Engineer-in-charge to accurately locate and determine the portions of services like water mains and drains, electric cables, telephone cables .etc, and shall fill them back as required and as ordered. The work shall be paid as per the item of excavation.

1.1.7 Widths of excavation for different diameter of pipes

The width of trenches for different diameters of pipes are to be given I.D. of pipe + 0.60m and it shall be paid as per actual excavation done but limited to ID of pipe +0.90m in case of more width done by the contractor. Contractor shall have to keep in mind that the working space at the bottom for easy laying and jointing of pipes.

1.1.8. Depth of Excavation of Trenches:

The depths of excavation for the trenches shall be calculated from the surface to the bottom of the foundation, No payment shall be made for any excavation, beyond the width and depth, as specified above.

1.1.9 A Grip to be cut for pipe collar:

Where a collars be provided or where socket of the pipe comes a grip shall be cut in the bottom of the trench or bedding as necessary below the bed of the pipes so that the pipe may have a fair bearing on its shaft and not rest upon its collars. Such grip shall be maintained clear until the joint has been passed by the Engineer – in – charge.

1.1.10 Trenches in Rocky Ground:

The trenches in stony or rock ground shall be excavated all along to the full depth such that the bottom of the excavation shall not be higher at any point than the bottom of the concrete bedding layer below the sewer pipe.

1.1.11 Measurement of length of Excavation:

The length of excavation for trenches shall be measured in the horizontal plane The excavation shall be taken up at such places and in such lengths as shall be approved by the Engineer-in-charge. The excavation shall proceed in such portions at one time as the Engineer-in-charge may direct. No permanent works shall be started unless the Engineer-in-charge approves the excavations. The length of trench excavated ahead of the laying and the length of trench which may remain open at any time shall at all times be subject to the approval of the Engineer-in-charge. It shall be at no time, longer than can properly be protected from caving. In case of tapering in excavation, average width in measurement shall be taken in to account.

The materials from the excavation shall be deposited on either side of the trench leaving a clear berm on each side at least 40cm wide or at such further distances from the edges of the trench, as may be necessary. To prevent the weight of materials from causing the side of the trench to slip or fall, or at such distance and in such a manner as to avoid covering fire- hydrants, sluice valves, gas siphons, manhole covers and the like and so as to avoid abutting any wall or structure or causing inconvenience to the public or other persons, or otherwise as the Engineer-in-charge may direct.

In case, where the Engineer-in-charge decides that the width of the road or lane, where he work of excavations to be carried out is so narrow as to warrant stacking of excavated materials away from the

site of the work the contractor shall have to remove the same if so directed within the lead of 250M. The excavated stuff shall be brought back for refilling the trenches when required. The surplus material shall be removed as directed. No claims for stacking the excavated stuff away from the site of work or bringing it back for refilling trenches shall be entertained.

1.1.12. Bottom of Trenches and foundation to be saturated with water

The bottom of all trenches and the foundations of all structure shall be saturated with water and well rammed wherever the Engineer may consider it necessary to do so.

1.1.13. Excess Excavation due to nature of sub-soil for additional foundation

If in any place, the Engineer-in-charge considers on account of the nature of sub soil additional foundations of concrete, rubble or other wise necessary or if at any place, for any purpose whatsoever he required the excavation to be carried out deeper than shown on the plans or described in the specifications, the same shall be carried out as may be ordered by the Engineer-in-charge and such additional works shall be measured and paid for to the contractors according to the rates. Excavation and necessary dewatering and shoring strutting for chambers, Main holes, Vent shafts etc, is also included in this item and no extra shall be paid for excavation for chambers manholes, Vent shafts etc.

1.1.14. Unauthorized excess excavation:

Where excavations are made in excess of the width and depth indicated on the drawings, either by error or by accident the hollows so formed shall be filled in with lime concrete or rubble masonry or otherwise as directed by the Engineer-in-charge to his full satisfaction at the expense of the contractor.

1.1.15. Fencing / Lighting and Watching:

The contractor shall make all proper provisions for protecting the work by fences and by watching and lighting at night, or otherwise as may be directed by the Engineer-in-charge. The posts of the fencing shall be of timber or of other approved material securely fixed in the ground not more that 3M apart. The timber posts shall not be less than 75mm in dia, and shall not be less than 1.2 M above the surface of the ground.

There shall be two rails one near the top of the posts and the other about 150mm above the ground and shall be 50 mm to 70mm dia and sufficiently long to run from post to post to which they shall be securely fixed as per direction of the Engineer-in-charge. The method of projecting rails beyond the posts and typing them together where they meet will not be allowed on any account al along the edges of the excavated trenches a bank of earth about 1.20m high shall be formed where required by the Engineer-in-charge for additional protection Adequate number of red lights wherever required shall be provided at night. Also a watchman shall be engaged to see that the lights are properly maintained during night.

In the event of contractor not fully complying with the provisions of this clause, the Engineer may with or without notice to the contractor put up a fence, improve the lighting and adopt such other measures as he may deem necessary for the safety and all costs of

such works including penalty as may be decided by the Engineer-in-charge shall be paid by the contractor the contractor shall also provide and display special Boards painted with fluorescent paints indicating the progress of the work along a particular road.

1.1.16 Maintenance of Water Pipes, Gas Pipes, Telephone lines, Electric lines and Drains Khalkuvas, Sewers during Excavation:

The contractor shall at the rates entered in the bill of quantities and rates, carry out all excavation as the Engineer-in-charge may require in order to locate the positions of water pipes, Gas Pipes, Telephone lines, Electric lines, drains, khalkuvas, sewers, or any other structures in connection with them and shall properly maintain and protect these services by means of shoring strutting planking over padding or otherwise as the Engineer-in- charge may direct during works resulting from the same shall be made good and effectively remedied by the contractor at his cost if the contractor fails to comply with the requirements, the Engineer-in-charge will got it repaired from any other agency at the expense of the contractor. If however, the Engineer-in-charge considers it impracticable for the contractor to maintain any such water pipes, drains, Khalkuvas, sewers or other works and that exigencies of the work necessitate the breaking down removal, or diversion of any such water pipes, drains, khalkuvas, sewers, or other work, them he may direct the contractor to break down or remove any of the above mentioned services and ask the contractor to provide such chutes pumps or other equipment of raising and temporary passage of the water or sewerage. The cost of pumping out or otherwise removing any water or sewerage which may escape from any such broken water pipes, drains, khalkuvas, and sewers shall be borne by the contractor.

1.1.17. Shoring:

1.1.17.1 Wherever shoring is found necessary by the Engineer-in-charge the contractor shall provide the same in the best possible manner with the materials as required and as directed by the Engineer-in-charge to his complete satisfaction. The contractor shall employ such kind or kinds of shoring as the Engineer may consider the exigencies of the work to require and it is to be distinctly understood that the word 'shoring' is to comprise all classes of such work and all appliances and appurtenances, including polling Corporations, sheet piling and runners (whether the joints be butt., groove and tongue, feather edge and grove, birds mouth and double splay, rebate or otherwise), together with walkways, strut, props point blank shores, raking shores, blocks, wedges, Iron dogs, bolts, screws, nails and everything that may be required for due execution of the work.

1.1.17.2 Contractors responsibility for secure shoring and / or all damages:
The contractor shall be responsible for providing secured shoring and for taking every other precaution which may be necessary or proper for protecting any building or any other structure from getting damaged by the excavation of any trench or otherwise by the execution of the works in the vicinity of such building of structure.
If the Engineer-in-charge shall require the adoption of any special or extra measures, or precautions, the contractor shall forthwith adopt and supply the same. However, this revision shall not in nay degree relieve the contractor from his responsibility or from liability under the conditions of the contract in respect of any claim made

against the Corporation for loss or damage which might be caused to any such building or structures by the execution of any works or otherwise.

After the work is completed near building, the contractor shall remove the shoring safety without slipping of soil of trenches if any and make good any cutting out or other damage that might have been done.

1.1.17.3 Liability of Timbering:

No work approved by the Engineer-in-charge or his representative about timbering shall absolve the contractor from his responsibility and he will be responsible for making good damage caused as about result of the failure of timbering to give proper support to the sides of the excavation. The timbering to the sides of excavation for structures shall be carried out in such a way that there is no obstruction caused to the fixing of form work for the walls. The supporting struts and walling shall be removed by the contractor in stage to facilitate progress of concreting pipe laying etc.
If the Engineer-in-charge finds that the standard of timbering is not according to requirements or that the sides of the excavations have not been secured in a manner to render such excavations safe for working may be one hour after notifying the contractor of his representative in writing about this shall employ his own men to mend the timbering and the cost of such workmen and materials employed including penalty shall be paid by the contractor.

1.1.17.4 Removing shoring:

No part of the shoring shall nay time be removed by the contractor without obtaining permission of the Engineer-in-charge While out shoring planks, the hollows if any, formed shall simultaneously be filled in with soft earth well rammed with rammers after watering.

1.1.17.5 Shoring left in Trenches:

The Engineer-in-charge may order in writing portions of shoring to be left in the trenches at such places where it is found absolutely necessary to do so, so at to avoid any damage to buildings, cables, water mains, sewers, etc. in close proximity of the excavation.

The contractor shall not claim, anything, whatsoever for the shoring which might have been left in the trenches.

1.1.17.6 Steel trench sheeting:

Where the subsoil conditions meet with are of a soft and unstable in trench excavation the normal methods of timbering will not prove sufficient to avoid subsidence of the adjoining road surface and other services. In such circumstances, the contractor will be required to use steel trench sheeting or sheet steel pining adequately supported by timber struts, welling etc. without any extra cost. The contractor shall supply, and subsequently remove trench sheeting or piling where no longer required.

1.1.18. Constructing Temporary bunds & sumps:

For the purpose of keeping the excavations dry the work shall, if necessary he divided into sections or separate portions, to be determined by the Engineer-in-charge and temporary bunds shall be put up by the Contractor. Sump shall be excavated by the Contractor

at such distances apart and of such depths, as the Engineer-in-charge may direct to allow the pumps to work. When and as the work progresses, other sumps shall be excavated by the Contractor from time to time. The sumps not in use shall be filled in by the Contractor to the satisfaction of the Engineer-in- charge. The contractor shall not claim anything extra for temporary bunds and sumps or their removal and refilling, nor shall such work be taken into measurements in any way.

1.1.19. Rate for Excavation:

The rates for excavation shall be included and cover without extra charge all the stipulations continued in every portion of these specifications, with regard to setting out, provision for the passage or traffic and for access to premises, arrangements for the continuance of drainage, khalkuvas or such points water supply or lighting (If interrupted by the works) arrangements, for the efficient protection of the life and property, fencing, lighting, watching, shaping the trenches, maintenance of water pipes, gas pipes, telephone lines, electric lines drains, khalkuvas and other work met with in or about the excavation driving them dismantling them, rebuilding them as necessary, subsequent re-excavation, on account of rain, holiday or special occasion, filling necessary dewatering etc. complete.

1.1.20 The excavation shall be carried out in the strata met with as specified in the proper manner and with lifts mentioned therein.

1.2. EXCAVATION FOR PIPELINE TRENCHES IN HARD MURRUM, BOULDERS INCLUDING DEWATERING.

1.2.1 All the items of excavation for trenches and manholes vent shaft, house connections, chambers and connecting sewers as described under 1.1 above shall also apply here.

1.2.2 This shall included all kinds of disintegrated rock or shale or indurate clay tending to the formation of conglomerate interspersed with boulders up to having at least dimension of 300mm in any direction which do not need blasting and could be removed by a pick and bar and shovel with some difficulty.

1.3 EXCAVATION FOR PIPELINE TRENCHES IN LARGE BOULDERS AND SOFT ROCK WITHOUT BLASTING INCLUDING DEWATERING.

1.3.1 All the items of excavation for trenches and foundation as described under 1.1 above shall also apply here.

1.3.2 Excavation shall be in soft rock as lime stone, sand stone, laterite hard conglomerate or other soft of disintegrated rock, which may be quarried on spilt with crow bars, boulders which do not require blasting having diameter in any direction not more than 300mm and any rock which in dry state may be hard, requiring blasting but which when wet becomes soft and manageable by means other than blasting and excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

1.4 EXCAVATION FOR PIPELINE TRENCHES IN HARD ROCK INCLUDING DEWATERING AND CONTROLLED BLASTING IF REQUIRED AND OF CHIESELING.

1.4.1 All the items of excavation for trenches and foundations under 1.1 above as applicable shall also apply here.

1.4.2 Excavation shall be in any rock or boulders having diameter in any one direction of more than 300mm for which the use of mechanical plant or controlled blasting is required. The classifications of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

1.4.3 Controlled blasting shall be carried out only with the written permission of the Engineer-in-charge All statutory laws, regulations rules etc. Pertaining to the acquisition, transport, obtaining permission of respective departments, handling and use of explosives shall be strictly followed,

1.4.4 When controlled blasting is permitted by the Engineer-in-charge in writing the same shall be carried out by any method of blasting consistent with the safety and job requirements.

1.4.5 The magazine for the storage of explosives shall be built to the design and specifications of the explosive department concerned and located at the approved site. No unauthorized person shall be admitted into the Magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The Magazine shall have an effective lighting conductor; the following shall be in the lobby of magazine.

(a) A copy of relevant rules regarding safe storage both in English and Gujarati
(b) A statement of update stock in the magazine.
(c) A Certificate showing the last date of testing of the lighting conductor.
(d) A notice that smoking is strictly prohibited.

1.4.6 In addition to these, the contractor shall also observe the following instructions and any further additional instructions may be given by the Engineer-in-charge & shall be responsible for damage to property and any accident which may occur to workman or the public on account of any operations connected with the storage, handling and use of explosives and blasting.

1.4.7 All the materials, tool and requirement used for blasting operations shall be of approved type and approved by the Engineer-in-charge. The fuse to be used in wet locations shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and known to determine its length.

1.4.8 The blasting operation shall remain in charge of competent, experienced supervisory staff and workmen who are thoroughly acquainted with the details of handing explosives and blasting operations.

1.4.9 The blasting shall be carried out during the time fixed and approved by the Engineer-in-charge. The hour of blasting shall be made known to the people in the vicinity.

1.4.10 Red danger signals shall be displayed in all directions during the blasting operation. People except those who actually light the fire shall be prohibited from entering the area.
The flags shall be planted at safe distance from the blasting area in all directions and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning whistle being sounded for the purpose.

1.4.11 The charge holes shall be drilled in suitable places to depths approved by the Engineer-in-charge blasting should be as light as possible consistent with required breakage of materials.

1.4.12 when blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rod with rounded ends. The Explosive Powder shall then be covered with tamping materials which shall be tamped light but firmly.

1.4.13 As the blasting will be only controlled one with light charges, dynamite etc. shall not be used.

1.4.14 At a time not more than the number of charges approved by the Engineer-in-charge will be prepared and fired. The charges shall be fired after observing the instructions given above and the explosions counted. The man in charge shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to work site.

1.4.15 In case of misfire the following procedure shall be observed.

(a) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.

(b) In the case of blasting powder missed charge, it shall be completely flooded with water. A new hole shall be drilled about 45 cm. from the old hole and fired. This should be repeated till the old charge is blasted.

1.4.16 The main in charge shall at once report to the contractor's office and the Engineer-in-charge of all cases of misfire the cause of the same and the steps taken in connection there with.

1.4.17 A careful and day to day account of the explosives shall be maintained by the contractor in an approved manner in a register which shall be open for inspection by the Engineer-in-charge at all times.

1.4.18 The rate shall include all stipulations mentioned under 1.1 over and above these stipulations, the rate shall also include excavation by chiseling or controlled blasting as required for the work.

1.4.19 The necessary permission of the concerned district authority shall be obtained by the contractor prior to the blasting operation and all safety and necessary arrangements shall be made as per his directions before the blasting operation is actually started. The rate shall be paid per Cu.M. and will be inclusive of necessary shoring, strutting, scaffolding, bailing out water, dewatering barricading etc. complete.

1.5 BEDDING AND REFILLING THE PIPE TRENCHES BY THE SAND AND EXCAVATED STUFF IN 15 CM TO 20 CM THICK LAYER, CONSOLIDATING UP TO POSSIBLE EXTENT AND DISPOSAL OF SURPLUS STUFF AS DIRECTED WITHIN THE PRESCRIBED LIMITS OF CORPORATION OR AS DIRECTED BY THE ENGINEER-IN-CHARGE.

1.5.1 After the sewer pipes have been laid and jointed and the manholes and vent shafts are constructed and as soon as the joints have been inspected and passed by the Engineer-in-charge and after all concrete work thoroughly set the trenches shall be fulfilled with the materials taken there from. In refilling the trenches the utmost care shall be exercised so as not to disturb, break or damage the jointed pipes. Over and around every pipes sand will be filled as per drawing no.-2. No lumps of rock earth or other material shall be put around the pipe or be thrown into the trenches until the same has been broken to specified size and pipes covered by the fine material above referred to. The selected sand shall be carefully placed next to the permanent work and well packed and well rammed in layers of 150 mm for a depth of at least 300 mm over the top of the pipe. The remaining of the excavation shall be filled in with the best and most suitable portions of the excavated material in layers of not more than 200 mm deep or as decided by the engineer in charge. Surplus soil shall be piled on top of the filling to the extent possible for expected subsidence. All road materials to from a compact neat surface. The contractor shall maintain all refilling and surfaces until completion of entire work. The contractor shall be responsible for claims arising from accidents due to subsidence or inadequate maintenance or improper refilling work. Where excavated material is not considered suitable for refilling by the Engineer-in-charge, the Contractor will be required to cart selected surplus excavated materials in place of unsuitable materials. The contractor may also be instructed to supply suitable granular or other hard filling material for use in refilling such imported filling material shall be paid for at the rates given in the Bill of quantities or as per S.O.R. of Rajkot Municipal Corporation.

When trench is excavated under or near any existing work likely to be affected by subsidence of the material in the trench, or where any permanent work will be constructed later of the trench. The contractor shall fill in the trench with M 100 concrete or take such other precaution means to prevent damage by subsidence as. The Engineer-in-charge may direct, Whether such work is shown in the drawing or not, whether it is billed in the quantities or not. Any extra work necessitated will be paid for according to the provisions of the conditions of Contract. Unless in the opinion of the Engineer-in-charge, it is necessitated by the contractor negligence, bad workmanship faulty materials or lack of reasonable foresight.

1.5.2 Subsidence in filling:

Should any subsidence take place in the filling up of the road on or about any part of the work whatsoever up to the completion of contract works the contractor shall make good the same at his own cost. In case of failure of the contractor to attend to the work, the Engineer-in-charge without notice to the Contractors shall make good the same in any way and with any material that the (Engineer-in-charge) may consider proper at the cost of the contractor. The Engineer-in-charge may, if he anticipates the occurrence of any subsidence employ watchman to give him timely notice of the necessity of making good the subsidence, and the cost of such watchman shall be charged to the contractor.

2.0 PROVIDING SAND BEDDING AND ENCASING OF PIPE INCLUDING RAMING,WATERING, CONSOLIDATING ETC COMPLETE.

The sand to be used for bedding and encasing shall be got approved from Engineer-in-charge before using the same for providing bedding on trench bed.

The providing of sand for bedding and encasing shall be done in required thick area as per instructed by Engineer-in- charge. It shall not contain dust, clay or other such harmful materials. If directed the sand shall be washed with water and screened before being used. The sand containing big clods shall be broken into small pieces and tree's roots. The tree's roots, meets, bit stones and other objectionable materials liable to decay shall not be used in the work. Sand brought from approved source shall only be used.

3.0 REMOVING SURPLUS MATERIALS:

After refilling all surplus excavated stuff shall have to be carted by the contractor within RMC limit including loading, transporting, unloading, spreading etc complete as directed by the Engineer-In-Charge.

Measurement: - Removal of surplus material shall be measured in Cu.m. of surplus material removed and rate will be paid per Cu.m.

4.0 BREAKING OF ASPHALT SURFACE:-

In this works, breaking of Asphalt surface is to be done as directed by Engineer-in-charge. For any damage to Gutter or Manhole due to breaking of asphalt surface, contractor is responsible for repairs. No extra payment will be paid for such work.

Payment will be made per square meter of work done.

EXCAVATION OF ASPHALT PAVEMENT

Under this item contractor shall demolish existing asphalt or WBM pavement met with during excavation for pipeline trenches. Only area of pavement intercepted in pipe laying shall be demolished. If excess area is demolished same shall be reinstated by the contractor. Work done to the extent of requirement for laying of drain and as per specifications shall measured in sq.m. and paid at the tender rate.

C GENERAL MATERIAL SPECIFICATION

1.0 CONCRETE:-

Cement Concrete (plain or reinforced):
All cement concrete to be used in the work shall conform to the requirements of I.S. 456.

Materials:

1.2.1 Cement:-

All cement for use on the works except otherwise stated shall be the standard Portland cement manufactured in India and shall confirm to the IS:269, IS : 8112, IS:12269 or latest versions. It shall be of the make and quality approved by the Engineer. (For this work, approved makes are Ambuja, Sidhi, L&T, Sanghi, Lotus, Hathi or equivalent. Mini cement plant cement shall not be allowed).

The cement shall be stored in weather proof go down or cement store specially constructed for the purpose in such a manner as to prevent deterioration due to moisture of instruction of foreign matters.

The weather proof go down shall have a soil impervious floor raised 300mm above the general ground level so that the cement stored thereon shall not come in direct contract with sub soil moisture. The passage and the general construction shall be such that it offers full protection from weather effects. Large stocks of cement shall not be kept at the works but only sufficient quantities should be kept to maintain continuity of the work.

1.2.2 Storage of Cement:

No cement that has been stored for more than 90 days shall ordinarily be allowed to be used in the works Cement stored for longer period than 90 days shall be used only after approved by the Engineer-in-charge who shall ascertain its quality before giving such permission.

The Contractors shall offer every facility to the Engineer for inspection of cement. The cement go down shall be so arranged by the contractor that each consignment could be stacked separately and in such a manner so as to allow counting of bags in each row with ease.

The cement, used in any type of concrete shall always be measured by weight and one cubic meter shall be taken as weighing 1440kgs. (Table 30 of A.C.C. hand-book)

1.2.3 Aggregates:

All the aggregates shall confirm to the latest IS : 383 The aggregates shall consist of naturally occurring sand and gravel or stones crushed or uncrushed or a combination thereof. They are classified broadly under two categories viz.(i) sand of fine aggregates and (ii) coarse aggregates, depending, upon their sizes. The fine aggregates, those which pass through Is sieve No.480 and the coarse aggregate are those which are retained on the IS sieve No.480.

1.2.4 Storage of aggregate:

The fine and coarse aggregate shall be stored separately and in such a manner that segregation of the various sized particles shall not occur, the stock piles shall be formed on platform of weak concrete timber of similar approved hard standing and aggregate shall be kept clean and free from foreign substances. Storage piles of aggregate shall be arranged with proper drainage and protection from rainfall in order to prevent excessive changes in moisture content taking place during concreting.

The aggregate both fine and coarse shall be hard, strong, durable, clean, free from veins and adherent coatings. The use of flaky and elongated pieces of aggregates shall be prohibited.

The aggregates shall not contain deleterious materials such as iron pyrite, coal mica, shale or similar laminate material, clay, alkali, soft fragment sea shells, organic impurities etc in such quantity as to effect the strength of durability of concrete or the reinforcement embedded in such reinforced concrete.

1.2.5 The maximum quantities of deleterious materials that may be permitted shall conform to the following limits by weights.

Deleterious Substances	**Fine P.C. by weight**		**Coarse aggregate P.C. by weight**	
	Uncrushed	**Crushed**	**Uncrushed**	**Crushed**
1) Coal and lignite	1.00	1.00	1.00	1.00
2) Clay lumps	1.00	1.00	1.00	1.00
3) Soft fragments	---	---	---	---
4) Materials passing through 75 micro sieve	3.00	3.00	3.00	3.00
5) shale	1.00	---	---	---

The total of various deleterious materials in any sample shall in on case exceed 5per cent. If the aggregate supplied is unclean, it shall be washed. If it is not properly graded, it shall be screened by hand or by mechanical means and the various sizes proportioned to get the required grading.

Storing of aggregates on dusty, muddy and grassy sports shall be avoided. They shall be stored on the works in such a manner as to prevention of foreign matter and protected from exposure to dust. They shall be placed in stock piles in individual units of suitable sizes and in suitable layers to prevent segregation. They shall no be allowed to run down slopes.

1.2.6 Sand or fine aggregates:

All fine aggregates shall consist of clean, hard strong durable uncoated siliceous gritty materials consisting of well graded particles obtained from rock, fragments If shall be free from clay lumps, injurious amounts of dusts, mica shells, soft or flaky particles shale, alkali, organic matter, lead or other deleterious substances.

The sand shall be taken from source approved by the Engineer. The sand or fine aggregates shall confirm to the latest IS No.383
If the Engineer considers it necessary, it shall be washed and or screened before use, all the expense of the contractors.

The sand shall have fineness modules of not less than 2.5 and not more than
3.0 and the grading shall confirm as far as possible to the following analysis:

I. S. Sieve No.	**Percent passing**	
	Natural sand or Crushed gravel.	**Crushed Stone.**
180	95 - 100	90 - 100
240	70 - 95	60 - 90
120	45 - 85	40 - 80
60	25 - 60	20 - 50
30	5 - 30	5 - 30
15	0 - 10	0 - 15

The specific gravity of sand shall not be less than 1.6. In no case shall fine aggregate be accepted containing more than 2 per cent by dry weight, not more than 2 ½ % by dray volume, not more than 5 percent by wet volume of clay, loam or silt, any sample of fine aggregate shows more than 5 per cent of clay, loam or silt, in one hour's settlement after shaking in an excess of water the lot represented by the sample shall be rejected.

The following two field tests are recommended for ascertaining the percentage of clay lumps and impervious organic material and the contractor shall carry out the same if the Engineer-in-charge deems necessary.

(1) Test for determining silt in sand :
Fill a calibrated tumbler with same to half its volume and add water there to until the fill a calibrated tumbler is three quarter full shake up the mixture vigorously and allow it to settle for about an hour. The volume of silt visible on top of the sand shall be measured. If the volume of the its standing over the sand exceeds 5 per cent of the total volume of sand same shall be rejected.

(2) Colorimetric test for organic impurities :
The sample of sand shall be mixed with equal volume of 3p.c. solution (about one ounce in a quarter of water) of caustic soda / sodium hydroxide taken in a plain glass an the mixture shall be allowed to stand for 24 hours. The liquid standing above the sand shall not be darker than lights straw (pale yellow) colour. If the colour is marked yellow of brown, then test would indicate presence of organic materials in excessive amount.

In case suitable sand is not available in adequate quantities within a reasonable and economical limit, the contractors may be allowed the use of crushed or pulverized

stone of gravel either along or mixed with natural sand in parts. The stone or gravel shall be clean, sharp and free from dust etc. and shall conform to the latest I.S. 383. In this case, approval of Engineer-In-Charge shall be obtained.
The percentage of crushed stone to be mixed with sand shall be such as to obtain the fineness modulus of the blended sand within the limits specified above, and or approved by the Engineer after Laboratory tests.

1.2.7 Coarse Aggregates:

All coarse aggregate used in concrete works shall consist of crushed rock gravel or other approved inert materials.

Broken or crushed rock from sound blue basalt or black trap zeolite shall be used in concrete as coarse aggregate. The particles of aggregate shall be clean hard, tough, and durable free from deleterious substance and shall contain no soft flat or elongated pieces. The coarse aggregate shall have specific gravity not less than 2.6 and the water absorption measured after being immersed for 24 hours in water shall not be more than 6 per cent by weight. The maximum percentage of deleterious materials in the coarse aggregate shall not exceed 5 per cent by weight in the aggregate when tested in conformity with IS No. 363

The nominal size of the coarse aggregate for reinforced concrete work shall be 10 to 20 mm. larger coarse aggregate up to 40mm size may be used if approved by the Engineer in plain concrete work. The maximum size of coarse aggregate shall be large as possible within the limits specified but in no case shall be greater than one quarter of the minimum thickness of the member, provided that the concrete can be placed in the form work without difficulty so as to surrounded to reinforcement thoroughly and to fill the corners of the form-work. The minimum size of coarse aggregate shall be as mentioned earlier such as to retain most of the material (90 per cent, 95 per cent maximum) on IS sieve No. 480.
Aggregating shall be screened and, if necessary blended to give the required grading when tested in the Laboratory at Contractor's cost by means of standard mesh sieves, the grading shall fall within the following limits:

Sieve size.	**Percentage retain by weight**	
	Plain C.C.	**R.C.C.**
40 mm	----------	----------
25 mm	10 to 15	----------
20 mm	35 to 40	15 - 0
10 mm	37 to 80	100 - 80
No.480	98 to 100	100 - 95

The percentage given above are for guidance and the Engineer-in-charge reserves the right to modify the same to any other lower of higher value if considered necessary by him, according to the requirements of the work.

In the event of undesirable segregation occurring in coarse aggregating in two or more suitable fractions as directed.

The grading so specified shall be such as to give a dance, water tight concrete of specified proportion and strength and required consistency. The Engineer shall have the right and authority to carry out routine control tests and analyses of the broken rock at any stage of the work processing and / or concerting operations and the contractors shall give necessary facilities in respect of such testing. The sampling and testing shall be carried out, as per standard IS practice entirely at the cost of the contractors.

1.2.8 Water:

The water used for the preparation of concrete, for washing sand etc. and for curing shall be clean and free from objectionable quantities of silt, organic materials, acid, alkali, salts, oil and other deleterious impurities and it shall be obtained from the source approved by the engineer. Potable water shall be obtained from the source approved by the Engineer. Potable water shall generally be found fit for preparation of concrete. The quantity of water to be added for making concrete shall be properly measured and controlled.

1.3 Water Cement Ratio:

Suitable water cement ratio for the different mixes and use shall be determined in consultation with the Engineer and shall generally not be exceeding 0.5 (i.e. 50 percent by weight) The exact value being fixed after taking into account all relevant factors such as strength required, weather condition, water absorbed by material, workability and slump required consistent with the work requirements, methods of compaction etc.

1.4 Concrete:

All cement concrete whether used in R.C.C. work or plain concrete work shall be designated in grades by the strength at the age of 28 days) M 100, M 150, M 200
& M 250 where M refers to the mix and the number 100, 150,200 and 250 represent the specified 28 days works cube compressive strength of the mix under reference, expressed in Kg/sq cm.
The proportions of cement, aggregate water for ordinary cement concrete shall be as designated below and shall generally consist of quantities as given in the table below per bag of cement.

TABLE No.1:– Concrete mix proportion for ordinary concrete.

Grades of Concrete	**Total quantity of dry aggregates per (Fine and coarse) cement by volume per 50kg. (Max. in liters) (Max. in liters).**	**Quantity of water 50 kg. Of**
M-100	300	34
M-150	220	32
M-200	160	30
M-250	100	27

The proportion of fine aggregate to coarse for the various mixes listed above shall generally be 1:2 by volume but variation from 1:1 ½ to 1:3 depending upon the grading of the aggregates may be permitted by the Engineer. The quantity of fine and coarse aggregates, however, shall not in any case exceed the quantity given in the above table No.1.

The cement concrete shall be tested for compressive strength at the age of 28 days on 15 cm. Cubes in accordance with the latest IS : 516 and the strengths developed for all type of concrete shall not be less than those given in Table-2.

TABLE –No.2:- Strength requirement of concrete.

Grades of Strength of cubes Concrete	**Minimum Compressive at 28 days in kg / cm2**	
	Preliminary Test	**Works Test**
M-100	135	100
M-150	200	150
M-200	260	200
M-250	320	250

For quick results the contractors shall carry out compression tests on 15 cm cubes cast in accordance with relevant IS 516 at 7 days in addition to the normal 28 days compressive strength. The 7 day strength of the various concrete mixes shall not be less than the values given in the Table NO.3 below. However the 28 days compressive strength alone shall be the criterion for acceptance or rejection of the concrete unless the Engineer is satisfied of the relation between the 7 days compressive strength and the 28 days compressive strength, established by carrying out a number of tests, in which case, he may relax the test frequency of 28 days compressive strength specified hereinafter.

TABLE –No.3:- Optional test requirement of Concrete Grades of Minimum Compressive strength on Concrete 15cm. Cube at 7 days in Kg / cm2

M-100	70
M-150	100
M-200	135
M-250	170

All test strength specified above are exclusively for 15 cm size cubes and they shall be adequately modified to suit the requirement of 15cm dia and 30 cm long cylinder moulds wherever used in the case of cylinder the strength values obtained should be multiplied by 1.25 to obtain the equivalent cube strength.

1.5 Control and Testing of concrete.

The following tests shall be carried out at site whenever required by the Engineer in accordance with IS 516

1. Works tests – 7 days and 28 days compressive strength
2. Consistency test.
3. Moisture contents in aggregates.
4. Unit Weight of concrete.

(1) Works test:

During concreting operations samples of concrete as placed in the work shall be taken every day and set of six cubes or cylinder shall be made there from for being tested for their compressive strength. The consistency (slump) test shall also made and the slump recorded.

All concrete cubes or cylinders shall be tested for compressive strength as specified under IS 456 and 516 at the approved material testing Laboratory generally as per specification under the latest IS 456 and IS 516. The above, specification cover concrete mixes of grade M-100 and above. Ordinarily it is not necessary to test the compressive strength of mix of grade M 100 as it is generally used for non structural purposes. However, where this mix (M 100) is used extensively on works (i.e. more than 75 cu.m. of concrete is to be placed one time in any work) it shall be tested in the same manner as other grades of concrete used for structural purposes. The minimum strength of various grades of concrete both at the age of 7 days and 28 days are given in Table 2 and 3.

In the case of concrete of mix M 150 and above, the above, the Engineer-in- charge may not insist on the testing of concrete if the quantity of concrete to be laid on any particular day is less than 10 cum. if however the quantity exceeds 10 cum, test specimen must invariably, be taken and sent to the Laboratory for testing.

Specimen shall be made for every sample and three of them tested for 7 days strength as mentioned earlier the 28 day strength of concrete shall alone form the criterion for acceptance on rejection of the concrete. With this point in view, the concrete sample shall be tested both for 7 days strength as well as 28 days strength at the start of the work and this shall be continued until the Engineer is satisfied that proper relation between the 7 days compressive strength is established, in which case he may decide to relax frequency of testing the concrete cubes for the 28 days compressive strength.

If the average strength of the specimen tested at the time of 28 days is not less than the strength specified in Table – 2, the test shall be considered satisfactory subject to the condition that only one out of 3 consecutive tests may give a value less than specified strength but not less then 90 per cent of the specified strength. If the tests are unsatisfactory, the contractors shall take immediate steps to carry out remedial measures as may be directed by the Engineer in respect of such works, entirely at the risk and cost of the contractor. Failure of a sample in test may entail partial or whole demolition of such work, heavy penalties, black listing of the contractors concerned and or such other similar steps. The results of the tests conducted at the approved material testing Laboratory shall be taken as final and binding

on the contactors. In case of any dispute, the decision of the municipal commissioner shall be binding to the contractors.

A record showing the location of test specimen and daily progress of the work done shall be maintained by the Engineer-in-charge and shall be countersigned by the contractors or their representative. In case record maintained by the Engineer-in-charge is not signed by the contractor or their representative the record kept by the Engineer shall be considered as correct and binding on the contractor. In the case of any disputes, the decision of the Rajkot Municipal Corporation shall binding to the contractor. The contractor shall deliver the specimen for testing at the approved Laboratory at the own cost in their moulds. The contractors shall pay usual testing fees for the tests carried out in the Laboratory. These fees may very as sanctioned by the competent authority.

(2) Consistency slump test:

The workability of concrete shall be cheeked at frequent intervals. The slump test shall be carried out in accordance with the standard methods given under I.S. specifications mentioned above. The slump shall be as small as practicable consistent with the efficient working and compacting of concrete. The slump shall not exceed 64 mm but the Engineer may under exceptional conditions, permit higher slump up to a limit of 150 mm.

The standard consistency test shall be applied very time at each mixer when test cubes are taken for the works of compressive strength test.

(3) Moisture Contents in the aggregates:

The moisture contents in the aggregates shall be determined in the field in accordance with the latest I.S. 2286 (Part – III) methods of test for aggregate for concrete.

(4) Unit weight of concrete.

It shall be determined by placing representative samples of concrete in a unit measures capacity and vibrating at extremely by shall vibratory or hand compacting to represent actual placing by conditions. The top of the concrete shall then be made truly flush with the top of the mould and the weight of concrete per cum. determined after curing and draying. The weight of dry concrete shall be between 2400-2625 kg / cum.

A complete record regarding various tests carried out at site and in the Laboratory shall be kept by the Engineer. The contractors shall provide at their own cost facilities for labour, material, and transport etc, required for the proper execution of the above tests. Any concrete, which does not comply with the above requirements, shall be liable for rejection by the Engineer.

1.6 Transporting Concrete:

The concrete shall be transported in clean metal buckets burrows, dumpers or trucks and the written approval of the Engineer must be obtained before any method involving the use of concrete pumps, placers, pipeline, chutes, or spouts may be used.

1.7 Placing Concrete:

(a) Unless otherwise approved, concrete shall be placed in a single operation to the full tackiness of slabs, beams and similar members and

shall be placed in horizontal layers not exceeding 600mm deep or 230 mm when manually compacted in walls columns and similar members.

(b) The contractor shall so organize has work that once concerting of a particular section of the work has started the operation shall be continued and each operation shall be completed prior to a stoppage for meal, etc. the contractor's attention is drawn to the requirements regarding the formation of construction joints.

(c) Where concrete is to be placed directly against the surface of excavations all soft material and debris shall be removed from the contact surfaces which shall be made dry, clean and firm. If the contact surfaces have become softened due to delay in placing the concrete or any other cause, they shall again be excavated to firm material and trimmed as directed immediately before the concrete is placed. The contractor in such event shall receive no payment for the additional excavation and trimming or for any additional concrete required to replace the material so removed.

(d) Concrete shall be well compacted between and round the steel reinforcement by approved means so as to ensure compact concrete with smooth surfaces, without air holes, flaws or voids. Great care shall be taken to prevent the displacement of the steel and form work before during or after concreting. Whenever possible all reinforcing members shall be fixed in position before the concreting has been started and securely wired together to prevent movement. Reinforcing members which must be inserted during the concreting shall be placed with the greatest care to ensure their perfect location in the finished work.

(e) Care shall be taken to prevent men engaged in placing concrete from introducing clay or other foreign matter into the concrete of form work by means of their body in any other way.

1.8 Compacting:

Concrete shall be properly compacted by use of vibrators or by rodding and spreading as directed by the Engineer. Tamping as above shall be continued until all the entrained air is removed and the concrete has been compacted and completely fills the form. The sides of the form work shall be gently tapped by spades during concreting.

1.9 Curing of Concrete:

All concrete work shall be protected from directed rays of the sun. The exposed surface shall be kept wet for a minimum period of 10 days or for such longer periods as may be directed by the Engineer-In-Charge, Concrete laid shall not be disturbed and shall be suitably protected from any injury until completely set, particular care shall be taken at all corners and edges of the member. All horizontal concrete shall be constantly wet by ponding or in any clear manner approved by the Engineer till the time of next pouring regardless of time. Concrete surface shall be cured either by sprinkling or by spraying water or by adopting any other method to keep the area moist. Flat or fine vertical surfaces may be covered with dump gunny bags and watered frequently water used for cut for shall be clean and free from any excessive silt, colouring matter or other impurities which may stain the finished work. In order to ensure adequate quantities of water for curing, the contractors shall make necessary arrangements such as providing sufficient lengths of temporary pipe lines of suitable size, storage of

water in tanks and / or sufficient nos. of Bhisties.

1.10 Concreting through water:

Concrete shall not be deposited under water without the prior consent in writing of the Engineer-In-Charge. In the event of permission being given the amount of cement in every batch shall be increased by twenty five per cent entirely at the expense of the contractor and he shall take every reasonable precaution to ensure that cement or fine aggregate is not washed out of any concrete so deposited by any flow of water.

1.11 Finish of Concrete:

On removal of the shuttering and after the approval of the Engineer-In-Charge, honeycombed surfaces shall be made good immediately by the method approved by the Engineer. Superficial water and air holes shall be filled in. Unless instructed to the contractor the faces of exposed concrete placed against shuttering shall be rubbed down with a carborandum stone immediately upon removal of the shuttering to remove fins or other irregularities. The face or concrete for which shuttering is not provided other than a slab, shall be smoothed with a wooden float to give finish equal to that of the rubbed down face where shuttering is provided. No cement wash master or paint may be applied to any concrete surface without the express instruction or permission of the Engineer.

1.12 Sulphate resisting and rapid hardening cement concrete:

Where sulphate resisting or rapid hardening Portland cement is specified or ordered by the Engineer in writing, extra cost will be paid over the price for a Portland cement concrete of similar grade.

1.13 Permission for starting the concrete work:

The surface where concrete or rock or form etc. on which concrete is to be placed, shall be got inspected and approved by the Engineer who shall then issue the permission for starting the work. Any concrete work done without such a permission shall be cut out and removed at the cost of contractors.

No concreting shall be started unless the surface of the foundation is first inspected and approved by the Engineer as stated above. If concreting is to be done on concrete previously laid, the surface of the old concrete shall be cleaned with wire brushed and all laitance removed to expose the original surface of metal and sand particles, etc. it shall then be covered with a 7 mm thick layer of cement mortar (1:2) before laying the fresh concrete.

1.14 Defective concrete:

The defective concrete shall be cut out and the work reconstructed with fresh concrete required quality in the presence of the Engineer. The concrete thus cut out shall not be reused under any circumstances. Should any concrete become permanently damaged due to creaking or broken or damage from whatever cause or should any concrete be found defective in quality due to honey combing or bad workmanship, it shall be removed forthwith and replaced by concrete of required quality at the cost of the contractors of the satisfaction of the Engineer.

2.0 FORM WORK:

2.1 Material:

All form work for concrete works shall be made either of planned and matched timber or MS plates. The timber for the form work shall be hard word dry and well seasoned. It shall not be so dry as to absorb water from concrete not shall it be so green as to shrink after erection. When steel plates are used for forms, the plates shall free from wrinkles, bents, lumps or other imperfections. The timber Corporations or steel plates shall have sufficient thickness to withstand the construction loads and the pressure exerted by the wet concrete as well as vibration during placing of concrete.

Normally the thickness shall not be less than 38mm for timber and 18 gauges for M.S. plates. However, in case where the depth of concrete to be pored in the form work is small the thickness of timber planks may be reduced in consultation with the Engineer.

2.2 Removal of form work:

In no circumstances shall forms to be strict off until the concrete reaches adequate strength as required or without obtaining permission of the Engineer. All form works shall be removed without such shock or vibration as would damage the concrete. Before the soffit and the struts are removed, the concrete surface shall be exposed where necessary in order to as certain has hardened sufficiently.

2.3 Surface treatment and finish:

When the form work is struck all the faces of concrete shall be smooth and sound, free from voids and air holes. Any roughness or irregularity on the exposed surfaces shall be immediately filled up while the concrete is still green with cement wash and or 1:1 ½ cement mortar properly trowel led and finished. Such patching of the concrete face shall be carried out with the permission of the Engineer. If the concrete is found honeycombed the honey combed portion and whatever surrounding the Engineer shall be dismantled and fresh concrete of proper quality shall be reinstated at Contractor's cost.

3.0 REINFORCEMENT:

The total reinforcement to be used on the work shall confirm to the specification of the latest IS: 1139, IS: 1786, IS: 226, IS: 432 as the case may be in respect of physical properties, chemical requirements tolerance limits etc.

All steel reinforcement and wire, nails etc, required for the works shall be supplied by the contractors who shall make their own arrangements for the procurement of reinforcement bars from the open market.

4.0 BRICK MASONRY WORKS:

4.1 Materials:

(1) Bricks: brick to be sound, well burnt, free from cracks, to ring when struck and not to crack or break when soaked in water or thrown on the ground on their flat face from a height of 60 cm, or when soaked in water in a saturated condition, regular in shape and uniform in size. They shall be of the best description obtainable in market and of the best quality and colour. They shall not absorb water more than 20 percent dry weight, when immersed in water for 24 hours. They shall have a crushing strength of not less than 35 kg / sq,cm.

(2) Sand: sand shall conform to the specifications detailed already for sand.

4.2 Cement Mortar:

All cement mortar to be used on this work shall be in proportion as specified and directed by the Engineer. The ingredients shall be in proportion as specified and directed by the Engineer. The ingredients shall be measured dry, by means of properly made gauge boxes on a covered platform and shall be thoroughly mixed dry before adding water to get the required consistency. Only such quantity of mortar shall be prepared at a time as can be used up immediately. Mortar after it has begun to set shall not be allowed to be racked up again, but shall be rejected and the contractor shall remove the same from the work site immediately.

4.3 Workmanship:

The work of brick shall be carried out in a workman like manner and in a prefect plumb, line and level as required. Brick shall be thoroughly cleaned well watered or soaked in water for at least 12 hours before being used on the work. No broken bricks shall be preserved throughout the work both laterally and transversely. All bed joints shall be horizontal in vertical walls, radial in arches and at right angle for the slopes in battered wells. In walling, the courses shall be kept perfectly horizontal and rise in plumb. The vertical joints shall break joints with the courses below and above. Use of bats shall be avoided as far as possible. The joints shall be close and regular and shall not exceed 12mm in thickness. The bond shall be English bond unless otherwise permitted by the Engineer. The contractors shall provide at their own expense all moulds, templates, centers, scaffolding etc. as may be required for the proper execution of the work and nothing extra will be paid for the same including dewatering where necessary.

The mortar used should be stiff. The brick work shall be kept wet while the work is in progress for at least seven days after completion, to the entire satisfaction of the Engineer. On Sundays and holidays when the work is not in progress, the masonry shall be watered continuously by engaging Bhisties. Watering shall be done carefully so as not to wash out the mortar of the joints. The Engineer shall be at liberty to engage Labours at contractor's cost to water/curing. If contractors fail to do so, the work shall be pulled down and rebuilt at the risk and cost of the contractors.

The whole of the masonry work shall be carried up at one uniform level through out but where breaks are unavoidable, the joint shall be made in good long steps raked so as to prevent cracks arising due to separation of old and new work. All junctions of walls shall be formed at the time the walls are being built and cross wells shall be carefully bonded into the main walls.

When the work is to be added to existing structure, the old work must be prepared to receive new work by roughening and grouting with a layer of rich mortar and both must be carefully bonded together.
During rains, the works to be carefully covered without extra charge so as to avoid fresh mortar being washed away.

4.4 Cement plaster:

Cement plaster shall be provided to brick masonry or rubble masonry

wherever directed by the Engineer.

(a) Materials:

(1) Cement: cement shall conform to the specifications detailed earlier.

(2) Sand: sand shall conform to the specifications detailed earlier.

(b) Cement Mortar: All cement mortar to be used on this work shall be in proportion as specified in the drawings and as directed. The ingredients shall be measured dry, by volume of properly made gauge boxes, on a covered platform and shall be thoroughly mixed dry before adding water to get the required consistency. Only such quantity of mortar shall be prepared at a time as can be used up immediately. Mortar after it has begun to set shall not be allowed to racked up again, but shall be removed from the work immediately. Cement mortar shall be used within 30 minutes after it leaves the mixing Corporation or mill.

(c) Workmanship:- All bricks shall be thoroughly wetted, joints and raked and well washed.

4.5 Pointing:

The whole of the exposed faces of the brick work, out stone work and stone paving when described as to be pointed are to have the joint raked out to a depth of 13 mm and pointed with cement and sand (unless otherwise described) in the proportion of one of cement to one of fine send flush with the face of the work and out straight, parallel and of uniform width.

The exposed faces of the rubble-work are to be similarly pointed (when described as to be pointed) but the joints shall be raked out to a depth of 20mm and shall be racked out to a depth of 20mm and shall be irregular in direction. The above description of pointing shall apply generally so all classes except only as the pointing materials which may in certain cases or otherwise described in this specification.

4.6 Protection of work from sun:

All cement work pointing, plastering and concreting shall be protected from the sun and the surface kept moisture until in the opinion of the Engineer-in- charge it is thoroughly set.

5.0 DEFINITION OF INCOMPLETE WORK:-

A line or trench of pipeline (including the excavation thereof and all other accessories thereto) will be considered incomplete unless entirely laid, jointed and fully tested, encased wherever required the trench filled and consolidated and all other detail.

The contractor shall have no claim for incomplete work and no incomplete work will be measured up for payment to the contractors.

5.1 Rates quoted in Bill of Quantities to cover everything necessary for complete Execution of work:

The rates quoted will be held to cover everything necessary of the due and complete execution of the work according to the drawings and the several conditions and the stipulations of the contract, including specification, or the evident intent and meaning of all or either of them or according to customary usage and for the periodical and final inspection and test and proof of the work in every respect and for measuring, numbering or weighing the same including setting out and laying or fixing in position and the provision of all materials, power, tool

rammers, beaters, labour, tackle platforms with impervious lapped joints for scaffolding ranging rods, straight edges, centering and boxes, wedges, moulds, templates, post straight rails, boning- staves, measuring rods, page boards, shores, barriers, fencing, lighting, pumping apparatus, temporary arrangements of passage of traffic, access to premises and continuance of drainage, water supply and lighting (if interrupted by the work) lard temporary sheds and buildings nahanis roofed in or otherwise haulage, painting, varnishing, polishing, establishments for efficient supervision and watching arrangements for the efficient protection of life and property and all requisite plant, implements and appliances every kind, except only such matter and things as it may be distinctly stated here in are to be supplied by the contractors. A rate for anyone description of work is to be held to include such items of other classes of and for these on separate specific charge will be admitted. The contractors shall keep every portion of the work clear of accumulation from time to time and shall leave every portion of the work clean, clear, perfect and at the conclusion of whole, providing at their own cost all such material implement appliances and labour as the Engineer may require to prove if it is to be so.

6.0 CONTRACTOR TO OBSERVE ALL CONDITIONS:

The contractors are particularly directed to observe from the Articles of Agreement and the specifications, what is to be included in their rates for the several portions of the work and also under what conditions payments are to be made.

Signature of Contractor

City Engineer
Rajkot Municipal Corporation

TECHNICAL SPECIFICATIONS

ITEM NO.1 :
Excavation for pipeline trenches with shoring, strutting and bailing out or pumping out water from trenches wherever necessary of required length, width and depth including excavation for socket and all safety measures and provisions such as site rails, fencing, lighting, watching including refilling the trenches and clearing the site etc as stipulated in the tender specification complete before starting work and after completion of work for the lift and strata as specified below including spreading the excavated stuff as directed with lead up to 90 Mtr.

1.1 0 to 1.5 mt depth.
1.1.1 ---do--- in all sorts of soil,soft murrum, hard murrum, boulders and macadam road
1.1.2 ---do--- In soft rock, Hard rock

1.2 1.51 to 3.00 mt depth.
1.2.1 ---do--- In soft rock ,Hard rock

Excavation for pipe line trenches with shoring, strutting, bailing or pumping out watered from trenches whenever necessary of required length, width and depth including extra excavations for sockets and all safety measures and provisions such as site rails fencing, lighting, watching including refilling the trenches in layers including ramming and removing the excavated staff with 90m lead and clearing the site etc. as stipulated in the tender specification complete before starting work and after completion of work for all lifts and soil strata as specified.

a) In all sorts of soil soft murmur, hard murrum, boulders, macadam and asphalt roads including breaking of lime and cement masonry and lime concrete.

b) In soft rock, cement concrete, hard rock, and cutting of cement concrete and R.C.C. of any proportion, etc. with controlled blasting and or chiseling whichever is necessary and feasible as required by site conditions.

c) In hard rock,

1.1 Clearing of sites :

1.1.1 The site at which the pipe line is to laid and the area required for setting out and other operations shall be cleared of all obstructions, loose stones, and rubbish of all kinds; stumps of trees, brushwood as well as all trees shall be removed as directed. The roots shall be entirely grubbed up.

1.1.2 The products of the clearings to be stacked in such a place and in such a manner, As directed by the Engineer-in-charge.

1.1.3 In site clearing, all trees not specially marked for preservation, bamboos jungle wood and brush wood shall be cut down and their roots grubbed up. All wood and materials from the clearing shall be the property of corporation and shall be arranged as directed by the Engineer-in-charge or his authorized agent. The materials found to be useful by the Engineer-in-charge shall be conveyed and properly stacked as directed within the specified limit. Unless materials will be burnt or otherwise disposed off as directed.

1.1.4 All holes or hollows, whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well rammed and leveled off, as may be directed shall not be paid for. The contractor shall get approval of design of shoring. The shoring shall be of sufficient strength to resist side pressure and ensure safety from slips and blows and to prevent damage to work and property and injury to persons. It shall be removed as directed after all the items of work for which it is required are completed.

1.1.5 Protection :

1.1.5.1 The foundation pits and trenches, etc shall be strongly fenced and red light Signals shall be kept at night in charge of watch-man to prevent accidents. Sufficient care and protective measure shall be taken to see that the excavation shall not affect or damage the adjoining structures. The contractor shall be entirely responsible for any injury to life and damage to the properties etc. Necessary protection work such as guide ropes, crossing places, barricades, the contractor at his own cost shall provide caution boards etc.

1.6 Classification of Strata :

1.6.1 The decision regarding classification of strata shall rest with the Engineer-in-Charge and his decision shall be final and binding to the contractor.

1.6.2 All the materials encountered in the excavation shall be classified as described in 2.0 of general specifications.

1.7 Dewatering :

1.7.1 Unless specially provided for as a separate item in the contract, the rate of excavation would include bailing or pumping out all water met with in excavation or which may accumulate in the excavation during the progress of the work either, by percolation, seepage, springs, rain or any other cause and diverting surface flow if any, by earthen bunds or by other means. The bunds shall be removed as soon as the work is completed.

1.7.2 Unless specially provided as a separate item of contract, pumping of water from foundation pit, trenches etc shall be carried out by the contractor at his won cost and he shall arrange for required numbers of dewatering pumping sets for the above work. He shall take precaution to prevent any damage to the foundation trenches, concrete or masonry or any adjacent structure. The excavation shall be kept free from water by the contractor (1) during inspection and measurement (2) When concrete and/or masonry work are in progress and till the construction work reaches above the natural water level and (3) till the Engineer – in – charge considers that the mortar is sufficiently set. The rate shall be paid for cum. of excavation.

1.8 Excavation in Rock :

1.8.1 Blasting with Gun Power:

Blasting operations shall be carried out with the prior permission and in the presence of the Engineer – in – charge or his authorized representative and during fixed time hours of the day. All safety precautions such as providing safety nylon netting etc. shall be carried out as per instructions of the Engineer – in – charge.

Red danger flags shall be prominently displayed and all the people, except those who have actually to light the fuse must be away to a safe distance, not less than 200 meters.

All fuses shall be cut to the length required before being inserted into the holes.

The number of charges to be fired and the actual number of shots heard shall be compared and the person responsible must satisfy himself by examination that all the charges have exploded before work people are permitted to approach the scene. The withdrawal of a charge which has not exploded shall under no circumstances be permitted, but the tamping and charge shall be flooded with water and the hole marked in a distinguishing manner. The next hole to be fired shall be at a distance of about 500mm from the old hole and fired in the usual way.

The contractor or any of his competent authorized person shall be in charge of the blasting operations and shall be held responsible for strictly observing the safety rules, particularly applicable to blasting operations, in addition to other safety rules.

In blasting rocks with dynamite, the following general principles shall be observed.

In general, the following diameter of drills shall be used for different depth of boreholes:

From 1 – 2 metres	25 mm diameter
From 2 – 3 metres	37 – 50 mm diameter
From 3 – 4.75 metres	50 – 60 mm diameter

The borehole should generally be not more than 1.3m deep and the distance apart should be from one and half to twice the depth.

Cracks and fissures in the rock to be blasted shall be carefully studied to as certain the best portion forth the boreholes. Charge shall always be placed in a round piece of rock, if possible not nearer than 30mm from the crack.

Rules for blasting with dynamite and other high explosives

The person - in- charge must show that he is thoroughly acquainted with all blasting operations and that he understands the rules herewith laid down. He will be held responsible for any accident that may occur.

Boreholes must be of such sizes that the cartridge can easily pass down them. The position of all holes to be drilled must be marked out with white paint and the person – in – charge must take particular note of these positions.

The drilling operation being finished, the person – in – charge must make a second inspection and satisfy himself that the boreholes marked out by him have been drilled. The person – in – charge must prepare all charges necessary for boreholes.

Only ten holes may be loaded and fixed at one time and the charges should be fixed simultaneously as far as practicable. Boreholes must be thoroughly cleared before a cartridge is inserted.

The loading is to be done by the person – in – charge himself and the position of the charge holes carefully noted by him. Wooden tamping rods only to be used in charging holes (not pointed but cylindrical throughout, one cartridge at a time must be inserted and gently pressed with the tamping rod.

Immediately before firing blast, due warning must be given and the person – in – charge must see that all the labourers have retired to safety.

The safety fuse of the charged holes are to be lighted in the presence of the person – in – charge, who must see that the fuses of the holes charged have properly ignited. After the blast, the person – in – charge must carefully inspect the work and satisfy himself that all the charges have exploded.

1.8.2 Misfires:

Misfires are a source of great danger, if it is suspected that part of the blast failed to fire or is delayed, allow sufficient time to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time, at least of an hour should be allowed.

None of the drillers are to work near this hole until the two following separations have been done by the person – in – charge.

(a) The person – in – charge should very carefully extract the tamping with a wooden scrapper and withdraw the fuse with the primer and detonator attached, after which a fresh primer and detonator with fuse should be placed in this hole and fired or.

The hole may be cleared of 300mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 150mm away and parallel to it, the hole to be then charged and fired. The person – in – charge shall also at once report to the Engineer – in charge all cases of misfire, that cause of the same and what steps have been taken in connection herewith.

1.8.2.1 Precautions against misfire:

The safety fuse should be cut in an oblique direction with a knife.

All saw dust must be cleared from the inside of the detonator this can be done by blowing down the detonator and tapping the open end. No instrument shall be inserted into the detonator for this purpose.

After inserting the fuse in the detonator, it shall be fixed by means of nippers.

If there is water present, or if the boreholes be damp, the junction of the fuse and detonator must be made water tight by means of grease, white or lead.

The detonator should be inserted into the cartridge, so that about one third of the copper tube is left exposed outside the explosives. The safety fuse outside the detonator, should be necessarily tied in position in the cartridge. Water proof fuse only to be used in the damp boreholes, or when water is present in the bore-holes.

If a misfire has been found to be due to defective fuse detonator or dynamite, the whole quantity or box from which the defective article was used shall be rejected.

Storage of materials for blasting shall be as per regulations/stipulations of the concerned authorities.

It shall be the contractor's responsibilities to arrange proper storage of explosives and obtain required permission from concerned authorities. No separate payment will be made for the above.

The refilling will generally refer to refilling of trenches up to ground level with excavated stuff.

Filling materials shall be from excavated stuff.
Excavated stuff to be used shall be cleared of all rubbish, large size stones, brick bats etc. Big clods shall be broken down to a size of 50 mm or less.

1.9 Refilling :
After the pipes have been laid and jointed and the chambers are constructed and as soon as the joints have been inspected and passed by the Engineer-in-charge, the pipe line has been tested for water tightness, and after all concrete work thoroughly set the trenches shall be fulfilled with the materials taken there from. In refilling the trenches, the utmost care shall be exercised so as not to disturb, break or damage the jointed pipes. over and around every pipe, the finest selected material shall be put. No lumps of rock earth or other material around the pipe or be thrown into the trenches until the same has been broken to specified size and pipes covered by the fine material above referred to. The selected fine material shall be carefully placed next to the permanent work and well packed and well rammed in layers of 150mm for a depth of at least 300mm over the top of the pipe. The remaining of the excavation shall be filled in with the best and most suitable portions of the excavated material in layers of not more than 600 mm deep, each layer shall be thoroughly rammed before the next layer is placed. One man shall be employed for hand ramming for every 30m of refilling up to the level of 300mm over the top of the pipe. Surplus soil shall be piled on top of the filling to the extent possible for expected subsidence. All road materials to from a compact neat surface. The surface of the filled in trench shall be hand rolled by a hand roller weighing not less the ½ tones as directed by the Engineer-in-charge.

The contractor shall maintain all refilling and surfaces until reinstated. The contractor shall responsible for claims arising from accidents due to subsidence or inadequate maintenance or improperly refilling work.

The contractor shall be responsible for any settlement during the defects liability period including monsoon and the same shall be refilled with stuff brought from outside, if necessary.

Where excavated material is not considered suitable for refilling by the Engineer-in-charge, the Contractor will be required to cart selected surplus excavated materials in place of unsuitable materials. The contractor may also be instructed to supply suitable granular or other hard filling material for use in refilling. Such imported filling material shall be paid for at the rates given in the Bill of quantities.

No payment shall be made for carting away surplus material arising either because of rejection of excavated material for refilling or because of surplus material.

Measurement:
The contractor's shall be for the **unit of one cubic meter** of the quantity excavated limited to the dimensions and provisions specified in the specifications or as directed by the Engineer-in-charge. The extra excavation to provide for jointing pipes, shoring etc. will not be paid for. The rates shall include cleaning and clearing the trench site by cutting grass, shrubs and trees of girth (circumference) not exceeding 10 feet and removing their obstructing roots in the trench cleaning the site, setting out works as per sanctioned plans, provide shoring, excavation and removal of all material from trenches, backfilling the trenches up to natural ground level and all other operations

described above. The wood obtained during site clearance shall be the property of the department concerned.

The excavated quantity divided into two sub groups

ITEM NO.2.
Providing and spraying murrum bedding of 150 mm thick below the pipe line over the prepared sub-grade in the pipe trenches, inclusive of watering, ratting, consolidation etc. complete.

2.1 from selected excavated earth

2.2 murrum brought from outside

Murrum to be used from selected excavated stuff./ Murrum brought from outside.

Specifications :
Any inherent material like Big clods, tress roots, weeds, big metals and other objectionable material liable to decay shall not be used in the bedding.

The bedding shall be placed uniformly with minimum thickness of 150 mm along the route of the excavated pipe trench as directed by the Engineer-in-charge. The bedding surface shall be smooth without any humps, depressions etc.

Mode of Measurement :
The quantity of work shall be paid **on the cum of the completed bedding** after proper consolidation and watering.

Item No.3
Providing & Supplying Ductile Iron pipe (K9)with internal cement mortar lining and external zinc coating with finishing layer of bitumen; manufactured ,tested and duty marked in strict accordance with conforming to IS:8329/2000 (as per latest amendment); suitable for push-on jointing, along with one number rubber gasket for each length of pipe (EPDM Gasket as per IS:5382/ 1985). including all texes, insurance, transportation, freight charges, inspection charges, loading, unloading to site of work

DUCTILE IRON PIPES
Note: Wherever International Standards or Indian standards / specifications are mentioned, their equivalent or higher standards / specifications are also acceptable

Supply and Delivery of **Ductile Iron Pipe as per IS:8329-2000 & IS 9523/2000 DI fittings** or its latest revision or amendments if any including jointing material as EPDM ring as per IS 5382-1985 and ISO: 4633-1996 or its latest revision or amendments if any.

Standards
The following standards, specifications and codes are part of this specification. In all cases, the latest revision of the including all applicable official amendments and revisions shall be referred to. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

1) ISO: 10803-1997 Design method for ductile iron pipes

2) IS:8329-2000 Centrifugally Cast (spun) ductile iron pressure pipes for water, gas
and sewage & IS 9523 for DI Fittings/Specials.

3) ISO:2531-1991 Ductile iron pipes, fittings and accessories for pressure pipelines.

4) ISO:4179-1985 Ductile iron pipes for pressure and non pressure-Centrifugal cement mortar lining – General requirements.

5) IS:8112 Specification for 53 Grade ordinary Portland cement.

6) BS:3416 Bitumen based coatings for cold application, suitable for use in contact with potable water.

7) ISO:8179-1995 Ductile iron pipes-External coating-Part-1 Metallic Zinc with finishing layer.

8) IS:638 Sheet rubber jointing and rubber insertion jointing.

9) ISO:4633-1996 Rubber seals-Joint rings.

10) IS:5382-1985 Specification for Rubber sealing rings for gas mains, water mains and sewers.

11) AWWA C600 Installation of ductile iron water mains and their appurtenances.

1.0 Internal Diameter:
The nominal values of the internal diameters of pipe, expressed in millimeters are approximately equal to the number indicating their nominal sizes DN.

2.0 Length:
The working length of socket and spigot pipes shall be 5 m ,5.5 m, or 6 metres.

3.0 Thickness:
The wall thickness of pipe 'e' in mm shall be calculated as a function of the nominal diameter by the following equation with minimum of 5 mm
$e = K(0.5 + 0.001\ DN)$
where : e = wall thickness in mm, DN = the nominal diameter, K = the whole number coefficient

4.0 EPDM Rubber Gasket:
Rubber Gasket shall be suitably for Push-on-Joint.
The spigot ends shall be suitably chamfered or rounded off to facilitate smooth entry of pipe in the socket fitted with the rubber gasket
Rubber Gasket shall confirm to IS 5382-1985 and ISO : 4633-1996 its latest revision or amendments if any

5.0 Sampling Criteria:
Sampling criteria for various tests, unless specified in IS 8329-2000, shall be as laid down in IS 11606. Mechanical test, Brinell Hardness test, Hydrostatic test etc are shall be as per IS 8329-2000

6.0 Tolerances on External Diameter:
The nominal external diameter (DE) of the spigot end of socket and spigot pipes and when measured circumferentially using a diameter tape shall confirm to the requirements specified as follow. The positive tolerance is +1 mm and applies to all thickness classes of pipes. The maximum negative tolerance of the external diameter are specified as follow:

DN	Nominal	Positive Tolerance	Negative Tolerance
80	98	+1	-2.2
100	118	+1	-2.8
125	144	+1	-2.9
150	170	+1	-3.0
200	222	+1	-3.0
250	274	+1	-3.1
300	326	+1	-3.3
350	378	+1	-3.4
400	429	+1	-3.5
450	480	+1	-3.6
500	532	+1	-3.8
600	635	+1	-4.0

7.0 Tolerance on Ovality:

Pipes shall be as far as possible circular internally and externally. The tolerance for out-or-roundness of the socket and spigot ends is given below:

Nominal Diameter in mm	Allowable Difference Between Minor Axis and DE in mm
80 to 300	1.0
350 to 600	1.75
700	2.0
750 to 800	2.4
900 to 1000	3.5

8.0 Tolerance in thickness

The tolerance on wall thickness (e) and the flange thickness (b) of the pipes shall be as below:

Dimensions	Tolerance in mm
Wall thickness (e)	- (1.3 + 0.001 DN)1)
Flange thickness (b)	+ (2+0.05b) & - (2+0.05b)

9.0 Coating

Pipe shall be delivered internally and externally coated.

External Coating: Pipe shall be metallic zinc coated and after that it shall be given a finishing layer of bituminous paint as per IS - 8329-2000 Zinc coating shall comply with IS:8329/EN 545/ ISO 8179. Only molten zinc spray coating shall be acceptable. The average mass of sprayed metal shall not be less than 130 g/sqm with a local minimum of 110 g/sqm. Bitumen overcoat shall be of normal thickness of 70 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II suitable for tropical climates factory applied preferably through an automatic process.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

Internal lining: Internally pipe shall be Portland Cement mortar lined (as per IS - 8329- 2000). The mortar shall contain by mass at least one part of cement to 3.5 part of sand. All pipes and fittings shall be internally lined with cement mortar using high speed centrifugal process in accordance with IWO 4179/IS 8329. Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards. No admixtures n the mortar shall be

used without the approval of the Engineer. The sand to cement proportion of sand if justified by the sieve analysis. Pipe lining shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 8329 Annex-B or ISO 4179. This is given below.

Nominal Pipe Size (mm)	**Nominal lining thickness (mm)**
Up to 300	3
350-600	5
700-1200	6
1400-2000	9

10.0 Joint

Jointing of DI pipes and fittings shall be push-on type

Push-on-joints

The Contractor shall source the push-on-joint gaskets only from the pipe manufactures. In turn the pipe manufacturer shall supply at least 10% additional quantity of gaskets over and above the requirement to the Contractor at no extra cost. The gasket used for joints shall be suitable for natural and purified water conveyance. In jointing DI pipes and fittings, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipments to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that once the rubber ring is correctly positioned before the joint is made, does not get damaged by friction or sharp edges of the spigot Chamfer. The rubber rings and the recommend lubricant shall be obtained only through the pipe manufacturer.

Rubber ring bundles form every lot shall carry with them manufacturers test certificate for the following mechanical properties.

1. Hardness
2. Tensile strength
3. Compression set
4. Accelerated again test
5. Water absorption test
6. Stress relaxation test

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, the month and year of manufacture and the shelf life.

11.0 Testing of Pipe:

The main test among others to be conducted shall be as per IS:8329-2000 or with its latest revision/amendments.

[a] Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes as specified in the Standards. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 11606-1986. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS;8329/EN 545 for pipes and IS:9523/EN 545 for fittings.

[b] Brinell Hardness Test

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut form the pipes used for the ring test and tensile test in accordance with IS:1500. The test shall comply with the requirements specified in IS:1500/ISO 6506.

[c] Re-tests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements the lot shall be accepted. Should either of these additional test pieces fall to pass the test, the lot shall be liable for rejection.

[d] For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in the standard for a period of minimum 15 seconds during which the pipes shall be struck moderately with a 700 g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

12.0 Quality Assurance

The manufacturer shall have a laid down **Quality Assurance Plan** for the manufacture of the products offered which shall be submitted along with the tenders and successful tendered shall have to get its approval from RMC. All the materials, pipe, specials, valves etc. shall have to be inspected through Inspecting TPI/PMC Agency whichever suggested by RMC and the charges for the TPI/PMC Shall have to be borne by the RMC .

Measurement of pipe lines:

Payment for providing, supplying, jointing and testing of DI Pipe shall be made as under:

Payment will be made in running meter of pipe.

Payment for providing and supplying of DI Pipes.

(i) 90% payment of pipes supply item shall be paid after satisfactory supply, lowering, laying, jointing of pipes.

(ii) Remaining 10% payment of pipes supply item shall be paid after satisfactory hydraulic test.

Item No.4
SPECIFICATION :
Lowering, laying and jointing in Position of DI K-9 pipe with CI/DI/MS special in proper position, grade and alignment as directed by Engineer including transportation to site of work, labour, giving hydraulic testing as per IS Code etc. complete.

A) EXTERNAL COATING :

1. Metallic Zinc with finishing layer of bituminous as per Annexure 'A' of IS: 9523/2000.
2. Zinc rich paint with finishing layer of bituminous as per Annexure 'A' of IS: 9523/2000.
3. Bituminous paint as per Annexure 'C' of IS: 9523/2000.

B) INTERNAL LINING :

1. Portland Cement (with or without additives) mortar as per Annexure – 'B' of IS: 9523/2000.
2. Cement Mortar with Coal coat as per Annexure 'B' of IS 9523/2000.
3. Bituminous paint as per Annexure 'C' of IS: 9523/2000.

C) METALURGY & MICRO STRUCTURE :

The metal used for manufacture of D.I. fittings as per IS : 9523-2000 shall conform to the appropriate grade as specified in IS : 1865-2005.

D.I. Fittings shall contain a Stub (as cast), minimum length -15mm x dia.- 10 mm., which at the time of Inspection can be cut at random to carry out Metallographic test to ascertain minimum 80% Graphite No dularity as per Clause – 9.1 of IS : 1865-2005, in the form - V or VI as per IS : 7754-2003.

D) MANUFACTURING & VERIFICATION:

All the DI fittings and specials shall conform to IS: 9523/2000 and shall be manufactured at well equipped foundries.

Quality Assurance

The manufacturer shall have a laid down **Quality Assurance Plan** for the manufacture of the products offered which shall be submitted along with the tenders and successful tendered shall have to get its approval from RMC before manufacturing clearance.

Measurement of pipe lines:
Payment for lowering, laying, jointing and testing of
DI Pipe shall be made as under:
Payment will be made in running meter of pipe.

Payment for lowering, laying, jointing and testing of of DI Pipes.

(i) 90% payment of lowering, laying jointing and testing item of pipes shall be paid after lowering, laying and jointing pipes as per specifications.

(ii) Remaining 10% payment shall be paid after satisfactory hydraulic test.

Item No.5

Providing, Supplying and Fixing of all type Ductile iron fittings (K12) like, bends, tees, reducers or any other specials as per IS-9523-2000(as per latest amendment) use with D.I. pipes manufactured as per IS:8329/ 1994 (With external bitumen & zink coating & internal cement mortar lining). including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading to site of work

1.1 General

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured from 6 to 10 mm thick steel plate as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

1.2 Bends

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

(b) 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.

(c) Bends shall be designed with deflection angle of maximum 10 deg. between segments.

(d) 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 the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.

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

(f) Details of thrust collars anchor bolts, holding down straps, saddle plates should be furnished together with full specifications in Contractor's fabrication drawing.

1.3 Flanges

Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary bolt holes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the sluice 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 Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

1.4 Blank Flanges

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel plates,

tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

1.5 Stiffener Rings

The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side. All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

1.6 Field Hydraulic Test

After erection at site and after the concrete anchor blocks have been constructed, the section of the pipeline shall be subjected to a hydraulic test as follows, to the test pressure as mentioned below:

1.6.1 The pressure test shall be conducted in as per IS- 5822-1986.

1.6.2 During the test, the pipe shall be struck sharp blows with 1 Kg hammer. Water shall not spout, ooze or sweat either through joints-welded or bolted or the body of the pipe. If any leakage noticed shall be repaired by the Contractor, which shall include coating and repairing of the damaged portion. Repairs and replacements and further testing including the cost of the plates and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost. **Wt. of pipe specials shall be carried out before guniting and shall be paid on weight per Kg bases.**

1.7 Welding of MS Pipe Line / Specials & cutting of pipeline

The item includes following operations:

i)Carting of pipes from departmental store to site of work

ii) Lowering and laying pipes and specials in trenches.

iii) Welding of pipes and specials as per IS 5822: 1994

iv)Testing of welded joint as specified in the IS 5822: 1994 para 6.2. & Tensile test for minimum one joint out of forty joints.

v)Hydraulic testing of the pipes

M.S. pipe/specials shall be lowered, laid and jointed by welding including preparation of ends wherever required, grinding as per relevant IS code of welding, testing etc. complete with hydraulic testing complete as per IS: 5822-1994.

Mode of Measurement :

Payment will be made in Kg. basis.

Payment for Supplying and Fixing of all type Ductile iron fittings(K12) like , bends, tees, reducers or any other specials as under,

(i) 90% payment of Supplying and Fixing of all type Ductile iron fittings(K12) like ,bends, tees, reducers or any other specials shall be paid after Supplying and Fixing as per specifications.

(ii) Remaining 10% payment shall be paid after satisfactory hydraulic test.

ITEM NO. 06.

Providing, supplying, Lowering, Laying, Jointing in Position of IS 14846 Sluice valves, of PN1.0 class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, stacking etc complete. (ISI marked PN-1 Marked)

SCOPE :

This specification covers the design requirements, features of construction, inspection, testing, painting, delivery, installation and commissioning of sluice valves with gaskets, hardware etc.

CODES AND STANDARDS :

The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the vendor of this responsibility. Valves shall conforming to **IS 14846 & ISI Marked only.**

DESIGN REQUIREMENTS FOR SLUICE VALVES :

Valve shall be provided with back seat arrangement. Renewable body and screwed wedge rings (riveted over and above) shall be provided.
Collared drain plugs of gunmetal shall be provided for all valves.
Valves shall be with non-rising spindle type and with indicator of valve opening-closing.
Valves shall be flanged and drilling shall conform to the standard as specified in data sheet.
Face to face dimension shall be as per IS 14846.
Gear operation when provided above 400 mm, the gear shall be packed enclosed (spur/worm) type. These gear boxes shall be sealed in such that there shall be no leakage of oil or grease even after long use.
Valves above 450 mm above shall be provided with a drain plug and air plug.
Valve of sizes 300 mm above shall be provided with machined shoe channel arrangement (with lining made of SS)
The face and seat rings shall be riveted over and above press fitted.
Valves shall be gear operated, manually hand wheel OR actuator operated.
Wherever specifically asked, valve shall be provided with actuators.
Appropriate bushing arrangement for replacement of packing without leakage for sizes above 300 mm and above shall be provided.
Stuffing box gland shall be of bolted type.

CLEANING :

Prior to factory inspection, all manufacturing waste such as metal chips, debris and all other foreign material shall be removed from the interior of the valve. All mill scale, rust, oil, grease, chalk and all other material shall be removed from the interior and exterior surfaces.

PAINTING :

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and adhere perfectly to the surface.

HAND WHEEL:

A hand wheel shall be provided for normal operation.

DIRECTION OF FLOW:

Direction of flow shall coincide with the flow direction indicated by "arrow" casted on the valve body.

TESTS AND INSPECTION:

Valves shall be offered for visual inspection and dimension check.

Valves shall be tested as per IS 14846 with latest amendments.
The hydrostatic testing shall be witnessed by the authorized representative of client.
Sluice valve shall be tested with and/or without actuator.

NAME PLATE :
All valves shall have permanent name plates indicating the services for which they will be used and the design temperature and pressure rating.

The item shall be measured and paid per number of Sluice valves provided including cost of necessary jointing material and all taxes, duties and insurance charges etc. complete and payment will be made as per payment schedule.

Mode of Measurement :

Payment will be made in Nos. of valves

Payment for Providing , supplying, Lowering, Laying, Jointing in Position of IS 14846 Sluice valves, butterfly valves & Reflux valves

(i) 90% payment of Providing , supplying lowering, laying jointing and testing item of Valves shall be paid after lowering, laying and jointing pipes as per specifications.

(ii) Remaining 10% payment shall be paid after satisfactory hydraulic test.

ITEM No.7.
Providing, supplying, Lowering, Laying, Jointing in Position of C.I. Air valves of 14845 ISI marked & quality of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, stacking etc. complete (DS2 - IS14845 fig. 3B)

GENERAL :

1) The double acting air valves shall have two ball chambers, having one outlet of Large capacity for admission and release of built volume of air during emptying and filing of the main another having small outlet for escape of smaller quantities of entrapped air. This type of air valves hall be of flanged type with full conformation with IS : 1538.
2) The ball sealed orifice always remains open while air is exhausting and is immediately closed when rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and causes the ball blown into the discharging air streams, blowing the valve shut prematurely.
3) The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/sec. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free air versus pressure differential for all sizes of valves offered by hi
4) Under no circumstances shall be large orifice ball blow shut prematurely.
5) The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

6) The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.
7) The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of glade 2 of IS : 210.
8) Where tenderer considers necessary a suitable drain shall be provided.

JOINTING MATERIAL :

1) Each valve shall be supplied with all necessary joint ring, nuts, bolts and washers for completing the joints such that it will ensure effective sealing of large orifice even at low pressures. The weights of floats of the same size and type shall not differ by more than 2%.

   The timber, if used in the manufacture of floats shall be seasoned and those provided in large orifice shall be ebonite coated. The float provided in high pressure chamber, if manufactured from seasoned wood, shall be coated with " ethylene propylene Rubber " (EPDM).

HIGH PRESSURE ORIFICE :

1) The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working condition by "EDPM" coated float.
2) The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

VALVE FLANGES :

All valves flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS: 1538 (PART-I TO XXIII)-1976 (specification for C.I. fittings for pressure pipes for water etc.)

COATING :

1) The casting shall be such that it shall not impart any taste or smell to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when exposed to a temperature of 77^0 C and not so brittle at a temperature of 15^0 C as to chip off when scratched lightly with the point of penknife.
2) Alternatively, two coats of black Japan conforming to type 8 of IS : 158-1969 (OR latest edition) shall be applied.

TESTING :

The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be waster tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

JOINTING MATERIAL :

The contractor shall have to provide all the jointing material like bolts, nuts, packing, white zinc etc. at his cost.

PAYMENT :

The item shall be measured and paid per number of air valve provided including cost of necessary jointing material cost of all jointing material and all taxes, duties and insurance charges etc. complete and payment will be made as per payment schedule.

Mode of Measurement :

Payment will be made in Nos. of valves

Payment for Providing , supplying, Lowering, Laying, Jointing in Position of C. I. Air valves of ISI marked

(i) 90% payment of Providing , supplying lowering, laying jointing and testing item of Valves shall be paid after lowering, laying and jointing pipes as per specifications.

(ii) Remaining 10% payment shall be paid after satisfactory hydraulic test.

Item No.8
Providing, Fitting and fixing of M S Special Plain / Flange Ended:

The Specials of different diameter shall have to be prepared from steel as per instructions. The work should be carried out in such a way that there should be no marks of welding etc. in the Specials in the Plain Ended and Flange ended. The work should be with finishing, neat and clean. These Specials should be leak proof and shall have to be fixed on site as per instructions in a systematic manner.

Mode of Measurement :

Payment will be made in Kg. basis.

Payment for Supplying and Fixing of all type M S Special Plain / Flange Ended or any other specials as under,

(i) 90% payment of Supplying and Fixing of all type M S Special Plain / Flange Ended or any other specials shall be paid after Supplying and Fixing as per specifications.
(ii) Remaining 10% payment shall be paid after satisfactory hydraulic test

ITEM NO.9 :
Providing & supplying reinforcement (for C.C. work for encasing pipes & thrust blocks) including cutting, bending, binding and placing in position etc complete. Tore steel: Fe-415 (TMT bars)

Details/dimensions of reinforcement for encasing pipes & thrust blocks shall be as per type design approved by the Engineer-in-charge shall be provided by the contractor at this own cost.

The reinforcement shall be of deformed steel bars of strength 415 Mpa complying with IS:1786 and in accordance with the requirements. The bars shall be free from oil, dirt, loose rust and scale.

Reinforcement for C.C. work for encasing pipes & thrust blocks also including work of cutting, bending, binding, and placing in position etc.

All reinforcement steel shall be of TMT bars confirming to IS: 1786 of Make TATA VIZAG, SAIL, ELECTROTHERM, GALLANT, NEELKANTH, or equivalent make approved by Engineer-in-charge and welded wire fabric to IS: 1566 for water retaining structure.

Reinforcement bars shall conform to IS-432, IS-226 or IS-1786 and welded wire fabrics to IS : 1566. Only TMT bars for reinforcement in RCC work shall be used which shall be clean, free from pitting, oil, grease, paint, loose mill scale, rust, dirty dust or any other such substance that will destroy or reduce bond.

The rate shall be paid for kg. bases.

Item No.10:
Providing, supplying, and fixing the set of MS Frame, RCC precast sleeper beam & sleeper covers for scraper manhole as per type design and specification (1 set comprises of (a) m.s. frame -1 no. (b) RCC precast sleeper beam-1 no. & © sleeper cover 4 nos.)

For this item, M S frame, RCC precast sleeper beam and sleeper covers shall be manufactured as per as per type design and drawings of Rajkot Municipal Corporation.

The mode of measurement shall be per one set complete of (a) M S frame - 1 No., (b) RCC precast sleeper beam - 1 No., and (c) sleeper cover - 4 Nos.

Item No.11
Brick Masonry work with cement mortar 1:6 complete:

Materials:
Water shall confirm to M-1.
Cement:
Cement shall confirm to M-3.

Brick:
The bricks shall be hard or machine moulded and made from suitable soils and burnt. They shall be free from cracks and flaws and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colors.

The bricks should not be broken when thrown on the ground from a height of 600 mm.

The size of modular bricks shall be 190 mm x 90 mm x 90 mm.

The size of the conventional bricks shall be as under:
(9" x 4.3/8" x 2,3/4") 225 x 110 x 75 mm

Only bricks of one standard size shall be used in one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.

Length ±1/8" (3mm) width : ± 1/16" (1.5mm)
Height: ± 1/16" (1.5 mm)

The crushing strength of the bricks shall not be less than 35 kg/sq.cm. The average water absorption shall not be more than 20 percent by weight. Necessary tests for crushing strength and water absorption etc., shall be carried out as per IS: 3495 (Part I

to IV) - latest edition.

Workmanship:
i) Proportion:
The proportion of the cement mortar shall be 1:6 (1-Cement, 6-Fine sand) by volume.

Wetting of bricks:
The bricks required for masonry shall be thoroughly wetted with clean water for about two hours before use or as directed. The cessation of bubbles, when the bricks are wetted with water is an indication of thorough wetting of bricks.

Laying:
Bricks shall be laid in English bond unless directed otherwise. Half or cut bricks shall not be used except when necessary to complete the bond; closer in such case shall be cut to required size and used near the ends of walls.

A layer of mortar shall be spread on full width for suitable length of the lower coarse. Each brick shall first be properly bedded and set frame by gently tapping with handle of trowel or wooden mallet. It's inside face shall be flushed with mortar before the next brick is laid and pressed against it. On completion of coarse the vertical joints shall be fully filled from the top with mortar.

The work shall be taken up truly in plumb. All coarses shall be laid truly horizontal and all vertical joint shall be truly vertical. Vertical joints in alternate coarse shall generally be directly one over the other. the thickness of brick coarse shall be kept uniform.

The brick shall be laid with frog upwards. A set of tools comprising of wooden straight edges, mason's spirit level, square half meter rub, and pins, string and plumb shall be kept on site of work for frequent checking during the progress of work.

Both the faces of walls of thickness greater than 23 cms shall be kept in proper place. All the connected brick work shall be kept not more than one meter over the rest of the work. Where this is not possible, the work shall be raked back according to bond (and not left toothed) at an angle not steeper than 45 degrees.

All fixtures, pipes, outlets of water, hold fasts of doors and windows etc. which are required to be built in wall shall be embedded in cement mortar.

Joints:
Bricks shall be so laid that all joints are quite flush with mortar. Thickness of joints shall not expose 12 mm. The face joints shall be raked out as directed by raking tools daily during the progress of work when the mortar is still green so as to provide key for plaster or pointing to done.

The face of brick shall be cleaned the very day on which the work is laid and all mortar dropping removed.

Curing:
Green work shall be protected from rain suitably. Masonry work shall be kept moist on all the faces for a period of seven days. The top of masonry work shall be kept well wetted at the close of the day.

Mode of measurement & Payment:
The measurement of this item shall be taken for the brick masonry fully completed in foundation upto plinth. The limiting dimensions not exceeding those shown on the plains or as directed shall be final. Battered tapered and curved position shall be measured net.
The rate shall be for a unit of one cubic meter.

The testing of material is to be carried out at the cost of the contractor.

Item No.12
Cement Plaster 12 mm thick using cement mortar in proportion 1:3 with Neeru Finishing, curing etc. complete

Material:
Water shall confirm to M-1.
Cement Mortar shall confirm to M-11

Workmanship:
12 mm thick cement plaster in single coat in CM 1:3 (1-cement : 3-sand) with a floating coat of neat cement slurry.

Scaffolding:
Wooden bullies, bamboos, planks, treatles and other scaffolding shall be sound. These shall be proper examined before erection and use. Stage scaffolding shall be provided for ceiling plaster which shall be independent of the walls.

This kind of Plaster is normally for interior side or as specified location by Consultant to be applied as above. NORMAL CEMENT PLASTER and the surface shall be rubbed smooth after coating it with a thick coat of pure Portland cement slurry while the base coat is still fresh. If Neeru plus cement finish is specified floating with neat cement will not be required.

Mode of Measurement & Payment:
The rate shall include the cost of all materials labour and scaffolding etc. involved in the operations described under workmanship.

All plaster shall be measured in square meter unless otherwise specified length, breadth or height shall be measured correct to a centimeter.

Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves or open joints in brick work, stone work etc. or space between laths. Thickness of plaster shall be average thickness with minimum 10 mm at any point on this surface.

This item includes plastering up to floor two level.
The measurement of wall plastering shall be taken between the walls or partition (dimensions before plastering being taken) for length and from the top of floor or skirting to ceiling for height, depth of cover of cornices, if any, shall be deducted.

Soffits of stairs shall be measured as plastering on ceilings. Elowigns soffits shall be measured separately.

For jambs, soffits, sides, etc. for openings not exceeding 0.5 sq.mt. each in area for ends of joints, beams, posts girders, steps etc. not exceeding 0.5 sq.mt. each in area and for openings exceeding 0.5 sq.mt. and not exceeding 3.00 sq.mt. in each area deductions and additions shall be made in the following manner:

a) No deductions shall be made for ends of joints, beams, posts etc. and openings not exceeding 0.5 sq.mt. each and no addition shall be made for reverse, jambs, soffits, side etc. of these openings, for finish to plaster around ends of joints, beams, posts etc.
b) Deductions for openings exceeding 0.5 sq.mt. but not exceeding 3.00 sq.mt. each shall be made as following and no addition shall be made for reverse, joints, soffits, sides, etc. of these openings.

i) When both faces of all walls are plastered with same plaster. Deductions shall be made for one face only

- For openings having door squares equal to or projecting beyond the thickness of wall. Full deduction for opening shall be made from each plastered face of the wall.
- In case of openings of area above 3 dq.mt. each deduction shall be made for opening but Jambs, soffits and slits shall be measured.
- The rate shall be for a unit of square meter.

Item No.13

20 mm. thick sand face cement plaster on walls and RCC structure up to height of 10 mt. and above ground level consisting of 12 mm. thick. backing coating of C.M. 1:3 (1 cement : 3 sand) and 8 mm. thick finishing coat in C.M. 1:2 (1 cement: 2 sand) etc. complete.

1.0. Materials

1.1. Water shall confirm to M-1. Cement mortar shall confirm to M-11.

2.0 Workmanship

2.1. The work shall be carded out in the coats. The backing coat (base coat) shall be 12 mm. thick in C.M. 1:3. Before the first coat hardens its surface shall be beaten up by edges of wooden tappers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has, been allowed to set for 3 to 5 day, depending upon the weather conditions. The surface shall not be allowed to dry during this period.

2.2 The second coat shall be completed to 8 mm. thickness in C.M. 1:2 as described above, including raising sand facing by bushing. The sample of sand face shall be got approved before the work is started. The whole work shall be carried out uniformly as per sample approved. This item includes scaffolding cost.

2.3. Curing:
The curing shall be started overnight after finishing of plaster. The plaster shall be kept wet for a period of 7 days. During this period, it shall be protected from all damages.

3.0. Mode of measurements & payment

3.1. The relevant specifications of the item shall be followed that the sand face plaster on outside up to 10 m. above ground level shall be measured under this item.

3.2. The rate shall be for a unit of One sq. metre.

ITEM NO.14 :
CC work 1:1.5:3 for Copping using aggregate of size 10-20 mm, centring, curing, finishing etc. complete (without reinforcement)
&
ITEM NO.15 :
Providing and Laying casting in situ mass cement concrete in 1:2:4 Graded stone aggregate 20 mm nominal size and curing complete including cost of formwork
&
ITEM NO.16 :
CC work 1:3:6 using aggregate of size 10-20 mm, curing, finishing etc. complete (without reinforcement) (without centring)

Details/dimensions of encasing pipes & thrust blocks shall be as per type design approved by the Engineer-in-charge shall be provided by the contractor at this own cost.

MATERIALS:

The specification of materials as given in IS Code is applicable here also.

CC 1:1.5:3

The proportion of concrete shall generally be 1 part of cement, 1.5 parts of sand and 3 parts of coarse aggregate by volume giving a strength of 200 kg/cm2 at 28 days. Curing shall be done for 7 days.

C. C. 1:2:4

The proportion of concrete shall generally be 1 part of cement, 2 parts of sand and 4 parts of coarse aggregate by volume giving a strength of 150 kg/cm2 at 28 days. Curing shall be done for 7 days.

Coarse aggregates shall be of black trap crushed chips graded from 10 mm to 20 mm size.

MEASUREMENTS:
The payment shall be made on cu.m. of completed work including all operations and final finishing.

C.C. 1:3:6

The proportion of concrete shall be 1 part of cement 3 parts of sand and 6 parts of coarse aggregate by volume. Size of coarse aggregate shall be graded from 40 mm to 50 mm size black trap metal. Curing shall be done for 7 days.

MEASUREMENTS:
The payment shall be made on cu.mt. of completed work including all operations and final finishing.

ITEM NO.17
Breaking of pavement surface.

Breaking of existing Payment surfaces of roads with breakers or with cutting tools etc. Payment shall be made on Sq.mt bases.

ITEM NO.18 :
Removing the surplus earth after refilling the tranches as directed as per instruction of Engineer in charge incl. spreading etc complete

After Refilling the pipe / chamber trenches by the excavated stuff is 15cm thick layer, including ramming, watering and consolidating up to possible extent as specified in excavation & refilling item, the surplus stuff shall be disposed off as directed within the prescribed limits of Rajkot Municipal Corporations limits as directed by the engineering in charge.

After refilling surplus earth shall have to carted by the contractor with in RMC limit including loading transporting unloading spreading without any extra cost.

MODE OF MEASUREMENT AND PAYMENT:
The rate shall be per Cubic Meter of truck-body bases.

Item No. 19)
900 MM dia bore hole by horizontal Drilling push through method complete including cost of bore & pushing casing pipe (With Weldind or Jointing) & pushing Carriage Sewage Pipe (With Jointing) excluding cost of casing pipe & Carriage Pipe.
The rate shall be for a unit of one running meter.

Item No. 20)
800mm Inside Dia 12mm Thick M.S. Pipe Electric Resistance Welded (ERW), outside coated with best quality bituminous paint having beveled ends plate Confirming to IS 3589 :2001 or its latest revision / ammendment. (Bare Pipe) for following thickness diameter lncludlng all taxes, lnsurance, transportatlon, frelght charges, octrol, inspection charges, Ioadlng, unloading conveyance to site of work etc. comp. As Directed by Engineering in charge.
The rate shall be for a unit of one running meter.

Item No.21 :
Providing and constructing Sewer manholes as per the type design in brick masonry in C.M. 1:4 and inside and outside plastering in C.M. 1:3 necessary coping in C.C. M-25, fixing H.D.P.E. Steps and fixing manhole frame and covers (But excluding supply of manhole frame and covers) :

The said drainage manhole as per drainage type design is to carried out in brick masonry in CM 1:4 and CC in foundation in 1:3:6 including bedding, benching in 1:2:4 and the inside plaster work in niru finishing in CM 1:3 as per drainage drawing is to be carried out whereas the outer plaster in CM 1:3 is to be done with necessary fixing of HDPE reinforced plastic steps of size 385 x 165 x 0.25 mm as per given type design is to be done. Precast RCC manhole frame and cover is to be done 1:1.5:3 by filling coping and fixing work. The work shall be such that there shall not be no leakage in the manhole, in which, the rate for excavation shall be paid separately which is not included the prescribed rate. The frame and cover shall be provided by RMC Store and same shall have to be transported from Store to Site at the cost of contractor and fixing work is to be carried out accordingly, for which, the rate for only fixing work shall be paid.

The rate for manhole shall be for one number in which, the rate for frame and cover shall be paid separately where for additional depth, the rate shall be paid on one running meter basis as shown in Schedule of this tender.

THE MANHOLE AND DEPTH OF MANHOLES :-
The manholes on the sewers shall be constructed in the form and of the dimensions shown in the Drawing. The depth of the manholes shall be measured from the top of cover to the invert level of the manhole.

The manholes shall be constructed at places shown on the drawings or whatever directed by the Engineer. Type designs for these manholes are shown on the drawings but the actual type and dimensions shall in each case be determined by the Engineer as the circumstances may require.

CONSTRUCTION OF BRICK MASONRY MANHOLES :
The brick masonry shall be constructed as per the type design shown in the drawing enclosed. The various types of manholes to be adopted as per the requirement have been indicated in the L-section and sewer layout drawing in general. The manhole will be fitted with R.C.C. pre-cast medium or heavy duty manhole frame and cover as the case may be. The brick masonary manhole shall be plastered from inside and outside as shown in the drawing and as shown CM proportion and thickness.

FLOORS AND 0.80 ID CHANNEL PIPES :
The floor shall consist of cement concrete. Concrete of R.C. 0.80 ID channel pipes of the required size and curves shall be laid and bedded in cement on the concrete base to the same lines and fail as sewers unless otherwise directed. Both sides of the channel pipes shall be trenched up in concrete and rendered in cement mortar 20 mm thick and formed to a slope of not less than 1 in 12 to the channel.

STEPS :
Where the depth of the invert exceeds 0.90 M below the surface of the ground, HDPE reinforced steps of approved pattern shall be provided as per type design shown in manhole drawings.

RATE OF MANHOLES :
The rate for construction of manhole to be quoted in the bill of quantities shall include complete masonry, structure, concrete cap, plastering with cement from inside and outside, bottom concrete or channels including providing and fixing of HDPE reinforced steps and fixing of R.C.C. manhole frame & covers complete as per type design drawing and cutting the pipes flush with the inside plaster of the wall. The manholes will be paid per numbers up to the minimum depth shown in the type design and for depth beyond the specified minimum depth for a particular type of manhole, extra will be paid per running meter depth. The rates includes dewatering during all stages of construction.

The brick masonry will be paid per number excluding excavation but including masonry, bottom concrete, plastering, benching channel fixing of RCC frame and covers. (Refer R.M.C. DRG for H.C.1, H.C.2)

The rate for Item No.21.1 shall be for a unit of one number whereas the rate for Item No.21.2 shall be for a unit of running meter.

Signature of contractor.

City Engineer
Rajkot Municipal Corporation

SPECIAL CONDITIONS:

1. The contractor shall have to provide his own level instrument for this work .

2. Work is required to be carried out in residential area where all the services like water supply, sullage water pipeline, gas pipeline, telephone / electric cable are existing. Under the circumstances, prior to starting the work agency shall have to excavate the trenches manually for up to minimum 1.00 mt. depth. During the course of execution, all the services shall have to be maintained by the agency and any damage to any services or property, the agency shall have to get it repair at their cost.

3. For excavation of trench, use of JCB machine will not be permitted directly on the top surface of the road. After excavation up to minimum 1.00 mt. depth from road surface or existing ground level, same shall have to be carried out manually or by using Breaker and after locating underground services like; water supply pipeline, gas pipeline, water connection lines, pipe gutters, telephone cables, electric cables etc., and thereafter upon taking the prior approval of the Engineer-In-Charge, the excavation can be carried out by using JCB machine.

4. Rajkot Municipal Corporation shall recommend to the competent authority to give Controlled Blasting License to the contractor for carrying out excavation in hard rock. In case of blasting license not permissible from the competent authority in some places then excavation is to be done by using wedges and hammers, chiseling, breakers, pneumatic tools, etc. Also in case where blasting license is permitted but even then if there is no possibility of carrying out the blasting for whatsoever reason, the excavation is to be done by using Wedges and hammers, chiseling, breakers, pneumatic tools etc. No extra payment shall be made for excavation to be carried out in any of the above mentioned both the situations.

5. Excavation in soft rock and hard rock shall have to be carried out only by Chiseling, Breaker (pneumatic tools) etc., as far as possible. If excavation is not possible in terms of above and if excavation is required to be carried out with the help of blasting then the same shall have to be carried out only after taking prior approval and necessary license for blasting from the competent authority.

6. In case of excavation not possible manually or by chiseling in certain place(s) as well as if blasting is also not possible due to various reasons i.e. to avoid damage to nearby water pipeline, pipe gutter, telephone cables / Duct, Raw houses / week buildings / narrow street etc., then the excavation by blasting will not be permitted. Under these circumstances, excavation shall have to be carried out only by Breaker (pneumatic tools) as per the instructions of the Engineer-In-Charge. No extra payment will be made for such type of excavation done by using Breaker. The rate for excavation shall be paid as per the rate of related item mentioned in Schedule-B.

7. The safety of the trenches is the prime important factor. Along the trenches on both the side, a hump of excavated stuff of minimum height 3 to 5 ft shall have to be provided till the work is got completed. However, where there is no defined road, in such area, the fencing/ lighting etc., requires to be provided as per safety clause. Sign Board shall have to be provided at required locations, so that there will not be any fatal accident.

8. The quantity of various items mentioned in the schedule-B is liable to increase or decrease up to any extent. Under the circumstances, the contractor shall

have to carry out the work accordingly without any rate escalation. Rajkot Municipal Corporation will not entertain any dispute in this regard.

9. In excavation, the decision regarding classification of strata shall rest with the Engineer-In-Charge and his decision in this regards shall be final and binding to the Contractor.

10. The rates are inclusive of dewatering, if required.

11. In case of any ambiguity found in specifications / drawings etc, the decision of engineer-in-charge shall be final and binding to the contractor.

12. The clear cover on pipe shall be 1.0 mt.

13. Rajkot Municipal Corporation shall recommend to the competent authority to give Controlled Blasting License to the contractor for carrying out excavation in hard rock. In case of blasting license not permissible from the competent authority in some places then excavation is to be done by using wedges and hammers, chiseling, breakers, pneumatic tools, etc. Also in case where blasting license is permitted but even then if there is no possibility of carrying out the blasting for whatsoever reason, the excavation is to be done by using Wedges and hammers, chiseling, breakers, pneumatic tools etc. No extra payment shall be made for excavation to be carried out in any of the above mentioned both the situations.

14. Excavation in soft rock and hard rock shall have to be carried out only by Chiseling, Breaker (pneumatic tools) etc., as far as possible. If excavation is not possible in terms of above and if excavation is required to be carried out with the help of blasting then the same shall have to be carried out only after taking prior approval and necessary license for blasting from the competent authority.

15. In case of excavation not possible manually or by chiseling in certain place(s) as well as if blasting is also not possible due to various reasons i.e. to avoid damage to nearby water pipeline, pipe gutter, telephone cables / Duct, Raw houses / week buildings / narrow street etc., then the excavation by blasting will not be permitted. Under these circumstances, excavation shall have to be carried out only by Breaker (pneumatic tools) as per the instructions of the Engineer-In- Charge. No extra payment will be made for such type of excavation done by using Breaker. The rate for excavation shall be paid as per the rate of related item mentioned in Schedule-B.

16. In case of any ambiguity found in specifications / drawings etc, the decision of engineer-in-charge shall be final and binding to the contractor.

Signature of Contractor

City Engineer
Rajkot Municipal Corporation

D. ADDITIONAL CONDITIONS:

1. Regarding the width of excavation, as (a) it is difficult to carry out the vertical trench excavation, (b) possibility of sliding the soil, and (c) uneven excavation trench width in case of blasting. In this connection, for every 1.5 mt lift if there is less width up to 5 cm at the bottom then the top width of excavated trench, it shall be considered as per the specified trench width or actual trench width carried out at the ground level by the contractor whichever is less. If excavation is carried out more than the specified width then the payment will be made only for the specified width of excavation.

2. After entering into an agreement, the agency shall have to finalize the agency for supply of the material like pipes, valves, etc., and the name of manufacturer / supplier should immediately be informed to Rajkot Municipal Corporation so that Rajkot Municipal Corporation can also expedite the manufacturer / supplier for the material. If necessary, Rajkot Municipal Corporation will visit and inspect the factory. During the inspection, if Rajkot Municipal Corporation is not satisfied then the contractor shall have to procure the material from other manufacturer(s).

3. While the work in progress, there is possibility of change in drainage line routes according to the site conditions. Under these circumstances, the contractor shall have to carry out the work accordingly, for which, no extra payment shall be made in such situations. Over and above, the decision of Engineer-in-charge for change in drainage line routes shall be final and binding to the contractor.

4. The prices shall have to quoted firm and fix including all the taxes and duties without any statutory variation.

5. The contractor shall have to get registered under ESI (Employer's State Insurance) Act and obtain ESI Registration as per rules. Also, the agency shall have to give all the benefits to the workers as available under the ESI Act. The agency should follow all the rules and regulations of ESI Act as per prevailing norms.

Signature of Contractor

City Engineer
Rajkot Municipal Corporation

Note on Schedule:

1. The bidder shall note that timely completion of this important work is of essence in meeting the overall schedule of completion of work under this sewerage project.

2. The bidder shall have to identify various risks involved in this work and shall accordingly frame the methodology for constricting the same.

3. The rates and prices shall be submitted in the formats given in the online Price Schedules. Rates and prices received in any other formats will be rejected and the Bids will be disqualified.

4. It will be entirely at the discretion of the Owner to accept or reject the bidder's proposal, without giving any reasons whatsoever.

5. In Price Schedule, bidder shall quote his percentage above/below for items listed in the schedule. Prices quoted in Schedule only will be considered for price evaluation & shall form a part of the Contract Agreement.

6. Only Price Schedule will be considered for financial evaluation of the bid with the successful bidder.

7. The bidder shall be deemed to have allowed in his price for provision, maintenance and final removal of all temporary works of whatsoever nature required for construction including temporary bunds, diverting water, pumping, dewatering etc. for the proper execution of works. The rates shall also be deemed to include any works and setting out that may be required to be carried out for laying out of all the works involved.

8. Where there is a discrepancy between the unit rates and the amount entered, in the price schedule the latter shall govern.

9. The Price Schedules are to be read in conjunction with the Conditions of Contract, the Specifications and other sections of these bid documents and these documents are to be taken as mutually explanatory of one another.

10. Prices quoted by the bidder shall be firm for the entire period of Contract without any escalation.

11. The bidder shall interpret the data furnished and carry out any additional survey work, or investigation work required at his own cost.

12. The prices quoted shall also include the cost of materials utilized for testing.

13. The bidder should acquaint himself with the site conditions including the access to Worksite. The successful bidder shall have to make suitable access to worksites at his own cost. These accesses will be used by the other Contractors working for RMC.

14. From each Running Account Bill, labour cess, Income Tax, Value Added Tax (VAT), Professional Tax, and other taxes prevailing from time to time will be deducted as per norms.

16. The contractor shall have to avail P F Code as per the prevailing Circular of Government for the employees on work. The process for preparation of bill will be taken up only after submission of the Challan for the amount of P.F. deposited every month for the employees on work, which will binding to the contractor. The

required documents shall have to be submitted every month by the contractor to the competent authority.

17. The quoted rates should be inclusive of all taxes and duties.

18. The prices shall have to be quoted firm & fix including all the taxes & duties without any statutory variation. RMC will not consider any statutory variation as well as the price rise in the market and if any, those shall be on account of contractor

19. The work contract tax shall be borne by the agency.

20. The contractor shall have to borne all charges for testing and inspection purpose

21. For hydraulic test of pipe, water, power, labor etc. required for the necessary test shall be arranged by the contractor at his own cost.

22. The rates of excavation are inclusive of shoring, strutting, dewatering, refilling etc. complete and hence no any extra payment shall be made for the same.

23. During construction activity, proper care must be taken for labour safety and all the provisions of the labour laws must be followed by the contractor.

24. Testing of the materials like Bricks, Sand, Aggregate, Reinforcement, structural steel, etc. should have to be tested periodically as suggested by the Engineer-in-charge at government approved material testing laboratory and testing charges for the same has to be born by the contractor.

25. This office Circular bearing No.RMC/C/329 dated 22-12-2012 and Order No.RMC/C/132 dated 10-06-2013 are uploaded separately as a part of tender document. The Contractors quoting their rates shall have to read, implement, and submit the same duly signed along with the documents to be submitted during physical submission.

26. In reference to the above Circular and Order cited in Para above, the Contractors who have quoted their rates for this work will be called in person for verification of original documents. The date and time for verification of original documents will be as prescribed in the tender document.

27. In Every running bill 0.10% amount shall be retained as extra security deposit If Drawings of work done are not submitted. As Road Restraining is the responsibility of work contract agency, in Every running bill 0.50% amount shall be retained as extra security deposit for purpose of Corrections for road restraining in case of settlement of surfaces of refilled trenches. These shall be released after 1 Year.

28. The manufacturer shall have a laid down **Quality Assurance Plan** for the manufacture of the products offered which shall be submitted along with the tenders and successful tendered shall have to get its approval from RMC. All the materials, pipe, specials, valves etc. shall have to be inspected through Inspecting TPI/PMC Agency whichever suggested by RMC and the charges for the TPI/PMC Shall have to be borne by the RMC .

29. No extra item or extra width will be paid due to excavating method or type of machinery.

30. Appendix - L provided in tender is a sample format. The bidder shall furnish the details of concern tender duly signed by Chartered Accountant and Tenderer. List of

on-going Works (i.e. Running Work details) must be attached. Ongoing work list shall include details name of work, total amount of awarded work, Work done amount till date, pending work today. In this Appendix, the details of experience and amount shall have to be mentioned in the respective column.

31. For any type of license regarding labour etc. has to be achieved by agency

32. The routes and levels shown in the maps are indicative and not final. There are possibilities of change in routes and levels at the time of execution of work and due to which the diameter of pipeline and depth of drainage line may increase or decrease. Under the circumstances, the contractor shall have to carry out the work accordingly at the approved rates without any extra cost. Rajkot Municipal Corporation will not entertain any dispute in this regard.

33. The contractor shall have to carry out the sub-soil strata investigation at his own cost.

34. If progress of work look slow, Extra Security Deposit may be recover from any running bill as decided by Engineer in charge up to maximum 5% amount of concern R.A. Bill amount.

35. Payment shall be only be done in case of complete section. Complete section - It is the length of laid Pipe part of the Work where sand bedding has been done and the same be backfilled as per tender norms be completed and the surface has been finished by proper compaction as per tender norms and / or as per instruction of engineer in-charge.

36. Where there are the areas having dense population or any other unsuitability, blasting may not be permitted.

37. Where there are the areas having narrow streets (3 to 4 Mtr. wide) big machinery may not enter.

38. Kachcha houses shall not be get damaged. Considering this manual labour work may be more feasible.

39. No extra item or extra width will be paid due to excavating method or type of machinery.

40. The tenders are advised to visit the project area and get acquainted with the local condition as the said area is residential area with numbers of underground utility services like water supply pipe line, sullage water pipe line, gas pipe line, telephone/electric cable, KHALKUVAS etc. which requires to be maintained during the progress of work. The safety of the work is prime important factor and all the tenderer should be very much vigilant for the same. Thus, there may be some locations where clear ROW or ROU may not be available due to certain reasons like TP Road open Issues, Permissions etc. If work of that much location is affected due to such reasons time limit may be extended considering that non-working period but in no case Price Escalation will be given for that extended period.

    Thus, it is to be clear that to work within utility services is a part of this work. If utilities are affected, it shall be the responsibility of tenderer to make same as it was as before. The expenditure and arrangement shall be bear by Tenderer.

41. Temporary drainage work like temporary diversion of gutter line, khal kuvas or bailing work of sub soil water, diversion of storm water way etc., is to be carried out by contractor without any extra claim. Cost towards shifting, repairing, replaced of utilities to be born by Tenderer.

42. In case of Extra Item, No on % age i.e. +ve % age Rate will be given but If there is Down % age i.e. -ve % age Rate that will be applied to that rate of that Extra Item.

43. Before procurement of Material the Quality Assurance Plan (QAP) shall be approved by RMC. QAP for approval shall be submitted in 3 Original copy duly signed and stamped by Manufacturer, Third Party Inspection Agency/ PMC and Tenderer. The draft QAP has been attached herewith.

44. The 'Vendor Form' provided in the tender document shall also have to be filled by the contractor and submitted along with all other required documents during the physical submission.

45. Any Financial document i.e. FDR, Demand Draft, Bank Guarantee etc., must be accompanied with the details like; Name and Address of Issuing Branch, Name and Address of Verifying Branch, Name & Designation of Contact Person, Contact Number, e-mail address, Fax Number etc.

Signature of contractor

City Engineer
Rajkot Municipal Corporation.

E EXECUTION OF WORKS

Bidders shall keep in view the following constraints / site condition for bidding purpose.

1. Bidders shall note that timely completion of this important link is of essence in meeting the overall schedule of completion of work under this work.

2. The bidders shall have to identify various risks involved in this work and shall accordingly frame his methodology for construction the same.

3. It should be noted by the bidders that payment schedule to be approved the Owner will be exclusively govern by the actual progress of the work.

4. General soil type encountered is rocky. Once the monsoon breaks over the area which is generally end of June the site becomes water logged due to flat terrain condition. The nallahs which are practically dry may have substantial flows owing to rainfall. The contractor shall have to keep in view this condition for his planning purpose.

   All the data, information etc, which are available, are given in the tender, similarly, the lengths of different trenches of pipeline and the profile indicted are based on the available topographic survey of the pipeline route. However, bidder should make his independent assessment of the pipeline route considering site conditions obtain and check all the data required from the sites and frame his bid accordingly.

5. Bidders shall take into account the change in alignments of the pipeline in both horizontal and vertical direction, along the entire route of pipeline. Pipe bends to suite the change in alignment a to be provided. Also anchor block / thrust block of suitable size are also to be provided considering the site situation.

6. The field hydraulic test pressure of the completed installation shall be as per relevant IS.

7. The makes for cement shall be Ambuja, Ultra Tech, Lotus, ACC, JK (Laxmi Brand), Sidhdhi.

8. The Fe-415 HYSD-Reinforcement conforming IS:1786 steel shall be of make TATA VIZAG, SAIL, ELECTROTHERM, GALLANT or NEELKANTH.

9. Regarding water supply for hydro testing, it was clarified that necessary water / power / labour etc. required for the necessary test shall be arranged by the contractor at his own cost.

10. There may be some locations where clear ROW or ROU may not be available due to certain reasons like DP Road opening issues, permission from concerned authority etc. If work of such location(s) is/are affected due to such reasons, time limit may be extended considering that non-working period but in no case Price escalation will be given for that extended period. It is to be noted that, the work within utility services will be a part of this work. If utilities are affected, it shall be the responsibility of tenderer in full to rectify and correct the same. All arrangements in this regard is to be done by the tenderer as well as all such expenditure will have to be borne by the Tenderer.

    Further, the pipeline work required to be carried out by crossing the existing compound wall of site, the damage to the compound during the execution of pipeline work will have to be rectified and corrected by the tenderer in whole, for which, no extra payment will be made by Rajkot Municipal Corporation.

11. The sanction from State/National Hgihway Authority / GSPC / PGVCL / Telephone Department etc. Concern authority department for the purpose of road crossing will have to be obtained by the Tenderer. Agency shall have to do whole liaisoning work at his own level, however, RMC will recommend for the same wherever necessary. The charges occurred for obtaining such permission will have to be initially borne by the tenderer. However, RMC will reimburse only such relevant charges paid to such department(s), upon submission of necessary document i.e. Receipt etc. in original.

Signature of Contractor _____

APPROVED VENDOR LIST

SR. NO.	PARTICULARS	DESCRIPTION
1.0	DI Pipes & Specials/Fittings	Electrosteel, Lenco–Khalasthi, Electrotherm, Jai Balaji industries Ltd., Tata, Kejriwal casting Ltd., Kiswok industries Ltd., Kartar, Yuvraj
2.0	SLUICE VALVE/BUTTERFLY VALVE ISI Marked only.	KIRLOSKAR / IVC / IVI / FOURESS
3.0	AIR VALVE	KIRLOSKAR / IVC / IVI / FOURESS / R&D MULTIPLE
4.0	MS PIPE SPECIALS	SAIL, WELSPUN, SAW, ESSAR STEEL & MANUFACTURERS IN GWSSB PRESENT VENDOR LIST.

Signature of contractor.

Part-3 : Electro-Mechanical Work

Scope for Mechanical, Electrical and Instrumentation Works for Construction of Sewage Pumping Station (SPS) at Mota-Mava Munjaka area of RMC shall include supply, erection/installation at site, testing and commissioning of various equipment of mechanical/piping, electrical and instrumentation works as specified here below and in SOQ/BOQ and shall be complete in all respects as per tender specifications at proposed pump house. The bidder shall note that the scope shall also include any other work or item/material as required to complete the work in all respects for the supply and for satisfactory installation, testing and commissioning and satisfactory operation of specified equipment/pumping station.

Scope shall include inspection of equipment as applicable as per tender specifications at manufacturers' works by Third Party Inspection (TPI) agency and RMC representative. Expenses incurred towards the inspection like commercial fees, to & fro charges, lodging and boarding etc., delivery of equipment at site or store as instructed by Engineer-In-Charge, unloading and storage at site etc. shall be borne by contractor.

Scope of work shall include submission of technical datasheets duly filled for major equipment in the format given in tender technical specifications at the time of Drawing/ Document approval.

MECHANICAL WORKS

The scope of mechanical works (for Munjka SPS) shall include but not limited to the following.

SITC of 2 nos. Submersible non-clog pumps having capacity 285 m^3/hr. and 16 m head (Type-1) coupled with electric drive (motors) and along with all related accessories like duck foot bend, auto coupling, SS lifting chain, guide pipes, power and control cable, RCC foundation etc. and SS hardware with all required accessories as per specifications and tender SOQ/BOQ.

SITC of 2 nos. Submersible non-clog pumps having capacity 355 m^3/hr. and 16 m head (Type-2) coupled with electric drive (motors) and along with all related accessories like duck foot bend, auto coupling, SS lifting chain, guide pipes, power and control cable, RCC foundation, etc. and SS hardware with all required accessories as per specification and tender SOQ/BOQ.

SITC of CI/DI DF electric actuator operated sluice valve at delivery of each pump, at each common delivery header after flow meter with all required accessories and hardware as per specification and tender SOQ and tender drawings.

SITC of CI/DI DF Non-return valve on delivery of each submersible NC pumps along with all required accessories and hardware as per specifications and tender SOQ and tender drawings.

SITC of CI/DI DF dual plate check valve on common delivery header along with all required accessories and hardware as per specification and tender SOQ and tender drawings.

SITC of CI/DI DF temper proof flanged air valve along with isolation sluice valve on each common delivery header line with all required accessories and hardware as per specification and tender SOQ and tender drawings.

SITC of SS metallic expansion bellows on delivery of each pumps, on common delivery header near flow meter, near header DPCV with all required accessories, hardware and as per specification and tender SOQ and tender drawings.

SITC of DI DF pipes and fittings for delivery and common delivery header line of submersible NC pumps as required, to connect header to rising main as per specifications and SOQ and tender drawings.

SITC of MS pipes, fittings and MS flanges as required, for common delivery header/rising main connections, any other to complete the work in all respects as per specification and tender BOQ.

SITC of electric actuator operated CI sluice gate at inlet pipe and at bypass line, on each inlet and outlet of screen chamber along with all required accessories and hardware as per specifications and tender SOQ and drawings.

SITC of 2 nos. manual box type coarse mesh screen of SS 304 with 1 set of cleaning rake along with all required accessories and hardware as per specifications and SOQ and drawings.

SITC of 2 nos. mechanical multi-rake coarse bar screen mechanism in SS 304 along with electrical control panel for auto-manual operation, screening disposal arrangement up to ground level to drop on belt conveyor with all accessories and SS hardware etc. as per tender specifications, SOQ and drawings.

SITC of Belt Conveyor as per tender specifications, SOQ, and tender drawings.

SITC of monorail electric chain hoist with electrically operated trolley of adequate capacity for submersible NC pump set lowering and lifting with all required accessories and hardware as per specifications and tender SOQ.

SITC of monorail electric chain hoist with electrically operated trolley of adequate capacity for manual mesh screen lowering and lifting with all required accessories and hardware as per specifications and tender SOQ.

Supply and testing of portable dewatering/desilting submersible non-clog pumps having capacity and head as per SOQ coupled with electric drive (motors) and along with all related accessories like flexible PVC pipe, lifting chain, pair of suitable cables, starter panel etc. as per specifications and tender SOQ.

Structural steel for electrical and mechanical equipment support on floor/wall/beam/ brackets etc. as per specifications and tender SOQ.

All under water (wetted) hardware shall be in SS 304 (Nuts, bolts etc.) and non-wetted hardware shall be GI.

ELECTRICAL WORKS

As the load demand is less than 100 kW/125 KVA, it is proposed to go for LT power supply system.

415V Power is expected from local Power Supply Company.

Power Supply Company (PSC) will provide their L.T metering panel in pumping station / plant. The LT power from Power Supply Company's LT Metering Panel shall be fed to MCCB near the PSC metering panel and from MCCB to incomer of PMCC Panel.

Major scope of work for electrical installation shall include the following:

SITC of PMCC/Main LV Panel including Starters, transformer no load losses fixed capacitors for power factor correction, spare feeders etc. along with complete all

required accessories and hardware etc. as per SOQ, tender specifications and SLD. Panel dimension/GA shall be as per site conditions.

SITC of APFC Panels as part of PMCC panel for power factor correction etc. along with complete all required accessories and hardware etc. as per SOQ, tender specifications and SLD.

SITC of PDB, LDB for indoor and outdoor requirements, Power Sockets, Welding Receptacles, etc. as required, along with complete all required accessories and hardware etc. as per SOQ and tender.

SITC of LV Power and Control Cables with cable end termination and connection etc. along with complete all required accessories and hardware etc. as per SOQ and tender.

SITC of Cable Tray and Cabling System etc. along with complete all required accessories and hardware etc. as per SOQ and tender.

SITC of Earthing system etc. along with complete all required accessories and hardware etc. as per SOQ and tender.

SITC of Internal and External area LED lighting system etc. along with required wiring, including all required accessories and hardware etc. as per SOQ and tender.

SITC of DG sets with AMF Panel for backup power in case of power failure from grid to ensure the continuous operation of Pumping Station/Plant as per SOQ and tender. Diesel for DG set operation for power generating work will be provided by the Client. Lubricating oil, other consumable (Except diesel) items/requirements shall be in the scope of contractor. DG set shall comply with all statutory requirements and applicable norms/provisions of CPCB as prevailing and other relevant authorities.

SITC of Safety Equipment/Accessories as per statutory norms/requirements along with complete all required accessories and hardware etc. as per SOQ and tender.

Chequered plates with supports steel structure works as required for cable trenches in HT rooms, LT rooms, Control rooms etc. rooms along with complete all required accessories and hardware etc. as per SOQ and tender.
Supports/Structural Steel works as required along with complete all required accessories and hardware etc. as per SOQ and tender.

All miscellaneous work for installation of electrical equipment with making cut out in panel room/pump house wall/slab for erecting of cables entering/out going from room etc. with mini. 100/150mm (as required) GI pipes with fixing, grouting, sealing etc. work and unforeseen/emergency work during installation etc. complete work for all electrical equipment.

Preparation of various drawings and layouts prior to execution viz. Cable and Cable Tray Layout, Earthing Layout and Lighting/Illumination Layout (indoor/Outdoor).

Liasoning works as required with Electrical Inspector/Statutory authority for obtaining power for pumping station/plant including submission and approval of drawings etc. for all electrical equipment and allied installation works. Liasoning work shall also include obtaining NOC for release of power on behalf of the Client.

INSTRUMENTATION WORKS

The scope of instrumentation work (for Munjka SPS) may include but not limited to the following.

Diaphragm type pressure gauge along with required accessories/hardware shall be provided at delivery line of each pump.

Hydrostatic type level transmitter differential level transmitter to be provided at upstream and downstream of screen to start screen at high diff level and stop at low differential level. Differential level shall be displayed at HMI and hi-hi differential level shall be annunciated at HMI/SCADA.

Ultrasonic type level transmitter at wet well along with necessary hardware for measuring sewage level in sump and high and low level alarm. The level transmitter shall provide local display and remote display at HMI.

Low level switches at wet well for dry run protection of pump and upstream of manual screen for high level alarm.

Electromagnetic flow meter at common discharge header of pumps to measure discharge sewage from pump house. The flow meter shall provide local display and remote display at HMI.

PLC based instrument control panel along with 10" color touch screen HMI, IO module, relay card, 4G or latest GPRS modem with SIM card for remote data transmission to central SCADA of client, online UPS, panel mounted process/flow indicator etc. Necessary modification/provision in existing central SCADA system at central control room (if any and as applicable) of RMC to monitor and control SPS from central control room.

Instrumentation cables (power, control and signal), mounting hardware, earthing, cable trays, junction boxes etc. as per SOQ/tender specifications.

Support / Structural Steel work as required as per SOQ/tender specifications.

OPERATION and MAINTENANCE

The bidder has to operate and run the pumping station along with operation and maintenance work and with all accessories etc. and maintain the same for two years with all supply of spares, tools, consumables, lubricants, man power etc. (at free of cost), after completion of successful execution, installation, trial run period and commissioning of works.

The O and M Period shall be commencing after successful completion of trial period of Sewage Pumping Station (Not from the date of inauguration). O and M period will be considered after successful completion of trial period. O and M payment shall be claimed after performance guarantee test certificate of TPI. The spares, tools and furniture etc. as applicable as per SOQ shall be handed over to client on commissioning of project/before start of O and M period.

ADDITIONAL SCOPE:

In addition to the above, following services are also included in the scope of the contractor for the proposed Sewage Pumping Station.

Alignment, drilling and grouting of equipment,

Drilling holes, zary work on walls/slabs for pipes and cables (if necessary),

Clamping and supporting of all pipes, cable tray etc.

Final painting of equipment at site after installation,

Drawings, operation and instruction/maintenance manuals of each equipment - 3 set,

Verifying the existing dimensions as relevant to the contractor’s scope,

Excavation, bedding and refilling as per requirement.

Temporary lighting during execution of work at site shall be arranged by the contactor.

Making good of the damage done to electro-mechanical installations and civil works and civil repairing work of the pump house during execution of all Electro-Mechanical works.

TECHNICAL SPECIFICATIONS FOR

MECHANICAL WORKS

SPECIFICATIONS FOR MECHANICAL WORKS

(A) SPECIFICATIONS FOR MECHANICAL WORKS (GENERAL)

Applicability

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

List of Standards

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

BS 5135	Specification for arc welding of carbon manganese steels
BS 5316 Part-2	Specification for acceptance test for centrifugal, mixed flow and axial pumps – Test for performance and efficiency
BS 6072	Method for magnetic particle flow detection
BS 6405	Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes: Class 1 & 2
BS 6443	Method for penetrate flow detection
ASTM A-36	Specification for Structural Steel
ASTM A-216	Specification for Steel Castings, Carbon suitable for fusion welding for high temperature service
ASTM A-276	Specification or stainless steel and heat resisting steel bars and shapes
ASTM A-351	Specification for castings, Austenitic – Ferric (Duplex) for Pressure containing parts
ASTM A-743	Specification for castings, Iron – Chromium, Iron – Chromium – Nickel and Nickel Base Corrosion Resistant for general Application
ASTM A-744	Specification for castings, Iron Chromium – Nickel, Corrosion – Resistant
IEC – 189 Part 1 & 2	Low frequency cables and wires with PVC insulation and PVC Sheath
AWWA C 501	Cast Iron Sluice Gates
IS 5	Colours for ready mixed paints and enamels
IS 210	Grey Iron Castings
IS 318	Leaded Tin Bronze Ingots and Castings
IS 325	Three Phase Induction Motors
IS 807	Code of Practice for Design, manufacture, erection and testing (Structural Portion) of cranes and hoists
IS 1239	Mild Steel tubes, tubular and other wrought steel fittings
IS 1536	Centrifugally Cast (Spun) iron pressure pipe for water gas and sewage
IS 1537	Vertically cast iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1554	PVC insulated (Heavy duty) electric cables
IS 2062	Steel for general structural purposes
IS 2147	Degrees of protection provided by enclosures for low voltage switch gear and control gear
IS 3177	Code of practice of electric overhead traveling cranes and gantry

	cranes other than steel work cranes
IS 3624	Vacuum and Pressure gauges
IS 3815	Point hooks with shank for general engineering purposes
BS 2910	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 3017	Specification for mild steel forged ram shorn hooks
BS 3100	Specification for steel castings for general engineering purposes
BS 3923	Methods for ultrasonic examination of welds
BS 4360	Specification for weldable structural steels
BS 4772	Specification for ductile iron pipes and fittings
BS 4870	Specification for approval testing of welding procedures
BS 4871	Specification for approval the sting of welders working to approved welding procedures
BS 4942	Short chain link for lifting purposes
IS 1710	Specification for Pumps – Vertical Turbine Mixed and Axial Flow, for Clear, Cold Water
IS 5120	Technical requirements of roto dynamic special purpose pumps
IS 5600	Horizontal / vertical non clog type centrifugal pump for sludge handling
IS 6595	Horizontal Centrifugal Pumps for Clear, Cold Water
IS 7090	Guide lines for rapid mixing devices
IS 7208	Guide lines for flocculator devices
IS 10261	Requirements for clarifier equipment for waste water treatment
IS 8413	Requirements for biological treatment and equipment
Part-II	Activated sludge process and its modifications
IS 10037	Requirements for sludge dewatering equipment, sludge
Part-I	Drying beds, sand, gravel and under drains
IS 6280	Specification for Sewage Screens
IS 3938	Electric Wire rope hoists

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

IS 210	Specification for grey iron casting
IS 290	Specification for coal tar black paint
IS 456	Code of practice for plain and reinforced concrete
IS 458	Specification for pre cast concrete pipes (with and without reinforcement)
IS 516	Method of test for strength of concrete
IS 638	Specification for sheet rubber jointing and rubber insertion jointing
IS 783	Code of practice for laying of concrete pipes
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1367	Technical supply conditions for threaded steel fasteners
IS 1387	General requirements for the supply of metallurgical materials
IS 1500	Method for Brinell hardness test for metallic materials
IS 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS 1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1916	Specification for steel cylinder pipes with concrete lining and coating

IS 2078	Method for tensile testing of grey cast iron
IS 3589	Specification for MS Spirally Welded Pipes
IS 3597	Method of tests for concrete pipes
IS 3658	Code of practice for liquid penetrant flow detection
IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5504	Specification for spiral welded pipes
IS 6587	Specification for spun hemp yarn
IS 7322	Specification for specials for steel cylinder reinforced concrete pipes
IS 8329	Specification for DI pipes
IS 9523	Specifications for DI fittings
IS 4984	Specifications for HDPE pipeline
IS 14846	Specifications for valves
IS 783	Code of practice for laying of concrete pipes
IS 3114	Code of practice for laying of cast iron pipes
IS 3764	Excavation work - Code of Safety
IS 4127	Code of practice for laying of glazed stoneware pipes
IS 5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS 6530	Code of practice for laying of asbestos cement pressure pipes.

Materials

All materials incorporated in the works shall be the **most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfection and selected for long life and minimum maintenance.**

Design and Construction

a. The plant design, workmanship and general finish shall be of sound quality in accordance with good engineering practice. Design shall be robust and rated for continuous service, at the specified duties, under the prevailing operational site conditions.

b. The general design of mechanical and electrical plant particularly that of wearing parts, shall be governed by the need for long periods of service without frequent attention but shall afford ready access for any necessary maintenance.

c. Similarly items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as the originals.

d. No welding, filling or plugging of defective work will be permitted without the written permission of the Engineer. All welding spatter shall be removed.

e. It shall be the responsibility of the contractor to ensure that all the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation.

f. It shall be the responsibility of the contractor to ensure his equipment interfaces with any existing equipment correctly. Any interfaces must not affect the integrity of the equipment, or invalidate any warranties or guarantees.

g. Each component or assembly shall have been proven in service in a similar application and under conditions no less than those specified therein.

h. The equipment shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.

i. All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.

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

Tropicalization

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

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

Climate

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

Maximum Ambient Temperature for Design Purpose	:	**50 ^{0}C**
Maximum Relative Humidity	:	95%

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

De-Rating due to the Climatic Conditions

i. All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 50 ^{0}C in accordance with the appropriate regulations unless otherwise specified.
ii. All materials and equipment which are subject to certification by testing authorities etc. shall be certified as being tested at 50 ^{0}C ambient unless other higher temperature specified elsewhere for specific equipment/product.

Packing and Delivery

a. All part and equipment as necessary shall be packed in first quality containers or packing; no second hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.

b. Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.

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

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

e. Lids and internal cross battens of all **packing cases are to be fixed by screws and not nails.**

Hoop metal bindings of cases are to be sealed where ends meet and if not of rust less material are to be painted. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges of which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All strut or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

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

f. Wood wool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.

g. Where applicable, indoor items such as electric motors, winch and control gear, instruments and panels, machines components etc. are to be 'cocooned' or

covered in polythene sheeting, selected at the joints and the enclosures provided internally with an approved desiccators.

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

i. Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forward to the Engineer; prior to dispatch. All items of material are to be clearly marked for ready identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings and are to bear an indelible identification mark relating them to the appropriate shipping documents.

j. Structural steel work, pipes, valves, encased fittings and metal work shall be similarly marked. In addition, one in every ten repeated articles shall bear the dispatch marks in suitable paint or other approved medium. When in the opinion of the Engineer, the dispatch marks cannot be applied satisfactorily to any item, they shall be stamped on a petal label attached to the item they shall be stamped on a metal label attached to the item or part by means of a piece of wire passing through holes at either end of the label and secured so that it lies flat with the item.

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

Finish

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

Wrought Steels

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

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

Castings

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

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

Steel Castings

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

Grey Iron Castings

All grey iron castings supplied shall be to the appropriate grade of IS: 210. The Contractor shall replace any casting which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or "burning on" will be acceptable.

Spheroidal Graphite Iron Castings

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

Bronze

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

Aluminum and Aluminum Alloys

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

Aluminum and Aluminum alloy Castings

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

Painting and Metal Protection

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

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

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

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

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

Chromium Plating

All chromium plating shall comply with IS: 1986.

Galvanizing

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

Attention shall be paid to the details of members in accordance with BS: 4479. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel including cracks, surface lamination, laps and folds shall be removed in accordance with IS: 6159. All drilling, cutting, welding, forming and final fabrications of unit members and assemblies shall be complete before the structures are galvanized. The surface of the steel work to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulfuric or hydrochloric acid, followed by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten zinc and brushed, so that the whole of the metal shall be less than 610 grams per square meter of surface galvanized, except in the case of tubes to BS 1387 when it shall be 460 grams per square meter.

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

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

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

Small areas of the galvanized coat damaged in any way shall be restored by following.

i. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
ii. The application of two coats of zinc-rich paint (not less than 90% zinc dry film), or the application of a low melting point zinc alloy repair rod or power to the damaged area, which is heated at 300 ^{0}C.

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

Fasteners

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

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

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

Forgings

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

Foundation and Settings of Machinery

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

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

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

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

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

The machinery shall be alighted, leveled and pulled down by the nuts of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration. The Civil Works Team shall then carry out the grouting and building in of the machinery.

However, the Contractor shall take responsibility for the satisfactory nature of this work, and shall have a representative present.

Built In Items

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

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

Location and Alignment

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

Coupling

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

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

Flexible couplings shall be supplied in matching balanced sets machined, balanced and marked before leaving manufacturer's works. The couplings shall be a tight fit on the shafts and secured with hand fitted keys and fully checked for alignment shall be a tight fit on the shafts and secured the hand fitted keys and fully checked for alignment. All necessary equipment for checking alignment shall be supplied by the Contractor.

Where flexible coupling are used, the Contractor shall fully describe the arrangements proposed for ensuring that the desired freedom of relative movement between the shafts is obtained when transmitting a torques corresponding to the continuous maximum rating of the motor.

Solidly bolted couplings shall be subject to accurate alignment and the Contractor's proposed alignment procedure shall be subject to the approval of the Engineer. In particular, the alignment procedures which involve rotating one half coupling only will not be accepted.

Overload release couplings shall not rely on shear pins. Release torque shall be adjustable over a wide range and preferably without the need to change components.

The coupling shall be capable of angular alignment of 1 degree maximum and 1mm displacement of shafts.

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

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

Bearings and Lubricators

The size of bearing shall be not less than that calculated for bearings and a minimum L10 basic rating life in accordance with BS 5512 Lubricators Part 1, taking into account all considerations of reliability materials of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running.

They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic condition prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable.

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

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

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

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

Gear boxes

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

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

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

The **mechanical service factor shall be not less than 1.5** when applied to the rated motor power or higher as recommended by equipment manufacturer.

The gears shall be manufactured from steel to BS 970 of grade selected by the Contractor and entered in the Schedule of Particulars. The teeth shall be profile ground and lapped to a high standard of accuracy and finish.

Rolling bearings shall be adequately rated to ensure a running life of not less than 50,000 hours L10 life.

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

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

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

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

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

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

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

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

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

Steelwork General

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

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

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

Hand Railing and Safety Chains
Hand Railing

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

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

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

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

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the hand railing and vertical flanges drilled for less than two bolts and line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5 m. centers. When provided in sections, hand railing shall be joined together with purpose made fittings secured by screws or grub screws.

All ladders, stairway or other openings shall be guarded on three sides by hand railing conforming to the requirements stated above.

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

Safety Chain

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

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

Open Mesh and Chequer Plate Flooring

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

Flooring shall be provided to span between the supporting members as shown on the Contract Drawings.

Where necessary intermediate support members shall be provided and fixed.

Galvanized mild steel toe plates 100 mm high and not less than 3mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the approved drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be obtained systemically around the center lines of the panels in both directions, so that

when the panels are fixed in extensive areas or in long runs, the bars of all panels are in line.

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

All flooring shall be designed to carry a loading of 750 kg/sq. meter and the deflection shall not exceed 1/200 of the span or 10mm whichever is the least.

All flooring shall be removable and set flush in mild steel galvanized frames. All frames shall be provided with lugs for building in.

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cutouts to permits its removal without disturbing or dismantling spindles, supporting brackets, cables or pipe work. Flooring spanning wide openings shall be supported on removable bearers and fixings to provide the required rigidity and these shall be supplied and fitted by the Contractor. These members shall be removable to afford clear access to the openings which includes ducts.

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

Stairways

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

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

Ladders

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

Rungs shall be 20mm diameter round bar at 250 mm c-c distance shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225mm from the wall.

All ladders shall have safety cages which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750mm. The hoops shall be at approximately 70mm centers and the first hoop shall be 2400mm. above ground or lower platform level.

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

Multiple Duct Covers and Frames

Multiple duct covers and frames shall be of cast iron, water proof, non-rocking and recessed for filling with concrete or similar material.

They shall be of the type incorporating integral, removable, intermediate beams to given the required clear pit opening as shown on the approved drawings.

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

General Requirements for Pipe work

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

Pipe work and fittings shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of the pumping mains shall be the closed valve head of the pump plus the maximum suction static head. The maximum surge pressure shall be limited to 125% of the maximum working pressure. All pipe work and fittings shall be of adequate strength to accommodate the maximum surge pressure of the system.

The minimum pressure rating of pipe work and fittings shall be 10 Bar or higher as per process requirement.

There shall be a sufficient number of mechanical joints to enable mechanical plant and valves to be disconnected from built–in pipe work. Such joints shall be tied and shall not be allowed to sustain the weight of any pipe work.

All pipe work and fittings shall be sized for the required capacity at a velocity limits depending on the nature of the fluid or substance to be conveyed.

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

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

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

Flexible joints shall be provided in all pipe work subjected to linear constraint.

All jointing work including the provision of suitable full face gasket not less than 5mm in thickness and galvanized fastenings or fastening as specified shall be included.

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

Unless otherwise specified, the pieces shall have a radial branch to enable a more streamlined flow from branch to body. Due allowance shall be made for reinforcement in the vicinity of the branch.

Prior to dispatch, each item of pipe work or associated fitting shall be clearly identified in paint with the plant item number indicated on the Contractor's arrangement drawing.

Puddle flanges shall be provided on all pipes where they pass through pumping station walls/water retaining structure walls. Each puddle flange shall be continuously welded to the pipe on both sides of the flange.

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout of other extraneous material into the joint annulus after the joint has been made.

The dimensions of gaskets shall comply with BS 4865 Part I. Gaskets shall be manufactured from material complying with BS 2494 for Type 1 rings.

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

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

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

Grey Iron Pipe work and Fittings

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

Spheroidal Graphite Cast Iron Pipe work and Fittings

All spheroidal graphite or modular graphite cast iron pipe work and fittings shall be to the appropriate grade of BS 4772.

Carbon Steel Pipe Work

Carbon Steel Pipe work for pressure purposes shall be to BS 3601 and assemblies shall be manufactured from pipe to this specification. The type of pipe shall be hot finished seamless steel. The wall thickness shall be not less than that required in BS 534 Table – 1.

ABS Pipe Work

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

Fabrication of Carbon Steel Pipe Work and Fittings

The Contractor shall fabricate the pipeline by butt-welding without utilizing a backing ring in accordance with BS 2971 Class II metal arc welding of carbon steel pipe work. Branches shall be formed in accordance with BS 2971 (Class I or Class II, depending on operating conditions) and shall be welded before so that at any point along the bend, ovality will not reduce the bore by more than 21%. Radii of hot bends for all pipes shall not be less than five times the outside diameter. Gusseted "Cut and Shut" and wrinkle.

All pipe flanges shall be of the wrought steel slip on type conforming to BS 4504 PN 16, welded on in accordance with BS 2971 (Class I or Class II, depending on operating conditions). No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or Victaulic coupling as necessary.

Welder Qualification

Before welding work commences on pipe work, the Contractor shall satisfy the Engineer's representative that the welders have previously carried out similar welding work within recent months. When instructed by the Engineer's representative, the Contractor shall arrange for the welder to produce test welds in accordance with the provisions of BS 2971.

Pipe Work Installation

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

Underground Pipes

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

Examining Pipes

Before being used, each pipe casting or fitting shall be properly examined and should appear defective in any way, it shall be set apart and not used until it has been examined and passed by the Engineer. All metal pipes which shall be buried in the ground shall, prior to their installation, be slung and sounded in an approved manner. Any pipe found to be faulty by this method, shall be set aside for examination by the Engineer.

Cutting Pipe Work

All pipe work shall be cut with proper pipe cutting tools. The use of hammer and chisel for this purpose shall not be permitted. Great care shall be exercised when cutting concrete/bitumen lined spun iron and ductile iron pipes, to ensure that there is no damage to the lining. Should any damage to the lining take place which is to an extent which the Engineer deems to be undesirable, then the pipe shall be rejected. The Contractor shall then prepare another pipe for incorporation into the works. All pipes which have been cut shall have the edges dressed and deburred.

Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items/equipment of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract.
All warning labels shall comply with BS 5378 parts 1, 2 and 3 and screw fixed rigid construction.

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

The Contractor shall provide 2 nos. enameled iron plates worked "Men Working of Plant". The plates shall be 200mm x 75mm with red lettering on a white background.
N. B.: All identification and warning labels shall be in ("Hindi Language") and English.

Guards

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

Suppression of Noise

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

Trolley and Chain Pulley Block

a. The chain pulley block shall be operated on the lower flange of the bridge girder.
b. The load chain shall be made of alloy steel as per IS: 3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.
c. The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet and shall be provided with roller type guarding to prevent snagging and fouling of the chain.
d. All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel Blanks. Pinions shall be of heat treated alloy steel. Gears shall be as per BS 436/IS: 4460.
e. The trolley track wheel shall be rim toughened, heat treated carbon steel or low alloy steel or CI and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.
f. The traveling trolley frame shall be made of rolled steel conforming to IS: 2062. The side plate of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin.
g. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

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

I. The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self–actuating load pressure brake. Brakes shall offer no resistance during hoisting.

j. If the weight of offered pump set/equipment is more than the craned capacity specified, the contractor shall offer the crane capacity 1.5 times higher than the weight of the pump set/ equipment or as per latest IS.

Pipes and Fittings

a. The cast iron pipes shall generally conform to class B IS: 1537/IS: 1536/IS: 7181 and pipe fittings shall conform to IS: 1538. Ductile Iron pipes shall conform to IS 8329/BS: 4772.

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

c. The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance as specified in IS standard.

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

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

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

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

Ventilation Systems

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

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

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

Supply Air Fans

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

be less than 3/9" thick steel plate. Support ring shall be continuously welded to the support plate.

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

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

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

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

Motors

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

The bearing life shall not be less than 20,000 hours at design conditions and motor shall be of class 'F' insulation to allow for operation up to 95 ^{0}C rise over the ambient temperature of 45 ^{0}C. External copper grease leads for lubrication of motor bearings shall be provided by the manufacturer.

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

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

The belt drives shall have stainless steel wire cage guards.

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

Exhaust Fans

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

All the exposed parts shall be of aluminum, with transparent anodic, anti-salt spray coating. All external fasteners shall be of stainless steel. Hood shall be hinged for accessibility and servicing. Fans shall be complete with aluminum bird screens, Plastic or light-weight aluminum back draft compels and electrical disconnecting means beneath the hood and protective grid guard below fan motor.

Motors shall be of relevant Indian Standards or British standards and shall have permanently lubricated ball bearings. The rating shall be adequate with service factor of 1.50 based on rated horsepower. All motor shall be TEFC and be suitable for continuous operation without exceeding a temperature rise of 50 ^{0}C over ambient.

The motor shall be of constant speed and squirrel cage type, operating on 415 V, 3 phase, 50 Hz supply. Roof mounted motors shall have electrical disconnects.

Contractor shall submit all catalogues showing the sizing and rating of fans with the size of openings to be provided for approval before proceeding with the work.

Dampers

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

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

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

Grilles and Diffusers

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

Installation

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

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

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

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

All fans shall be protected and painted to avoid corrosion.

Lubrication

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

NOTES/PROVISIONS

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

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

2. For all imported equipment, the motors, gearbox etc. items and components as per manufacturers' standards and makes shall be acceptable.
3. For items like mechanical screens, grinding screens, belt filter press, turbo/centrifugal blowers, centrifuge/decanter, SBR decanter, electric actuator etc. the motors, gearbox as per manufacturers' standards and makes shall be acceptable.
4. For items like screw pumps, dosing pumps, valves, gates, EOT Cranes/Hoist/Material handling equipment etc. the gear box as per manufacturers' standards and makes shall be acceptable.
5. Make of Crane Duty (S4) Motors of small capacity (**≤ 5.5kW**) for EOT Crane/Electric Hoist as per manufacturers' standards shall be acceptable.
6. The construction and general requirements for starter/control panel supplied by vendor along with equipment (applicable for motor rated **≤ 15kW/32A** incomer rating only) can be accepted as under.

    - The control panel shall be generally floor mounting type, free standing, totally enclosed and dust, damp and vermin proof. Enclosure shall have IP-42/IP-52 or better degree of protection to be mounted indoor or under shed with suitable protection unless better protection class specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). Cubicle sheet steel shall be CRCA minimum 1.6mm for load bearing and non-load bearing members. Gland plate shall be CRCA sheet minimum 2.0mm thick unless higher thickness or better MOC (SS 304 or such better MOC enclosure) specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). For motors rated **≤ 15 kW**, the common equipment panel with multiple starters up to 6 numbers within single cubicle can be accepted. However for motor rated **> 15 kW**, individual starter cubicle only shall be provided. For panel offered with multiple starters, the main incomer breaker shall be MCCB of suitable rating.

    - Starter shall be fuse less type. Incomer shall be with ammeter, voltmeter, indicating lamps etc. Start/Stop (Mushroom head stay put type with padlocking facility)/Overload Reset Push Button and Auto-Off-Manual, local-remote selector switches etc. shall be provided. Ammeter with Y-Phase CT shall be provided for all starters with motors rating **ranging from 7.5 kW to < 30 kW,** and ammeter with selector switches shall be provided for all starters with motors rating of **≥ 30 kW**. Control and power wiring shall be with minimum 1.5 sq. mm. FRLS Copper flexible. CTs, wherever provided shall be resin cast.

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

- For equipment starter required with/provided with VFD based starting or with Soft Starter based starting following to be noted:
  - ✓ VFD shall be selected such that the de-rated current of VFD/Soft Starter for 50 ^{0}C continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor. Alternatively, VFD shall be provided of at least one rating higher than the motor rating.
  - ✓ The VFD for sewage/STP and industrial effluent or such application shall be with 3C3 conformal coating and for raw/drinking water or rest applications shall be with 3C2 conformal coating.
  - ✓ The Fast Acting (Semi-conductor) fuse for VFD/Soft Starter protection are not required for motors rated **< 75 kW**.
  - ✓ The series contractor in line of VFD/Soft Starter after breaker is not required for motors rated **< 75 kW**.
  - ✓ VFD shall be with communication port (RS 485 Modbus or suitable) and shall be connected with plant PLC/SCADA for remote data, power monitoring and diagnostic data.

- Shall be suitable for remote monitoring and control from PLC/SCADA system. Required potential free contacts shall be provided for On/Off, Trip and L/R selector switch status as a minimum. In case of PLC based control offered, the PLC shall be with communication port (Modbus protocol or suitable) to communicate with plant/main PLC/SCADA for remote monitoring and control.

- Bidder to refer the specifications for electrical works and instrumentation works for rest all requirements.

7. The detail specifications for various mechanical equipment provided below are general specifications/general requirements. Operation philosophy and construction methodology may vary for each manufacturer and for the type of equipment offered and can be accepted keeping the design philosophy/application requirement as specified in tender or as per process requirement and such minor variation in specifications can be accepted subject to review (if required with justification/supporting documents) and Client's approval.

(B) SPECIFICATIONS FOR MECHANICAL ITEMS (SPECIAL)

1.0 SUBMERSIBLE NON-CLOG SEWAGE PUMP SET

General

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

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

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

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

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

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

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

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

The auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts or as per manufacturer's recommendation/approved size.

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

Features of Construction

PUMP

Pump shall be vertical submersible centrifugal, single stage, non-clog suitable for permanent installation in wet-pit/sump. The pump shall have bottom suction and side

discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

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

Casing

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

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

Impeller

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

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

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

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

Impeller Nut

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

Shaft Seal/Mechanical Seals

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

Bearings

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

Auto Coupling/Guide Pipe/Lifting Chain

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

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

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

Lifting Hook

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

INDUCTION MOTOR (Submersible)

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

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

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

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

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

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

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

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

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

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

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

Protection

Protection against increase in stator winding temperature (15^0 C) shall be provided. Minimum three number thermostats/bimetallic switches in series shall be provided to sense the stator winding temperature.

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

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

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

Submersible Cable

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

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

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

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

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

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

Motor Cooling

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

Materials of Construction

The specific requirement shall be considered as under:

Pump Casing	CI IS 210 Gr. FG 260
Casing Wear Ring/Wear Plate	CI IS 210 Gr. FG 260
Suction cover/Oil Chamber/Motor Casing	CI IS 210 Gr. FG 260
Shaft	AISI 410
Shaft Sleeve	AISI 316 (if applicable)
Impeller/Impeller Nut	CF8M
Auto Coupling Unit	CI/WCB
Hardware (Nuts, Bolts, Fasteners, etc.)	SS 304
Motor Jacket (if applicable)	SS 304
Guide Rail Pipe	Heavy Duty minimum 50 mm dia. of SS 304 of suitable length
Lifting Chain	SS 304, Minimum equivalent to sump depth + 3m, with dual 'O' rings/shackles at every about 1.5m center to center.

Bolts, Nuts, Fasteners etc.	SS 304 (All, Wetted and Non-wetted)
Cable length (each run)	As per BOQ or Minimum equivalent to sump depth + 10 m, whichever is higher
Maximum Permissible Solid Size	As specified above in pump specifications

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

2.0 VALVES

General

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

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

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

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

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

Valves shall be free from sharp projections.

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

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

SLUICE / GATE VALVES

Design Requirements and construction Features

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

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

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

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

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

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

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

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

Valve shall be non-rising or rising spindle type and rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ.

Stem sealing shall be done with NBR wiper ring in case of resilient seated and bonnet gasket shall be of EPDM. Valve shall be powder coated electrostatically internally as well as externally by RAL blue colour.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with repacking arrangement as per IS: 14846.
2. The valves 600mm and above size shall have channel and shoe arrangement as per IS: 14846.
3. The valves 350mm size and above shall have spur/bevel gear arrangement as per IS: 14846.
4. All valves shall have valve's OPEN/CLOSE indicator arrangement as per IS: 14846.

Materials of Construction

a) Body and Bonnet	:	CI IS: 210 FG 200 **OR** DI IS: 1865 Gr. 500/7
b) Wedge	:	CI IS: 210 FG 200 **OR** DI IS: 1865 Gr. 500/7 and core fully Encapsulated with EPDM rubber with integral wedge nut **(For non-rising resilient seated valves)**
c) Spindle Nut	:	Bronze IS: 318 Gr. LTB2
d) Spindle	:	SS BS 970 Gr. 304 S16
e) Seat Rings	:	SS BS 970 Gr. 304 S16
f) Back Seat Bush	:	Bronze IS: 318 Gr. LTB2
g) Shoe and Channel Linings	:	SS to BS 970 Gr. 304 S16

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

However, valves 15mm to 40mm size shall be generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended.

NON RETURN VALVES

Design Requirements and Construction Features

Non return valve (Swing check type) confirming to IS: 5312 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type. The valve shall be suitable for mounting on horizontal pipe line.

The internal parts shall be easily accessible for inspection through inspection hole.

Hydraulic passages and doors shall be designed to avoid cavitation.

Valve body shall be designed for 1.5 times the rated pressure.

Valve shall be of swing type or ball type. Ball type valve must house a freely moving ball in such a way that return flow is effectively prevented.

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

Flow direction shall be clearly embossed on the valve body.

Valve flange face shall be parallel to each other and shall be at right angles to valve centerline. Flange back shall be machined or spot faced for proper seating of bolt head and nut.

Valve shall be rated to PN 1.0/PN 1.6 bars.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with by-pass arrangement as per process requirement as per IS: 5312.
2. Valves 300mm and above size shall be provided with drain plugs as per IS: 5312.
3. Valves 450mm size and above shall have support foot as per IS: 5312.

Materials of Construction

a) Body, Cover, Doors and Hinge	:	CI IS: 210 FG 200 **OR** DI IS: 1865 Gr. 500/7
b) Body Ring	:	SS BS 970 Gr. 304 S16
c) Disc Ring	:	SS BS 970 Gr. 304 S16
d) Bearing Bushes Gr.	:	Bronze IS: 318 Gr. LTB2/ SS BS 970 304 S16
e) Gasket	:	Grafoil Filler SS 304 Spiral Wounded
f) Ball (if applicable)	:	To Be with EPDM Rubber

However, valves 15mm to 40mm size shall generally as per API 6D/API 602 and having carbon steel body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended

DUAL PLATE CHECK VALVES

General

All double flanged dual plate check valves shall conform to API 594 (1997) and API 598 or its latest amendment for pressure rating PN 1.6/class 300. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials.
The internal dimensions and shape of the body, plates etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve as per manufacturing standard.

The designs of the plates, hinge pin, stop pins etc. shall ensure free swinging of the plates. The spring action shall optimize the equal closing rates of each plate. The dual plates face shall have close face contact with the body seat ring in close position. Valves shall be designed for horizontal and vertical mounting position. The plates shall not vibrate under full or partial flow condition.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of plates, springs and hydraulic passages.

Features of Construction

Body

Valve body shall be double flanged. The minimum thickness of metal for body shall be as per directives given in the API 594 and shall be maintained throughout any section uniform. The flange to flange dimensions shall be in accordance with manufacturing standard (Tables 2A and 2B).

Body of the valve shall be fitted with removable seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each check valve shall carry an embossed ARROW to indicate the direction of flow.

Flanges

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The finish on facing shall comply with MSS SP-6/ASME B 16.5. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS: 1538, Table IV and VI.

Plates and Hinges

Plates and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Plates shall be securely positioned on body seat face with the assistance of required nos. of spring or other devices. Plate seating face shall be renewable or uniformly deposited weld metal machined and lapped using good manufacturing process so as to provide leak less seating on body face ring.

The spring action shall optimize the equal closing rates of each plate. The plates shall be totally vibration free under full or partial flow condition.

Internal Wetted Parts

Internal wetted parts shall be suitable for the specified service conditions. The term shall include but not be limited to hinges, pins, bolts, bearings and any other part in contact with the fluid medium other than the body, plates, trim, springs and pipe plugs.

Optional Items

1. Valves 300mm and above size shall have lifting eyebolts.
2. Valves 600mm and above size shall have support foot.
3. Valves 600mm and above size shall have bypass arrangement as per process requirement.

Materials of Construction

a) Body	:	CI to IS: 210 FG 200 **OR** DI IS: 1865 Gr. 500/7
b) Disc (Closure Plate)	:	Cast Steel (ASTM A216 Gr. WCB)
b) Seat	:	Nitrile
c) Spring	:	Spring Steel
d) Stop/Hinge Pin and Space Washers	:	SS 304

KNIFE GATE VALVES

General

Knife edge gate valve shall be manufactured and tested as per MSS SP 81 standards.

Knife gate valves shall be suitable for use in waste water and sewage water containing solids and fibrous wastes etc. These shall be suitable for use at suction and delivery side of pumps as well as in branch lines in a sludge handling application of treatment plant or a pumping station.

The valve should be provided with gate made of stainless steel and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off/closure in sewage environment.

Design

The valve should preferably be bonneted up to 300mm size and bonnet-less for higher sizes. Valves shall be of wafer lug type construction up to 450mm size and full flanged construction for higher sizes. The valve shall be provided with flange drilling to suit ANSI 16.5B 150# with raised face or DIN PN 10 or IS: 1538 (1993) flange connections in between pipelines.

The valves shall be designed to PN 1.0/1.6 pressure as per SOQ/BOQ. It should be suitable for unidirectional application and should be able to withstand small bi-directional pressure.

The valve body should be cast and provided with replaceable type flexible sealing seals to offer drop tight shut off. The seals should be made of PTFE or EPDM rubber and should be held in place by an easily removable type seal retainer ring.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid

seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished and buffed.

Bonneted type valves shall be provided with O-rings based arrangement to seal the rear opening and reduce the operating torque. Bonnet-less valves shall be provided with sufficient ply of stuffing seals in the inbuilt stuffing box to seal the rear opening. The seals should be of non-asbestos PTFE to reduce the friction and offer higher life. Provision shall be made to enable tighten the stuffing seals. Replacement of stuffing seals should be possible to be carried out in installed condition of the valve but without there being line pressure.

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

Materials of Construction

The following materials of construction shall be offered for the knife gate valves.

Body	: Bonnet less CI FG 260 IS: 210 **OR** DI IS: 1865 Gr. 500/7
Knife Gate	: AISI 304 Gr. ASTM A240
Retainer Ring	: Ductile Iron/Steel Hard Chromed/Stainless Steel Gr. CF 8
Inlet Seal	: PTFE / EPDM
Spindle	: Stainless Steel Gr. ASTM A276 Type 410 / 303
Spindle Nut	: Bronze IS: 318 GR LT B2
Stuffing Plate	: Cast Steel ASTM A216 Gr. WCB
Stuffing Seal	: Synthetic Fiber (Yarn) impregnated with PTFE
Support Plate/Channel	: Carbon Steel Epoxy Painted/ SS 304

BUTTERFLY VALVE

Butterfly valve shall be as per IS: 13095/BS 5155. Valve shall be suitable for mounting in any position.

For valve size 150mm and above end connection shall be flanged and for sizes up to and including 125mm shall be flanged/full lug wafer type.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 400mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

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

Butterfly valve where specified shall be electrically operated.

Materials of Construction

Sr. No.	COMPONENT	MATERIAL
(a)	Body	Cast Iron IS: 210 FG 260 **OR** Ductile Iron IS: 1865 Gr. 500/7
(b)	Body Ring	Stainless Steel BS 970 Gr. 431 S29
(c)	Disc	Ductile Iron IS: 1865 Gr. 500/7
(d)	Shaft	Stainless Steel BS 970 Gr. 431 S29
(e)	Disc Ring	EPDM Rubber
(f)	Bearing	Teflon

BALL VALVES

General

Ball valve shall be manufactured as per BS EN ISO 17292 and Inspection and testing standard shall be BS EN 12266-1.

Ball valve shall be supplied with a lever/wrench unless it is gear or electric actuator operated.

Soft-seated ball shall be with antistatic devices.

Soft-sealed BW/SW end ball valves shall have a 100mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats/seats.

The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ANSI class up to 200mm NB size. Valves 200mm NB onwards shall be in class 150 where the face-to-face dimensions shall be as per API 6D long pattern.
.
The ball of ball valve shall not protrude outside the end flanges of valve and shall provide 100% through passage to the flow of liquid.

Ball valve shall be of floating ball/trunnion mounted type as per following.

Class 150	200mm and below	Floating Ball
Class 150	250 mm and above	Trunnion Mounted

Unless otherwise specified, bore of all reduced bore ball valve shall be limited to one size lower than the nominal bore.

Valve Design	:	3 Piece Ball Valve
Type of Bore	:	Full Bore

Materials of Construction

Body and End Caps	:	ASTM A-351 Gr. CF8M
Ball/Stem	:	AISI-316
Seat	:	PTFE

End Connection : Less than 50mm – Socket Weld End (SW)/Threaded (Screwed End)

50mm and above - Flanged end, 150#

Operation of Valve : By Lever/Gear/ Electric Actuator as per SOQ/BOQ

AIR VALVE WITH ISOLATION SLUICE VALVE

DI temper proof flanged air valve with isolation sluice valve as per IS: 14845 PN 1.6 and IS: 14846 PN 1.6 respectively with SS 304 float, gun metal nozzle, complete hardware, bolts, nuts and washers, gaskets etc.

Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

KINETIC AIR VALVE

General

The double acting kinetic air valve shall be manufactured as per IS: 14845 (2000) or its latest amendment suitable for the specified pressure rating. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from blow hole, flaw burr or other defects and sharp projections which are likely to get clogged with stringy materials.

The valve shall be capable of releasing air from pipe automatically when the pipe is being filled by liquid without generating high air pressure in pipe and shall remain closed once the pipe is filled to prevent spillage and loss of liquid and maintain rising main's pressure. Similarly, the valve shall be capable to admit air automatically to prevent development of vacuum while the pipe is being emptied.

Features of Construction

Body

Body of the air valve shall be flanged type and shall have high pressure and low pressure chambers to accommodate high pressure and low pressure float respectively. The chambers shall be designed and have proper guide for small orifice float and guide ribs with minimum clearance to large orifice float so as to allow wobble free upward and downward movement of floats in the chamber when required for releasing or admitting air without any obstruction.

Body shall be designed to avoid prematurely closing of the valve by the air whilst being discharged.

The cone angle of the low pressure chamber shall be such that even at critical velocity of air escaping at 344 m/sec the total impact force on the float is less than the suction force on the annular area between the float and cone. Cone angle and the minimum body thickness shall be as specified in IS: 14845 (2000). The low pressure cover shall be designed to withstand full operating thrust in working Conditions.

The seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

High Pressure Orifice

The high pressure orifice shall be so designed that the orifice is effectively sealed in working condition. The orifice shall be of size not less than 2.5mm and tapering to 10mm

suitable to release accumulated air within the pipe. The edge of orifice shall be carefully profiled to avoid damage to the float surface. The orifice shall be protected by a Suitable plug of stainless steel.

Flanges

All valve flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat and drilled in accordance with IS: 1538, Table 4 and 6. Flange bolt shall be drilled off center.

Floats

The float size shall be as per individual design subject to minimum as specified in IS: 14845 (2000).
The buoyancy of the floats shall ensure effective sealing of large orifice even at low pressure. The float shall be made of seasoned wood or any other material having bearing strength and equivalent specific gravity. The floats shall be externally coated with vulcanite or rubber having required shore hardness as per IS. The floats shall be non-clogging and self-sealing type for trouble free operation.

Low Pressure Seat Ring

Low pressure seat ring shall be of natural or synthetic rubber having required shore hardness. The central orifice shall be profiled for maximum discharge in any given condition of pressure differential between the chamber and atmosphere. The float shall make contact with inner profile of the seat ring and seat ring shall withstand the bearing load under working condition without any deterioration in the quality.

Joint Supporting Ring

Low pressure seat ring shall be held securely in place under low pressure cover by a joint support ring to prevent it from sagging when the float is not sealing the orifice.

Cowl

A cowl shall be temper proof and designed to provide protection to low pressure, large orifice chamber, seat ring and float. It shall be designed to prevent direct ingress of foreign matter inside. There shall be sufficient clearance between the orifice and the cowl to ensure easy passage of air under a given pressure differential.

Materials of Construction

Body and Cover	:	DI IS: 1865 Gr. 500/7
Floats	:	Stainless Steel 304
Gasket	:	EPDM or Nitrile Rubber ASTM D 1418
Cover Bolts and Nuts	:	Carbon Steel

Accessories

1. Isolating DI DF sluice valves manufactured as per IS: 14846 of identical size and rating.

Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

ELECTRIC ACTUATOR (APPLICABLE FOR VALVES/GATES)

All local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.

The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single-phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

Each starter shall be equipped as follows as a minimum.

a) AC electric motor.
b) Reduction gear unit (with thrust bearing if required).
c) Torque switch mechanism complete with set of torque switches for "Open" and "Close" position.
d) Limit switch mechanism complete with set of limit switches for "Open" and "Close" position.
e) 2 numbers of auxiliary limit switches to be provided for each direction in the switch mechanism in addition to the torque/limit switch for travel termination (if specified for any application in scope of work/process description & specifications).
f) Hand wheel for manual operation.
g) Hand-auto changeover lever with suitable locking arrangement.
h) Local control switch/push buttons.
i) Forward/Reverse integral starter.
j) 1 Set "Open", "close" and "Stop" buttons as applicable.
l) 1 number Local – Off –Remote switch with padlocking facilities as applicable.
m) Space heater, 220V rated.
n) Position indicator.
o) Position transmitter with 4-20 mA analogue output for valve open/close position if requirement specified elsewhere in tender as per application.

The following relays/potential free contact shall be provided.

- Full open
- Full close
- Torque switch open
- Torque switch closed
- Thermo-switch/thermal overload relay tripped
- Selector switch position local-remote-off
- Single phasing power supply failure.
- Remote position feedback in the form of 4-20 mA (if required/specified).

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ times the maximum required torque and shall be suitable for at least 15 minutes continuous operation.

AC Electric Motor

Each motor shall be fully tropicalized and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variations of electric supply specified.

The electric motors shall be of 3 phase, minimum class 'F' insulated with temperature limited to that off class B, high torque low inertia motors of 15 minutes rating, squirrel cage type with 'O' ring seal to provide complete environmental protection during long period of inactivity. The winding shall be impregnated to render them non-hygroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour.

Motor Protection

Following motor protection shall be provided.
a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
b) Motor temperature shall be sensed by a thermostat to protect against overheating.
c) Single phasing protection.

Motor Controls

The reversing contactor starter and local controls shall be integral for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a 220V control transformer (120V AC for energization of contactors and 24V DC rectifier supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.
Local control shall comprise push buttons for open close and stop operations, and a local/remote selector switch lockable in the three positions as below.
Local control only,
Remote control plus local stop only,
Stop locked off - No electrical operation.
Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

Wiring and Terminals

Internal wiring shall be of grade PVC insulated stranded cable of 650V and of minimum 1.5 mm^2 copper for control circuits and of minimum 4 mm^2 for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

Enclosure

The actuator enclosure shall be weather proof to IP 68.

Reduction Gear Unit

Reduction gear unit shall be of the totally enclosed oil bath lubricated type. The gear box

shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at a speed sufficient to cover the full extent of travel.
The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.
The gearbox shall have suitable stops to prevent movement of shaft beyond fully open/close position. The gearbox shall also be designed for 15% more torque than maximum sluice gate/valve torque.

Torque and Position Limit Switch Mechanism

Each actuator shall be provided with both open and close torque limit switches, open and close (end position) limit switches for remote indication and interlocking plus two sets of auxiliary limit switches in each direction for intermediate position indication and interlocking if specified above for minimum provision in starter. Means shall be provided to prevent the open torque switch tripping during initial hammer blow effect. Torque protection reset shall not allow repeated starting in same direction when the control signal is maintained.
The torque switch mechanism shall function as follows to stop the motor on closing or opening of the sluice gate, upon actuation by the torque when the sluice gate 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 sluice valve is fully closed. The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during opening cycle or when the value is fully open.
The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

Hand Wheel

A hand-wheel shall be provided for emergency operation. The hand-wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency.

3.0METALLIC EXPANSION BELLOWS

Expansion bellow shall be fabricated in accordance with the EJMA/ASME standard.

The bellows shall be metallic corrugated design of MOC as specified and shall have flanged ends on both sides with liner/internal sleeve. The fatigue life expectancy considered for EB shall be minimum 3000 cycles. The drilling standard of EB flange shall be matched on piping side to ensure proper alignment and bellows is not subjected to torsional forces due to misalignment. It shall be single bellow design and suitable for axial movement of up to total 30mm (20mm axial compression and 10mm axial extension). Further it shall be suitable accommodate angular misalignment of piping for up to minimum 5mm/3 degrees for installation. The overall length of expansion joint for up to 300mm dia. size shall be 250mm, for above 300mm and up to 1000mm it shall be 300mm and for above 1000mm the same shall be 350mm. The austenitic stainless steel shall be welded using the TIG welding method. The shipping bracket of bellows shall be removed only after installation of the bellows at site.

To achieve maximum flexibility coupled with required resistance to pressure, bellows shall be formed with single or multiple walls using a number of concentric cylinders (multi-ply construction) of specified MOC, each longitudinally welded. However for the blower application the bellows shall be of multi-ply construction only.

Generally the expansion joint is provided of single bellow design as a dismantling/disassembly joint in piping near valve or pump or flow meter or such device or equipment for ease of removal and jointing. Tie rods/threaded draw bars attached to expansion joint assembly shall be provided for this application.

In case of bellows used for air piping application/in air blower discharge piping or such application witnessing vibration and temperature variations the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement. In case of bellows used for diaphragm type dosing pump or such pulsating service the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

The weld end pipe shall be suitable for design pressure (Minimum PN 10 or higher as per design) and for CS/MS weld end pipe shall be with minimum corrosion allowance of 3mm for water/waste water application. However for blower application the bellows shall be designed for a working pressure of minimum 1 Bar or higher as per design and for a temperature of minimum 115^0C or higher as per design and for velocity of minimum 25 m/sec or higher as per design and the liner thickness shall be suitable for the same.

During installation the bellows as a practice shall always to be placed between two fixed points. Thrust block or saddle welded to pipe to make it fixed must be provided on both sides of EB. For blower application generally after the bellow the first support (saddle or suitable) shall be provided at 4D distance and second support 14D distance from bellows to dampen the vibrations.

Materials of Construction

Component Description	**Water/Sewage/Sec. Treated including Effluent/Air Application**
Bellows	SS 304 (ASTM A 240 Type 304)
Internal Sleeves/Liners	SS 304 (ASTM A 240 Type 304)
Weld End Pipe	CS/MS
Flanges	IS: 2062 with drilling as per IS: 1538, PN 10 or Higher as per Design/BOQ
Tie/Limit Rods	Carbon Steel (CS) as per IS: 1367, CL 4.6
Nut, Bolt, Hardware	CS as per IS: 1367, CL 4.0

4.0 DI / CI / MS / GI PIPES and FITTINGS

4.1 DUCTILE IRON PIPES and FITTINGS

(a) General

Ductile iron pressure pipes (up to Class K9) shall comply with IS: 8329 and shall be welded on flanged pipe.

Ductile iron pressure fittings (up to Class K12) shall comply with IS: 9523 and shall be welded on flanged fitting.

All fittings shall be socketed unless specified except for incoming and outgoing below unit shall be flanged.

This specification gives the general requirement of pipes/fittings. However, **it is the responsibility of the bidder to take the actual measurement and obtain client's**

approval prior to the placement of orders to the main supplier / manufacturer as per site conditions during execution of work.

(b) Materials

The materials used in the manufacture pipes and fittings shall comply with IS: 8329 and IS: 9523.

(c) Tests

Tests on pipes and fittings shall be carried out in accordance with IS: 8329 and IS: 9523.

Testing of Pipe

The main test among others to be conducted shall be as per IS: 8329-2000 or with its latest revision/amendments.

(a) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes as specified in the Standards. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 11606 (1986). The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/EN 545 for pipes and IS: 9523/EN 545 for fittings.

(b) Brinell Hardness Test

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut form the pipes used for the ring test and tensile test in accordance with IS: 1500. The test shall comply with the requirements specified in IS: 1500/ISO 6506.

(c) Re-tests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in the standard for a period of minimum 15 seconds during which the pipes shall be struck moderately with a 700 g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

Quality Assurance

The manufacturer shall have a laid down Quality Assurance Plan for the manufacture of the products offered which shall be submitted along with the tenders.

The Employer’s representative shall be permitted free access to the place of manufacture for the purpose of examining and witnessing the testing of pipes and fittings.

Joints

(a)Spigot and Socket Joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS: 12820 suitable for carrying raw sewage with high septicity.

EPDM Rubber Gasket

Rubber Gasket shall be suitable for Push-on-Joint on lines carrying septic sewage.

The spigot ends shall be suitably chamfered or rounded off to facilitate smooth entry of pipe in the socket fitted with the rubber gasket. Rubber Gasket shall confirm to IS: 5382 (1985) and ISO 4633 (1996) its latest revision or amendments if any. Rubber ring bundles form every lot shall carry with them manufacturers test certificate for the following mechanical properties.

- ☐ Hardness
- ☐ Tensile strength
- ☐ Compression set
- ☐ Accelerated again test
- ☐ Water absorption test
- ☐ Stress relaxation test

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, the month and year of manufacture and the shelf life.

(b)Flanged Joints

The flanges shall comply with dimensions and drilling details in IS: 8329 for applicable class. All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints.

These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All materials shall be supplied by a specialist manufacturer and be to the approval of the Employer's representative.

Linings

Ductile iron pipes and fittings shall have a sulphate resistant cement mortar lining, in accordance with IS: 11906 or ISO 4179.

Pipe linings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Employer's Representative. The Contractor may use specialist mortars, mortar additives or curing agents only with the approval of the Employer's representative.

Certain sections are amplified as follows.
Sulphate Resistant Cement shall be used and no other additive shall be used without the written approval of the Employer's representative and shall be used strictly in accordance with the manufacturers' recommendations.

The minimum thickness of the lining at one point shall not be less than 4mm.

Internal lining

Internally pipe shall be SRC Cement mortar lined as per IS: 8329 (2000).

The mortar shall contain by mass at least one part of cement to 3.5 part of sand.

All pipes and fittings shall be internally lined with cement mortar using high speed centrifugal process in accordance with ISO 4179/IS: 8329. Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards. No admixtures in the mortar shall be used without the approval of the Engineer. The sand to cement proportion of sand if justified by the sieve analysis.

Pipe lining shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 8329 Annex-B or ISO 4179. This is given below.

Nominal Pipe Size (mm)	**Nominal lining thickness (mm)**
Up to 300	3
350-600	5
700-1200	6
1400-2000	9

Coating

Pipe shall be delivered internally and externally coated.

External Coating

Pipe shall be metallic zinc coated and after that it shall be given a finishing layer of bituminous paint as per IS - 8329-2000. Zinc coating shall comply with IS: 8329/EN 545/ ISO 8179. Only molten zinc spray coating shall be acceptable. The average mass of sprayed metal shall not be less than 130 g/sq. m. with a local minimum of 110 g/sq. m.

Bitumen overcoat shall be of normal thickness of 70 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II suitable for tropical climates factory applied preferably through an automatic process.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(a) General

Ductile iron pipes and fittings shall be zinc coated with a bitumen over coating, all in accordance with the following Specifications. Buried pipes and fittings shall also have a site or factory applied polythene sleeving. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Employer's Representative.

(b) Zinc Coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m^2 as described in clause 5.2 of ISO 8179.

(c) Bitumen Coating

Bitumen coating shall be of normal thickness 0.07mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II

suitable for tropical climates, factory applied in accordance with the manufacturers' instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(d) Polythene Sleeving

Where polythene sleeving is specified to be applied in addition to bitumen coating it shall comply with ISO 8180. Site applied sleeving shall be stored under cover, out of direct sunlight, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

4.2CI PIPES and SPECIALS / FITTINGS

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

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

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

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

All pipes and fittings shall be flanged.

Pipe Work

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

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

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

The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before dispatch from the manufacturer's work, the ends of the pipe, branch pipe etc. shall be suitably be

removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instrumental and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer-in-Charge.

CAST IRON PIPES

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

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

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

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

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

a) Manufacturer's name, initials or identification mark
b) The nominal diameter
c) Class reference
d) The last two digits of the year of the manufacture
e) IS Certification mark

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

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

Caulking

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

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

New Flanged Joints

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

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

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

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

Testing

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

Tyton Joints

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

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

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

The lead shall be more than 99%. It shall be soft bluish grey pig lead free from admixtures of tin or other impurities. The lead shall confirm to the IS: 3114 (1965).

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

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

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

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

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

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

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

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

Consumption of lead for jointing of pipe lines shall be as follows.

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

Sr. No.	Size of pipe line for joint in mm	Consumption of lead in kg	Depth of lead joint in cm
1	80	1.86	5.00
2	150	3.62	6.00
3	200	5.00	6.00
4	250	6.12	7.75
5	300	7.70	8.00
6	350	10.45	8.12
7	400	11.20	8.25
8	450	14.30	8.40
9	500	16.25	8.50
10	600	19.00	9.15
11	700	21.00	10.00
12	800	31.50	10.50
13	900	41.00	10.50

Hydraulic Tests

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

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

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

The pipe line shall be subjected for following test:

Leakage Test

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

There shall not be any leakage in the pipe or at the joint. A seepage allowance of a 2.5 liters per kilometer per hour per centimeter diameter of the pipe shall be permissible and that quantity will not be considered as leakage.

If the retest is delayed for more than 48 hours after any test has proved unsuccessful the Engineer-in-charge, after giving 24 hours notice, shall have every right to get all defects rectified and carry out other necessary works and take hydraulic test/leakage test to the contractor. Any damage done to the pipes, materials, the other labour cost, etc. incurred there under shall be recoverable from the contractor either from his bill or deposit.

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

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

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

When the section of the pipe line is tested successfully the contractor shall remove the blank flanges, pump out water from the pipes and back fill the portion as per directions of the Engineer.

CI double flanged pipes/piping within pump house shall be tested for 150% of maximum system pressure.

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

CAST IRON FITTING and SPECIALS

Providing and supplying at site of work CI fittings/specials confirming to IS: 1538 (1993) with latest amendments.

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

The CI fittings and specials shall conform to IS: 1538 (1993) with latest amendments.

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

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

The mass of CI fittings/specials shall strictly conform to IS: 1538 (1993) with latest amendments.

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

4.3MS PIPES, SPECIALS / FITTINGS and FLANGES

MS Pipes

Provide, fabricate, test, paint and supply of MS pipes of specified ID / OD and wall thickness conforming to IS: 3589 (2001)/IS: 1239 (1990). The pipes up to 150mm shall confirm to IS: 1239 with latest amendments of required class. The pipes of 200 and above shall confirm to IS: 3589 Fe410 with latest amendments.

Quality of Steel
Pipes shall be fabricated from steel plates conforming to IS: 2062 E250 BR and IS: 10748 Gr 3.

Thickness of Pipes
The pipe shall have minimum specified wall thickness as mentioned in Table-3.

TABLE - 5
MINIMUM SPECIFIED THICKNESS OF PIPES

Nominal Size (mm)	: Minimum Specified Thickness of pipe in mm up to 150 NB Heavy IS: 1239 Part 1 From 168. Mm OD IS: 3589 FE 410
Up to 300	: 4
above 300 to 500	: 5
above 500 to 600	: 6
above 600 to 850	: 7
above 850 to 950	: 10
above 1000 to 1500	: 12

Hydraulic Pressure Test

Each pipe shall be hydrostatically tested at the manufacturers' works before the pipe is coated, wrapped or lined at the manufacturers' works as per applicable standard.

The Hydraulic test pressure shall be the pressure calculated from the following formula, except that the maximum test pressure shall not exceed 5Mpa.

$$P = \frac{2 \times S \times t}{D}$$

P = Test pressure
S = A stress in MPa which shall be taken as 40% of the specified minimum tensile strength.

t = Specified thickness in mm and
D = Specified outside diameter in mm.

Test pressure shall be applied and maintained for sufficiently long time for proof and inspection.

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

MS SPECIALS

Scope shall include providing, fabricating, testing and supplying/installing MS specials suitable to MS pipes, valves and other fittings from steel plates. MS Specials shall be confirming to IS: 7322/IS: 1538 dimensionally. MS specials and fittings shall be fabricated at site of work tested to specified test pressure and including providing flanges required, painting inside zinc epoxy coating and outside anti corrosive red oxide primer, coated with three coats of anticorrosive water proof paint including freight, loading, unloading, carting, stacking as directed, and including all taxes, insurance etc. The sizes and types of specials shall be as per requirements taking into consideration in tender items like pumps, sluice valves, non-return valves, scour valves, expansion joints, dismantling joints etc.

Flanges

All MS flanges conforming to IS: 6392, PN 1.0 or 1.6 and their dimensions of drilling be in accordance with IS: 1538/IS: 6392 suitable for pressure 10 kg/cm^2 (specification for MS fittings for pressure pipes for water, gas and sewage) or its latest revision. The flanges shall be flat faced with off center bolt holes. Prior to manufacturing process, the contractor shall have to obtain approval of Engineer in charge for all sizes and types of flange drawings.

Galvanizing

Hot dip zinc coated Mild Steel Tubes/Pipes and fittings shall be as per IS: 4736 (1986).

Inspection

The equipment shall be offered for factory inspection and performance testing as per relevant standard if required by Purchaser/client /client's consultant.

MS SPIRALLY WELDED PIPES

Manufacturing, supplying, lowering and laying in position sleeve/swaged ended, outer coated, spirally weld MS pipes confirming to IS: 3589 (2001) including all type of necessary coping, welding, outer coating treatment with corrosion chloride resistant treatment of "Corrocretive Te" or 4mm thick pipe coat, inner lining, safeguarding, lightening, barricading, fencing, field welding and hydraulic test as per the detailed item specifications and as per the direction of Engineer– in–charge.

Material

Spirally submerged arc welding pipes shall be manufactured from steel produced by the open hearth or electric or one of the basic oxygen process.

Steel to be used in manufacture of spiral welded pipe shall be conforming to IS : 2062 (1992) and to its latest amendments also. Steel should be of Grade – B designated as Fe 410 in IS: 2062 (1992).

Sampling of pipes shall be as per IS: 4711 (1994).

Manufacture

The pipes shall be manufactured from steel strips by spirally submerged arc welding as per IS 4353. The weld must be automatic and continuous. All the edges of the plates/strips should be prepared suitable prior to the welding of pipes. Welding joints and its manufacturing process shall conform to IS: 3589 (2001). Weld consumable for SAW IS: 814, IS: 3613, IS: 6419 and IS: 7280.

Length

The Client intends speedy as well as easy laying work of pipes procured through this tender. Accordingly, spiral welding pipes of all the sizes shall be supplied in single random length form 5.50 meter to 6.50 meter. Pipes in such lengths shall be 90% of the total quantity. Remaining 10% (Maximum) pipes of the ordered quantity may have length 10% shorter/longer in running meters to the length specified above.

Wall Thickness

Wall thickness shall be as per IS: 3589 (2001) without negative tolerance.

Finished pipes shall not deviate from straightness by more than 0.1% of the total length. Straightness shall be checked out by using a taut string or wire from end to end, along the side of the pipe to measure, the greatest deviation.

Hydraulic Pressure Test

Each and every pipe shall be hydraulically tested at the manufacturers' works at test pressure. Testing shall be carried out as specified in IS: 3589 (2001).

Mechanical Test

I. Tensile Test

Tensile test shall be carried out as mentioned in IS: 1894 (1972) as well as IS: 3589 (2001). The tensile strength and percentage elongation of the pipes shall strictly conform to the provisions of IS : 3589 (2001). The manufacturer shall submit the required test certificates at free of cost, both for the pipes as well as steel strips also.

II. Guided Bend Test

Guided Bend test shall be carried out as per the provisions of IS: 3589 (2001) and necessary test at free of cost for ERW pipes. Flattening test shall be as per IS: 1239/IS: 3589.

Other Tests

Radiographic testing or Ultrasonic testing in factory (15% of welded length of each pipe) as per IS: 3589 (2001). Radiography as per IS: 2595 ASME Section V Article 2 & 22 and Ultrasonic test As per IS: 7343 ASME Section V Article IV.

Chemical Composition

As mentioned earlier the steel used for manufacturing shall strictly conform to IS: 2062 (1992) having grade designation Fe 410W A. Chemical composition should be conforming to IS: 2062 (1992) and various constituents viz. Carbon, Manganese, Sulphur, Phosphorus, Silicon, Copper etc. shall be within prescribed permissible limits. The manufacturer shall submit the required test certificates at free of cost, both for the pipes as well as steel strips.

Pipe Ends

I. All the pipes shall have one end swelled and one end plain suitable for field welding. Both the edges of each pipe must be truly vertical. The swelled end shall be formed, strictly as per the dimensions mentioned in IS: 3589 (2001).

II. The sleeve/swelled end of pipes shall be formed in such a way that the plain end of the pipe shall be inserted inside freely/easily.

Mass

The mass of steel shall be 7.85 g/cm^3.

Workmanship

I. All the pipes shall be clearly finished and when visually inspected shall be free from defects such as cracks, surface flaws, lamination etc. The ends of the pipes shall be cleanly cut as mentioned in 7.0 and truly vertical with the axis of the pipe.

II. The copy of the ISI License for manufacture of pipes for the particular unit from where the pipes will be manufactured shall also be submitted.

III. Owner intends to utilize the pipes with two coats of red oxide as anti-corrosive primer. The pipes shall be supplied oxide to avoid corrosion during monsoon period, the anti–corrosive primer shall be applied to the inside and outer side of the pipes.

Marking

Each pipe shall be legibly marked at free of cost with the following details.
(a) Manufacturer's name or trade – mark
(b) Outside diameter in mm
(c) Wall thickness in mm
(d) ISI mark
(e) Purchaser's Name
(f) Last two digits of the year of Manufacture

Field Welding

The welding and joint of the pipes in the field shall comply with IS: 816 (1965) or its latest amendments/IS: 9595.

The weld shall be run in three runs of welding. The welding and testing of the weld shall also be done as per the procedure laid down in IS: 823 (1964) or its latest amendments. Experienced welders whose performance shall be tested from time to time, shall only be permitted to carry out the welding work. No apprentices or helpers shall be allowed to do any welding work, No apprentices or helpers shall be allowed to do any welding whatsoever. If any un authorised person is found to do welding work, he shall be removed from the work and the work carried out by him will have to be redone after

gauging out the same. The following points shall be borne in mind by the contractors.

Electrodes

The contractors shall use standard AWS E7018 electrodes its number (i.e. type) depending on the thickness of plate and the type of joint, they shall also use standard current and voltages required for the machine in use. Electrodes be of ESAB India, ADVANI and D & H only.

Electrodes to be used in welding work shall conform to IS: 814 and 815 and welding shall conform to IS: 816, 822 and 823. The electrodes must be of make "ESAB-INDIA", "Advani", "D & H" only.

Testing of Welded Joints

(i) General

The weld joints shall be tested in accordance with specifications of IS: 823 (1964) and IS: 3600 (1973) or to its latest amendments.

The test pieces shall be taken out from the pipes pointed out by the Engineer without any delay. They shall be immediately delivered at the Engineer's Office for being numbered, machined and tested.

The shape of the test pieces removed from the pipes shall be such that it will give a specimen of the required dimension and at the same time leave a hole in the pipe with round corners. This hole shall be closed up by patch plating from the outside so as to have overlap of 3"on all sides of the opening. Great care shall be taken in preparing required MS plates for this, is included in the item. After the jointing is completed, all protruding portions shall be chipped off, and the portion of the pipeline near the field joint shall be thoroughly scrapped and cleaned to receive the guinite.

(ii) Details of Tests

The following test shall be carried out.

Tensile Test

The test specimen taken perpendicularly across the weld shall be shaped in accordance with the IS: 1663 (1962). The specimen shall be taken from the end of the pipe or at any joint in the pipe as directed by the Engineer and shall be cut with the weld approximately in the middle of the specimen. The tension test specimen shall be machined. The protruding welding portions from both inside and outside shall be removed by machining or grinding before the specimen is tested.

At least one field joint out of every 100 shall be subjected to test by taking out a specimen. If a test specimen shows defective machining or taking out a specimen. If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen substituted.

The weld joint shall show a strength not less than the minimum tensile strength specified for the plate.

Bend Test

The bend test specimen shall be prepared in the same way as for tensile test and tested in the presence of the Engineer. The specimen shall be taken from the pipe selected for

tensile test. The specimen shall stand being bent cold through 180 degrees around a pin, the diameter of which is equal 4 ½ times the thickness of the plate without developing cracks. In making the bend test be placed next to the pin.

Outer Coating

Corrosion and chloride resistant treatment shall be carried out as specified below.

I. Prior to application of treatment, the pipe shall be made free from all mill scale, rust, foreign matters or any such materials must be removed from the pipe surface by use of wire brush followed by sand blasting to "SA 2 ½ standard immediately prior to the application of priming coating.

II. In addition, metal surface should be free of oil, grease and other impurities which can impair the adhesion.

In case of COROCRETIN_TE (i.e. thixotropic two component resin system with modified amine harder) layer, outer coating shall be carried out as below.

Prior to application of treatment, the pipe shall be made free from all mill scale, rust, foreign matters or any such materials must be removed from the pipe surface by use of wire brush followed by sand blasting to "SA 2 ½ standard immediately prior to the application of priming coating.

Application

I. Mix the individual components (Component A & Component B) separately homogeneity. Mix one part of component A and one part of component B by weight thoroughly and apply using conventional brush, roller and spray.

II. Immediately after preparing surface by sand blasting apply one coat of Corocretine TE(S). Apply two more coats within the interval of 12 to 48 hours until the surface is completely free from pores.

Following care should be taken while application of this treatment.

i. Due care should be taken to prevent impurities and dampness on the surface in the time between the every application of treatment coat.
ii. If longer time is anticipated between topcoat, then the existing coat should be roughened before fresh coating is applied.
iii. After application Corocretin TE(S) should be protected from moisture (rain, dew, fog) for a period of 6 to 8 hours.

Consumption

For one prior coating and two topcoat each of 80 micron (total 240 micron) the consumption of Corocretin TE(S) shall be 750 gm/sm.

a) Painting near expansion joints internally and external paintings of patch plates.

b) For curing, depth of 20 to 30 cm of water be maintained in the flat portion of the pipeline to maintain adequate humidity in the pipe required for curing.

c) Carrying out performance test for 'C' value.

Outer coating work, in case of "Pypekot" material shall be carried out as below.

1) All the mill scale, rust, foreign debris or any such material must be removed from the pipe surface by use of wire brush/power brush immediately prior to the application of primer on the surface of the pipe.

2) One coat of fibre coal tar and solvent based compatible primer of density 0.92 gm/cum and viscosity of 1000 to 2000 CPS at 150 gm/sq. meter shall be applied. The primer shall be allowed to dry until the surface becomes tacky. The primer shall be applied to dry until the surface become tacky. The primer shall be allowed to dry until the surface becomes tacky. The primer shall be applied to dry until the surface becomes tacky. The primer shall be applied in such a manner that it produces an effective bond between metal and subsequent coating of the 4mm thick polymeric tape.

3) Tape may be wound either circumferentially or spirally with using thermo-fusion process to completely adhere with primer coated surface maintaining minimum 15mm overlaps to the two adjacent layers. Cost of overlap is included in the item and no extra payment shall be done for it.

4) Either end of the pipe shall be left uncoated to enable proper installation/laying as well as field welding work. This area shall be coated in situ after the installation/laying and welding of the pipes in the trench. In case of any damage is occurred to the outer coating of the pipe during handling, laying and installation at any place of the surface, the rectification shall be done by patching up the damaged area by thermo-fusion at no extra cost.

5) Holiday test as described in IS: 10221 shall be conducted at the cost of the Contractor in the presence of an authorised representative of and if any fault/defect is found, it shall be rectified at no extra cost.

6) Cross adhesive test.

Inner Lining

This clause covers scope of material and application of cement mortar lining on the inside surface of the pipe line. The application of mortar lining covers lining of straight pipe sections, long, short radius bends, vertical shafts and all specials etc. the lining shall be carried out through an access by a machine that progress uniformly through an access by a machine that progress uniformly through the pipe and applies mortar against the pipe surface and mechanically trowels it to obtain smooth lining of bends, specials and areas adjacent to valves shall be appropriately dealt with according to the best practice of the trade for the diameter concerned. The Contractor should specify what is the best practice and produce acceptable evidence therefore.

All access openings and feed openings or manhole for feeder hoses shall be re-welded in position after lining them. The line will be restored to the satisfaction of the owner.

The scope further includes mobilization of equipment, making access openings wherever required and curing of the mortar lined pipe including testing. Patching access holes, etc. as described in following pages.

The main items of work will be generally as follows.

a) Mobilisation of equipment, plant and machinery.

b) Deciding access openings in the main and providing temporary access up to openings wherever necessary.

c) Making trenches of suitable depth, width and length for making access openings in case of underground (U/G) pipe including dewatering and refilling.

d) Breaking gunited/concreted surface (if any) of U/G pipe and cutting the top portion of pipe (Underground as well as above ground) to provide for access opening.

e) Provide necessary platform for installation of mixing machinery.

f) Remove and re-fix appurtenances, provide additional ventilation openings and plugs, if required. Take suitable measures for adequate ventilation in case of U/G pipes.

g) Maintaining the pipe temperature between 50 degree F and 90 degree F.

h) Cleaning the pipe surface internally.

i) Mortar lining the internal surface of the pipe lines.

j) Curing the mortar lining.

k) Inspection and testing of mortar lining.

l) Hand lining with cement mortar for top and bottom portion of pipe removed for access opening. While at enter side it should be coated with 4mm thick Thermo-fusible polymeric corrosion protection tape called "PYPE COAT" conforming to IS: 10221.

General Cement Mortar Lining Design

a) Composition

Mortar for the lining shall be composed of cement, sand and water that have been well mixed and are of such consistency as to produce a dense, homogenous lining. Unless otherwise specified by the Owner, the mortar may also include admixtures as per IS: 3589 and IS: 11906 (1986).

b) Proportions

The approximate proportions of cement and sand in the mortar for the mortar for the lining shall be 1 part of Portland cement to 1 part of sand by volume.

The exact proportions shall be determined by the characteristics of the sand used. Admixtures, if added, shall be used in strict compliance with the Manufacturers' recommendation.

The Contractor should specifically state as to the cement proportion to use having regard to his experience (to be stated) and the practice or specifications his principle follow generally and recommend in this particular case.

c) Water Content

The water content shall be as per IS: 456. The minimum quantity that produces a workable mixture with full allowances made for moisture collecting on the interior of the pipe surfaces. Slump tests should be made periodically on freshly mixed mortar immediately prior to the mortar lining conveyed to the lining machine. The test results of slump test should indicate slump of Mortar required consistency or as per directives of the Engineer-in-charge. Each lot cube will be taken and tested as per IS: 3589.

Mortar shall be mixed long enough by machine to obtain maximum plasticity. The mortar shall be used before initial set.

d) Field Test

The slump test for compressive strength of mortar shall be carried out by the Contractor for determining the Quality of mortar.

e) Thickness of Lining

The lining shall be uniform in thickness within the allowable tolerance, except at joint or deformations in the pipeline, Cement mortar lining thickness shall be 9.5mm. The tolerance for lining shall be + 2.5mm for pipe and + 5.0mm for specials with no minus tolerance, the mortar lining work shall be by single application.

Laying of Pipes

Carting and Handling

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Employer's representative. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or swelling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5m.

Fittings/Specials shall be stacked under cover and separated from pipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

Laying

f) Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer/Employer's representative. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Employer's representative.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Employer's Representative. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½^0. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes in case of flexible joints only

The cutting of pipe for inserting valves, fittings, or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

g) Thrust Blocks

Thrust blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by the Employer's representative especially at horizontal and vertical bend.

h) Jointing

Jointing for pipes and fittings/specials shall be done in accordance with the relevant Employer's requirements depending upon the type of pipes being used.

i) Testing and Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer's requirements.

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

Further the contractor shall offer ultrasonic testing for 15% of welded length of each field joint of pipe at site.

j) Backfilling

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand-operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care bring taken to avoid damage to the pipeline. In case of the mild steel pipes/specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

k) Reinstatement of Road/Footpath

Reinstatement of road/footpath shall be done as per the requirements of local authorities and the Employer's Requirements after completion of work.

l) Clearing of Site

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the Employer's representative and the construction site left clean to the satisfaction of the Employer's representative.

4.4G I PIPE and FITTINGS

All GI pipes shall conform to IS: 1239.

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

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

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

Flanged or screwed valves shall be installed in locations shown on the drawings as per specification for screwed or flanged joints. All completed GI lines shall be hydrostatically tested to a test pressure of 5 Kg/cm^2.

5.0 WALL THIMBLE MOUNTED CAST IRON SLUICE GATES

General

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

The Sluice gates shall be Wall thimble mounted only except for shallow channels. For shallow channels of up to 3.5 meter depth with water head not exceeding 2.0 meter and Gate/Shutter area not exceeding 1.5 m^2 wall mounted gates can be accepted instead of wall thimble.

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

Design and Construction Details

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

Gate Frame

- The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall either be flat back type or flange back type to suit the designed head and site condition.

- Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the Cast iron wall thimble mounted on the wall. A rubber gasket will be provided between the wall thimble and the gate for ease in future dismounting of the gate for repairs / replacement and seal any leakage between the flange of frame and wall thimble.

- The gate frame of these sluice gates shall either be self-contained type or non-self-contained type depending upon site requirement. In case of non-self-contained gates the frames shall have short length extension guides and shall be without yoke at their top. The length of extension guides in such cases shall be sufficient to engage at least half the overall vertical height of door when the gate is full open and shall be in accordance with the relevant provisions of IS: 13349. In case of self-contained gates the frames shall have full length extension guides and shall be provided with a yoke at their top. The length of extension guides in such cases shall be sufficient to engage the overall vertical height of door when the gate is full open position.

Wall Thimble

- The Wall thimble will be made from cast iron for placement in the concrete wall. Its front flange will be machined, drilled and tapped to match with the frame flange.

- The cross section of the thimble shall be F shaped and the depth of thimble shall be minimum 300mm long. Gates subjected to high unseating heads shall have thimble cross section shape.

- To permit entrapped air to escape as the thimble is being encased in concrete, cast holes of 40mm diameter shall be provided at the bottom of wall thimble in each entrapment zone.

Gate Slide / Shutter / Door

- The gate slide/shutter/door will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head.

- The gate slide/shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

Seating / Sealing Faces

a. Materials: These should be of Stainless steel or Bronze or as specified.

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

c. The front faces of integral extension guides which can come in contact with the sealing faces of door while opening, shall also be fitted with sealing faces of the same material as that of the sealing faces on door. This is required to offer non corroding smooth sliding surfaces to the sealing faces of door/shutter during its vertical travel for opening and enhance the effective life of gate.

d. Finish: The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces, in gate closed position, does not exceed 0.1mm.

Wedging Devices

- The sluice gates shall be provided with individually adjustable wedging devices to ensure forced contact between frame and shutter seat facings, when the gate is in closed position.

- The gates meant for seating head shall be provided only with side wedging devices. Gates meant for unseating head of sizes larger than 600mm, shall be provided with side, top and bottom wedging devices or with side and top wedging devices and flush bottom closing arrangement as required.

- The wedging devices comprise of wedge brackets fitted on gate aperture frame and door. The wedge bracket on frame shall remain in fixed position and those on door shall be adjustable or vice versa. A sort of slot and Tennon arrangement shall be provided on base of wedge brackets to prevent any tendency to shift. Provision shall be made to clamp the adjustable brackets firmly in adjusted position.

- The wedging devices shall be made of cast iron. If the wedges/wedge blocks of wedging devices are of Cast Iron, then these are to be lined with contacting faces of the same material as that of sealing faces attached to the gate frame and door.

Conventional or Flush Bottom Closing

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

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

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

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

Flush Bottom Closing shall involve a flexible rubber seal at the bottom of the gate, mounted either on the shutter or on the frame, ensuring that the sealing face remains flush with the floor. The cast iron bar fitted at the bottom of the frame is required to be embedded in the channel/chamber floor and for this a cut out/recess of ample dimensions is required to be provided beneath the waterway opening along the gate invert, while constructing the floor. The dimensions of this cut out shall be provided depending upon the feasibility to do so as per actual site conditions.

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

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

Gate Operating Head Stock / Lift Mechanism

- The operating headstocks shall be designed in such a manner as to permit the gate operation by a single person under the specified maximum operating head with an effort of less than 18kgs on the crank or hand wheel with a radius not exceeding 375mm. Vendor shall provide torque calculations in support of same.

- The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.

- Geared headstock shall be supplied with easily removable crank handle or hand wheel with a radius not exceeding 375mm.

- All the gears of geared headstock shall be kept completely encased in cast iron housing to protect them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease nipples shall be provided at proper places for lubricating with grease.

- Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

Lifting Spindle / Stem

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

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

Stem Block / Connecting Block / Thrust Nut

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

Safety Stop Nut

The stem shall be provided with a safety stop nut to prevent the chances of over closing of gate which may otherwise damage either the stem or the lifting platform. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set in such a way that its bottom remains about 1 to 2 mm away from the top of headstock, in gate closed position.

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

Spindle / Stem Couplings

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

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

Stem Guide Brackets

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be Adjustable Centre Type

- wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offer minor adjustment in the direction parallel to the wall.

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

Pipe Hood for Stem

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

Gate Opening Indicating Arrangement

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

Materials of Construction

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

Gate Frame, Shutter , Thimble,	Plain Cast iron IS: 210 FG 200
Headstock, Wedges, Stem Guides	Plain Cast iron IS: 210 FG 200 Stem Guide shall be with LTB-2 Lining
Seating / Sealing Faces and Wedge Lining	Stainless Steel ASTM A 240 type 304
Rubber Seals (If Applicable)	EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar (If Applicable)	Plain Cast iron IS: 210 FG 200 / Stainless Steel ASTM A 240 type 304
Stem, Stem Guide Brackets, Coupling & Stop Nut	Stainless Steel ASTM A 276 type 304
Assembly Bolts, Nuts and Fasteners	Stainless Steel ASTM A 276 type 304
Yoke (If Applicable)	Mild Steel to IS: 2062 grade A, Epoxy Painted
Stem block	Leaded tin bronze to IS: 318 type LTB2
Lift nut for manual ungeared	Leaded tin bronze to IS: 318 type LTB2
Pipe Hood for Stem	Transparent fracture resistant polycarbonate material
Operation	
Lift nut for manual geared / actuator Operation	As per gear box/actuator manufacturers' Standards

6.1 REMOVABLE BOX TYPE COARSE MESH SCREEN (FOR SPS-01)

The removable box type manual coarse mesh screen shall be fabricated from SS 304 mesh made of 9 mm dia. SS 304 round bar materials and welded/fixed in SS rectangular box frame made of SS equal angles suitable to screen solids of minimum size as specified in BOQ.

The overall size of screen shall be as follows.

- 900mm (W-or actual chamber width as per site) X 1400mm (H) X 300mm (D) in cubical shape (having mesh size 50mm x 50mm).

Screen shall be of two parts - (1) Bar mesh Screen with box frame and (2) Solids collection box.

The screen shall be welded to a common frame as fabricated from minimum 50mm X 50mm x 6 mm thick or higher as require of equal angle throughout its perimeter of SS 304 to provide sufficient strength with intermediate supports.

Screening collection box shall be of following size.

- 900mm (W-or actual chamber width as per site) X 300mm (H) X 300mm (D) in cubical shape

It shall be fabricated from 3mm SS 304/316 sheet, covered from all three sides and bottom and welded on common frame of screen. Screening/Solids collection box shall be framed in minimum 50mm X 50mm x 6mm thick or higher as require of SS 304 equal angle. Both the side of cubical frame of box screen also shall be covered together with top of screen using 3mm SS 304 sheets. The side and bottom surfaces of solid collection box shall be suitably perforated (10mm dia. holes with maximum 10% perforation area) to drain the sewage.

The screen shall have min. two lifting hooks, spaced sufficiently apart from the center at the top of the screen frame along with pair of SS chain with lifting rings of min. 300 mm long each at a distance of 1.5 meter of required length up to 1 meter above top to facilitate easy removal of screen from sump. The side of the screen shall have replaceable wear shoes of SS/gunmetal plate at top and bottom edge. The screen shall be rectangular in shape and shall be capable of being lifted by means of mechanical/ manual lifting arrangement (electric chain hoist) and raised above the operating platform, as and when necessary.

The Box screen shall be lowered in screen wet pit, suitable to slide complete screen through rollers between guide passage made through C channel of MCP 400 as per IS: 808, grouted/ anchored/welded with equally long insert plates of 10mm thick and securely fixed.

Screen shall be supplied with 1 sets of cleaning rakes/shovels with required long wooden/FRP arm for collecting/removing screenings gathered/collected on screen.

(Note: 1. Screen suitable for 1000 mm wide screen chamber or to suit site requirement.)

6.2 REMOVABLE BOX TYPE COARSE MESH SCREEN (FOR SPS-02)

The removable box type manual coarse mesh screen shall be fabricated from SS 304 mesh made of 9 mm dia. SS 304 round bar materials and welded/fixed in SS rectangular box frame made of SS equal angles suitable to screen solids of minimum size as specified in BOQ.

The overall size of screen shall be as follows.

- 1200mm (W-or actual chamber width as per site) X 2000mm (H) X 300mm (D) in cubical shape (having mesh size 50mm x 50mm).

Screen shall be of two parts - (1) Bar mesh Screen with box frame and (2) Solids collection box.

The screen shall be welded to a common frame as fabricated from minimum 50mm X 50mm x 6 mm thick or higher as require of equal angle throughout its perimeter of SS 304 to provide sufficient strength with intermediate supports.

Screening collection box shall be of following size.

- 1200mm (W-or actual chamber width as per site) X 300mm (H) X 300mm (D) in cubical shape

It shall be fabricated from 3mm SS 304/316 sheet, covered from all three sides and bottom and welded on common frame of screen. Screening/Solids collection box shall be framed in minimum 50mm X 50mm x 6mm thick or higher as require of SS 304 equal angle. Both the side of cubical frame of box screen also shall be covered together with top of screen using 3mm SS 304 sheets. The side and bottom surfaces of solid collection box shall be suitably perforated (10mm dia. holes with maximum 10% perforation area) to drain the sewage.

The screen shall have min. two lifting hooks, spaced sufficiently apart from the center at the top of the screen frame along with pair of SS chain with lifting rings of min. 300 mm long each at a distance of 1.5 meter of required length up to 1 meter above top to facilitate easy removal of screen from sump. The side of the screen shall have replaceable wear shoes of SS/gunmetal plate at top and bottom edge. The screen shall be rectangular in shape and shall be capable of being lifted by means of mechanical/ manual lifting arrangement (electric chain hoist) and raised above the operating platform, as and when necessary.

The Box screen shall be lowered in screen wet pit, suitable to slide complete screen through rollers between guide passage made through C channel of MCP 400 as per IS: 808, grouted/ anchored/welded with equally long insert plates of 10mm thick and securely fixed.

Screen shall be supplied with 1 sets of cleaning rakes/shovels with required long wooden/FRP arm for collecting/removing screenings gathered/collected on screen.

(Note: 1. Screen suitable for 1300 mm wide screen chamber or to suit site requirement.)

7.1 MECHANICAL MULTIRAKE COARSE BAR SCREENS

PURPOSE & SCOPE

e. The mechanically cleaned bar screens shall be capable of performing the screening duties in storm water/waste water pumping stations/water intake structure and in water and waste water treatment plants. The screens shall be suitable for operation in a flow having a high content of fibrous screenings and may be heavily grit laden. These screens should be capable to screen out most of the medium and large floating material such as plastic bags, floating debris, weeds, paper wastes, clothes and rags etc. which are generally clogging the impellers of the pumps installed downstream of the screens. The screens shall be so constructed that there is no undue wear or

deterioration during its operative life and so designed that the maintenance is kept to a minimum.

f. 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 mechanical screen should withstand all condition.
g. The mechanically cleaned bar screens shall be supplied along with all accessories such as screens structure, bars, rakes, chains, sprockets, bushes, scraper assembly, geared motors, local control panel and all fasteners required for erection/installation of the screen.
h. The operation of the screen shall be automatic through 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 traveling raking mechanism to start/stop its operation in auto mode (for Differential level transmitter specifications and make refer instrument section).
i. A complete electrical control system shall be supplied and shall be mounted independently near to the screen installation. The system shall provide for total automatic operation of the screen with the feedback from the level/differential level controller or through timer as per operator selection in addition to manual operation through panel mounted selector switches as per the choice of operator. The panel shall be in with double door, **SS enclosure** and with canopy for protection from rain and suitable for outdoor application.

DESIGN PARAMETERS

a.	Minimum debris discharge height over top of channel	:	750 mm
b.	Minimum water approach velocity	:	0.3 meter/sec
c.	Maximum head loss @ 50% clogging	:	250 mm
d.	Bar spacing	:	20 mm or as specified elsewhere in tender/ BOQ
e.	Bar Size	:	10 mm thick x 50 mm deep Flats or as specified elsewhere in tender/BOQ
f.	Vertical bar height/Screen field length	:	Shall be equivalent to the maximum water level plus an additional minimum 300mm of freeboard or higher as specified in tender/ BOQ
g.	Angle of screen inclination from horizontal	:	75 degrees
h.	Minimum rake travel speed	:	7-8 meters/min
i.	No. of rakes	:	As per manufacturers' design based on channel depth (app. 1 rake per 1.5-2 meter of screen chamber depth as a minimum)
j.	Chain Breaking Load	:	Minimum 90kN for channel up to 12 m Minimum 112kN for channel depth > 12m

SPECIFICATIONS

- **Materials of construction**
  All parts of screen including fixed bars, rakes, screen frame, guide rails, dead plate, chains & sprockets and discharge chute shall be constructed from stainless steel material grade **minimum SS 304** for long life in aggressive sewage environment. Suitable measures shall be taken to ensure long life of parts.

- **Screen Construction**
  - The bars shall be of flat profile having bar size and bar spacing as specified above in design parameters/in process design criteria and detailed specifications. The screen field bars shall be of sufficient length to suit the flow. The screen field length shall be equivalent to the maximum water level plus an additional 300mm of freeboard or higher as specified in tender/ BOQ.

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

  - The rake shall be made of Ultra High Molecular Weight Polyethylene (UHMWPE) fixed on stainless steel plate.

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

  - The drive chain for the rakes shall be link type roller chain and made of stainless steel grade AISI 304 with special grade hardened stainless steel pins. **The chain shall have a breaking load of minimum 90kN**. This is very essential considering highly corrosive sewage atmosphere.

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

  - To effectively remove the debris from the bottom most portion of the screen, the screen shall be provided with curved structure at the bottom of the screen.

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

  - The upper sprocket bearing shall be re-grease-able and flange type.

  - Lower bearings shall be made of non- re-grease-able special ceramic bushes.

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

  - The rake mechanism should be operated by an Electro brake motor and be suitable for automatic operation controlled by a level sensor and electric control cabinet.

  - Torque switch should be provided to protect the screen from damages resulting from excessive torque.

  - After fabrication and assembly the stainless steel parts, 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.

  - Cover plate of minimum 2mm thick shall be provided over the portion of screen remaining outside the screen chamber slab.

  - To remove screened material away from the screen, horizontal curved chute with 450mm dia. and minimum 2mm thick stainless steel of suitable length as per the site requirement shall be provided. Screened material shall be discharged in to

this chute and from this chute the waste shall slide in to the collection trolley kept beside the screen chamber.

- **Level Sensor**
  The level sensor shall be of ultrasonic differential type (Refer Instruments' Specifications).

- **Electrical Motor**
  The motor shall be of TEFC type with IP 55 protection and Class F insulation and be suitable for operation on 3 phase, 415 V ± 10% and frequency of 50 Hz ± 5%. Motor shall be provided with canopy/cover. For efficiency class and other requirements **refer specifications of motor under Electrical Specifications**. However considering the specific application the motor make as per manufacturers' standards' can be accepted.

- **Control Panel**
  The control panel shall have **SS enclosure** with IP 65 protection and shall be comprising of
  - Required fuse-less type starters for screens as well as belt conveyor.
  - Mushroom head emergency stop.
  - Overload relays for motor protection.
  - Control Circuitry to operate the screen with differential type ultrasonic level sensor.
  - Selector switches to operate the screen in Auto, Off and JOG mode.
  - Provision to run the screen on timer in case of failure of level sensor when selected in auto mode. Additionally it shall be possible to operate the screen through panel mounted selector switches when selected in manual mode of operation.
  - The belt conveyor operation shall be interlocked with operation of screen.
  - The panel shall be in with **double door, SS enclosure** and suitable for outdoor application.
  - The panel shall be provided with FRP/GI (minimum 2mm thick) canopy with cover on all 3 sides to protect from sun and rain.
  - Refer electrical specifications for other general requirements/specifications and make of switchgear.

a. **SPECIFICAITONS FOR BELT CONVEYOR (FOR COARSE SCREENS)**

A common belt conveyor shall be provided for collecting screening from coarse / fine bar screen will drop the screening in a trolley type container kept at one end of the conveyor for taking out the screening for disposal. The belt conveyor shall be 600 mm wide and suitable length to cover all the screen channels.

Each assembly of conveyor will consist of two pulleys with their shafts and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys will have three roll 20º roughing idlers. The bottom level idlers for belt return will be flat roll type.

At the end of belt drive an adjustable scrapper shall be provided for diverting the screening from conveyor to the container. The whole conveyor will be supported on steel structure over the screen channel.

The belt material will be 2/3 ply nylon with 3 mm neoprene covering on carrying side and 0.75 mm NBR / neoprene covering on pulley side. The speed of the belt will be about 20 m/min.

The power supply shall be by TEFC motor couple to the worm reduction gear box. Motor shall be provided with canopy / cover.

The gear box shall have a minimum service factor of two.

The belt conveyors shall be provided with dog box type canopy made of 2 mm thick Mild Steel sheet with adequate opening for screening to fall on belt to prevent the dispersal of screening in the plant from over the belt due to wind. The covers shall be openable from top / shall have inspection doors at top with hinged covers and handle for routine inspection / cleaning without dismantling entire cover.

8.0 ELECTRIC CHAIN HOIST AND EOT WITH MONORAIL

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

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

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

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

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

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

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

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

Drive motors shall be suitable for crane duty (S4) application and generally conforming to latest IS: 12615/IEC 60034-1 standards as applicable.
Hoist shall be designed into two separate independent units, i.e. motor and hoist for easy maintenance.

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

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

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

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

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

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

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

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

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

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

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

General

The pump shall be non-clog, vertically-mounted, single stage with semi open/open-impeller type and close coupled to its fully submersible electric motors designed for dewatering.
The total head capacity characteristic of pump shall be continuously rising towards the shutoff with the highest at shut off. It shall be suitable for handling turbid water containing stringy materials. The pump shall be designed to handle solids up to 25mm dia. size.
The pump shall run smooth without undue noise and vibration.
The power rating of the pump motor shall be minimum 150% more than the power required from zero discharge to zero head.

Features of Construction

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

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

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

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

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

Induction Motor (Submersible)

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

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

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

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

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

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

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

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

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

Materials of Construction

Casing/Casing Cover/Wear Plates/Oil Chamber/Motor Housing	CI IS: 210 Gr. FG 260
Impeller	CI IS: 210 Gr. FG 260
Shaft/Shaft Sleeve	AISI 410
Shaft Sealing	Double Mechanical Seal
Lifting Arrangement	SS 304 chain or wire rope with hook/s and having minimum length equivalent to sump depth + 3 m.
Cable length (each run)	Minimum equivalent to sump depth + 10m
Hose pipe	PVC or suitable with required clamps in SS, Minimum equivalent to sump depth + 25m length

GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENT

- **PAINTING**

MS/CI/DI BODY OR PARTS OR STRUCTURE (GENERAL FOR PIPING AND PUMP/ BLOWER/EQUIPMENT IF NOT PROVIDED AS SPECIFIC)

Painting shall be carried out with one coat of red oxide/epoxy primer followed by two coats of epoxy paint after proper surface preparation as recommended by paint manufacturer/shot blasting prior to dispatch, to a total DFT of minimum 150 microns inclusive of priming.

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting as applicable. The max of zinc rich epoxy primer shall be prepared at work site not earlier then 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40-45 micron and DFT 30-35 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employer's representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hours of mixing or as recommended by manufacturer and fresh mixing shall be done for every new application. Every successive coat of paint shall be applied only after 48 hours of previous coat. Before applying the next coat, the surface should be properly cleaned by duster.

CED Coating i.e. Cathode electro deposition coating which is the latest technology for corrosion resistance with uniform coating is also permissible and preferable over conventional painting.

OPEN CHANNEL GATES/SLUICE GATES (THIMBLE MOUNTED GATES)

Following painting procedure shall be adopted for the gates.

Surface Preparation	: Blast clean to near white metal finish using shot blasting.
Priming	: one coat of red oxide primer.
Finish Painting	: Black bituminous paint for gate assembly. Minimum DFT 200 microns inclusive of priming. Yoke and Headstock to be provided with red oxide primer and epoxy grey paint having minimum DFT 150 microns inclusive of priming.

For Stainless steel gates, SS gate assembly shall be shot/grit blasted, pickled and passivated before delivery.

EOT CRANE

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

- **DOCUMENT SUBMISISON**

In general, the minimum document submission for various items shall be as described below to be submitted by vendor for review and approval during detailed engineering / execution & prior to manufacturing and manufacturing shall be carried out as per approved documents only and after complying comments as applicable.

PUMP and PUMP-MOTOR SET (CENTRIFUGAL / POSITIVE DISPLACEMENT / PROGRESSIVE CAVITY (SCREW) / RECIPROCATING (DOSING) etc.)

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

1. Product technical data sheet.
2. Preliminary outline dimensional drawing (GA Drawing) showing the details of pump and motor, suction, discharge connections and foundation details.
3. Performance curves showing capacity v/s total head, efficiency, NPSH required and kW requirements ranging from run out to pump shut off for minimum, maximum and rated impeller diameter of the offered pump.
4. Typical cross sectional drawing showing internal features of pump, parts and their materials.
5. Torque – Speed curve of the pump.
6. Catalogue showing type of construction.
7. Quality Assurance Plan.

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

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

1. Product technical data sheet.
2. General outline dimensional drawings.
3. Cross sectional drawing showing constructional details with part list with their quantity and MOC confirming to relevant standards.
4. Catalogues showing type of construction.
5. QAP of the product.

In addition to above, following documents shall be furnished for review and approval when valves are required with electric actuator for operation.

1. Actuator data sheet.
2. GA and wiring drawing of electric actuator.
3. Valve torque calculations.
4. Product catalogue.

SLUICE/OPEN CHANNEL GATE

The manufacturer shall submit following drawings.

1. Product technical data sheet.
2. General outline dimensional drawings along with part list with their quantity and MOC confirming relevant standards.
3. QAP of the product.

In addition to above, following documents shall be furnished for review and approval when valves are required with electric actuator for operation.

1. Actuator data sheet.
2. GA and wiring drawing of electric actuator.
3. Valve torque calculations.
4. Product catalogue.

EXPANSION BELLOWS

The manufacturer shall submit the following drawings.
1. Product technical data sheet.
2. GA Drawing.
3. QAP of the product.

EOT/HOT CRANE/CPB/HOT-MONORAIL

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

1. Product technical data sheet.
2. Preliminary outline dimensional drawings.
3. Requirement of girders/ISMB including minimum required size with all calculations.
4. Wiring diagram of panel.
5. QAP of the product.

MECHANICAL/MANUAL TYPE COARSE and FINE SCREENS

The manufacturer shall submit the following drawings.

1. Product technical data sheet.
2. GA drawing.
3. Hydraulic calculation for head drop across screen for design/peak flow @ 50% clogging.
4. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
5. Recommended cable schedule (as applicable).
6. QAP of the product.

BELT CONVEYOR

The manufacturer shall submit the following drawings.

1. Data sheet.
2. GA drawing.
3. QAP of the product.

PIPES (METALLIC: CI/DI/MS and NO-METALLIC: HDPE/uPVC/RPVC)

The manufacturer shall submit the following drawings/documents.

1. Bill of materials
2. QAP of the product.

Note: The data sheet and GAD as specified for equipment shall also be considered to include coupled items like electrical drives/motor including its performance curves, electric actuators including its wiring diagram, pneumatic actuators etc. as applicable.

- **INSPECTION and TESTING REQUIREMENTS**

The material shall be cleared for dispatch based on review of documents/test certificates or by carrying out inspection and testing at manufacturers' works as per requirement specified in tender for various equipment and as per approved Quality Assurance Plan. Client reserves the right to waive inspection at manufacturers' works or ask for inspection at manufacturer's works even though not specified in tender but in client's opinion is required and contractor shall hold no objection to the same.

Inspection and testing of mechanical equipment at manufacture works shall be conducted for equipment/components in presence of Engineer-in-charge/Client's representative or PMC/Third Party Inspection Agency appointed by client.

All the charges for PMC/third party inspection shall be included in the scope of contractor. Inspection and testing at manufacturers' works' shall be carried out as specified below/as per applicable governing standards viz. IS/BS/API etc.

The Contractor/OEM / Vendor shall provide all instrument and equipment required for such tests. The instruments shall be calibrated and certified by an approved independent testing authority preferably NABL accredited with valid calibration certificates as on date of inspection.

All the tests shall be carried out as per the relevant standards, codes and approved QAPs.

The inspection category and brief description of tests to be carried out for various equipment is as follows.

CENTRIFUGAL PUMPS

Hydrostatic Test

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.
- Unless otherwise stated in data sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.
- OEM shall provide internal test certificate of hydrostatic test for review and acceptance by PMC and Client.

Mechanical Balancing

- Major rotating components of the pumps like impellers, shaft, shaft sleeve etc., shall be individually statically as well as dynamically balanced preferably at rated speed.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

Performance Testing

Pump shall be tested for its full operating range in accordance with the applicable standards and approved data sheets/QAPs.

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

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

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

Material Test Certificates

Material test certificates for the various pumps components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

Witnessing PERFORMANCE TESTING of PUMPS (HSCF/VT/HNC-VNC SEWAGE/ /SEWEAGE SUBMERSIBLE

Pump Rating	**Pump Performance Test to be witnessed for each duty and type with JOB MOTOR (Also see notes below)**
Up to 30 kW motors	Visual/Performance test witnessing not required. Vendor to submit internal test certificates for review, approval and dispatch clearance as per note given below prior to dispatch.
> 30 kW up to 160 kW motors	25% quantity or minimum 1 No. whichever is higher per duty/type.
> 160 kW	50% quantity or minimum 1 No. whichever is higher per duty/type.
Notes: (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender. Hydrostatic test certificate, dimensional check certificates etc. as per approved QAPs and data sheet, of each pump for review, record and dispatch clearance prior to dispatch of pumps. **(2)** Vendor shall provide certified parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance test witnessing.	

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

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

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

SLUICE

Closed end test of all sluice valves shall be carried out in presence of Engineer-in-charge/client's representative at manufacturers' works and testing certificates shall be furnished along with each lot of supply.

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

KGV

Body and gate of valve shall be subjected to hydrostatic tests conforming to MSS SP 81 1995 for 2 minutes duration minimum.

BUTTERLY

Body and disc of valve shall be subjected to hydrostatic tests as described in IS: 13095 (1991)/BS EN 593 for 2 minutes duration minimum.

NRV/DPCV

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

AIR VALVE

Valve shall be subjected to hydrostatic tests as specified in IS: 14845 (2000) for body test, high pressure orifice seat test and low pressure orifice seat test for minimum 2 minutes duration.

Witnessing PERFORMANCE TESTING of VALVES

Size of Valves	**Performance Test to be witnessed for each size/rating and type (Also see note below)**
Up to 300 mm diameter	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> 300 mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
Note: Manufacturer shall test all the valves internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of valve type for review, record and dispatch clearance prior to dispatch of materials.	

EXPANSION BELLOWS

Each bellow shall be subjected to following tests.

- Hydrostatic tightness test for 1.3 times of design for 15 minutes duration minimum.
- Compression and expansion test as per data sheet for 1 number of each size
- Dye Penetration (DP) test for weld joints.
- Dimension and visual check.

Witnessing PERFORMANCE TESTING of EXPANSION BELLOWS

Size of Expansion Bellows	**Performance Test to be witnessed for each size/rating and type (Also see note below)**
Up to 500 mm diameter	Visual/Performance test witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> 500 mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
Note: Manufacturer shall test all the expansion bellows internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of expansion bellows for review, record and dispatch clearance prior to dispatch of materials.	

SLUICE GATE

Following shop tests at manufacturers place will be conducted.

a)	Movement Test	Movement test shall be conducted in horizontal/vertical assembled condition using stems and headstock. The gate should be operated once from full close to full open and back to full close condition with a maximum force of 135 Newton-meter on the crank or hand wheel.
b)	Shop Leakage Test	Shop leakage test by applying unseating hydraulic pressure will be conducted at manufacturer's shop with gate mounted vertically on a test bench. A hydrostatic pressure equal to maximum seating/ unseating head shall be applied to gate at centerline of gate opening from the back, i.e. unseating face of the gate in closed position, through pump. A suitable scaled calibrated pressure gauge put on the unseating face of the gate shall indicate reading equal to unseating pressure head. Water leakage through the gate under above condition shall be collected in a collection pan and measured. The leakage so measured should not exceed the limit of 2.5, 3.5 and 4.5 LPM per meter sealing perimeter for class I, class II and class III sluice gates as stated in the IS 13349 (1992). No alternate testing arrangement will be permitted in place of above method. Gates can be applied with a coat of primer to prevent rusting due to water exposure during testing.
c)	Hydrostatic Body test	After the leakage test, hydrostatic body test will be conducted at manufacturer's shop. A hydrostatic pressure equal to 1.5 times the maximum operating head should be applied on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.
d)	Torque test at operating Head	Torque test at operating head would be conducted at applicable head at manufacturer's shop for gates up to 2000mm x 2000mm size.
e)	Dimensional Check	

f)	Seat clearance check	Important dimensions shall be checked with reference to approved GA drawing. With the gate in closed condition, 0.1mm thick feeler gauge should not pass through between seat facings.
g)	Material Test Certificate	Material tests certificates for all important components of gates such as thimble, frame, shutter, seat facings, spindle and rubber seals etc. to be furnished at the time of inspection.
h)	PMI Test	Positive Material Identification (PMI) test to be conducted for sealing/seating faces, rubber seal retainer bar (if applicable) and stem/spindle during the inspection.

Witnessing PERFORMANCE TESTING of SLUICE GATE

Size, Class and Type of Sluice Gate	**Performance Test to be witnessing for each size, type and class of Sluice Gate (Also see Note below)**
Up to 1000 mm dia./square (up to 1 m^2 area)	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given Below prior to dispatch.
> 1000 mm dia./square (>1 m^2 area)	10% quantity or minimum 1 number whichever is higher per size/ class and type.
Note: Manufacturer shall test all the sluice gates internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, clearance check test, leakage test, movement test, dimensional check certificates, actuator internal test records for gates etc. as per approved QAP and data sheet of sluice gate for review, record and dispatch clearance prior to dispatch of material.	

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

EOT/HOT Crane/CPB/HOIST/HOT monorail shall be tested for overload tests at 125% of the rated load (150% overload in case of manually operated), speed of lifting and deflection check at manufacturer works as per governing standards. All required test certificates shall be furnished for hook, wire rope, brake etc. and complete crane/hoist/CPB/monorail.

Witnessing PERFORMANCE TESTING of EOT/HOT CRANE/CPB/HOIST/HOT-MONORAIL

Type of Material Handling Equipment	**Witnessing/Review for each type and capacity**
(Electric/Manual) CPB/HOIST/HOT-Monorail/Chain Hoist EOT/HOT Crane up to 3 MT	Visual/Performance witnessing is not required. Manufacturer shall test all the CPB/Hoist, HOT/EOT (up to 3 MT) internally and shall provide their internal test records along with material test certificates for all major parts as per tender, dimensional check certificates etc. as per approved QAP and data sheet of CPB/Hoist, HOT/EOT (up to 3 MT) for review, record and dispatch clearance prior to dispatch of materials.
EOT/HOT Crane > 3 MT Capacity	10% Quantity or Minimum 1 No. whichever is higher per size (capacity) and type shall be witnessed at manufacturers' works for performance test as per approved QAP and data sheet.

MECHANICAL/MANUAL TYPE COARSE and FINE SCREEN

Review/Witnessing of Performance Testing requirements

Type of Screen	**Witnessing/Review for each type and size**
Manual Removable/Fixed Coarse Bar Screen	Visual/Performance witnessing is not required. Manufacturer shall check all manual screens internally and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance, prior to dispatch of materials.
Mechanical Coarse Bar Screen	10% quantity or minimum 1 No. whichever is higher per size of Mechanical screen shall be subjected to: - Witness for dimension check and performance test at manufacturer works, - Review of internal inspection report, PMI test report (for SS grade checking), dye penetration test report (for checking the soundness of welding joints) and material test certificates for all major parts etc. as per approved QAP and related documents and tender specifications.

BELT CONVEYOR

Visual/Performance witnessing is not required.

Manufacturer shall carry out internal inspection for the offered equipment and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance prior to dispatch of materials.

CI/DI/MS PIPES and FITTINGS

CI/DI pipes and fittings shall be offered for inspection and testing as per applicable standards. Pipes and fittings shall be subjected to hydrostatic test, mass/weight check and dimensional check as per approved QAP and bill of materials.

WITNESSING of PERFORMANCE TESTING of CI/DI/MS PIPES and FITTINGS

Size, Class and Type of Pipes and Fittings	**Performance test to be witnessed for each size/class and type of pipe and fittings (Also see notes below)**
up to 300 mm diameter	Performance witnessing is not required.
> 300 mm diameter and up to 900 mm diameter	10 % quantity or minimum 1 number whichever is higher per type size/class/length and type.
> 900 mm diameter	25% quantity to be witnessed.
Notes: **1)** Manufacturer shall test all the pipes & fittings internally and shall provide their internal test records for hydrostatic test along with material test certificates, mass/weight check statement, dimensional check certificates etc. as per BOM and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials. **2)** For pipes **above 300 mm dia. and up to 900 mm** dia. size, if the total quantity required for entire pumping system/project is **less than 250 meters**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC. **3)** For pipes **above 900 mm dia.** size, if the total quantity required for entire pumping	

system/project is **less than 150 meters**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC.
4) For all fittings of all sizes if the total weight of total quantity required for entire pumping system/project is less than **750 kg**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/PMC.
5) For all fittings of all sizes if the total weight of total quantity required for entire pumping system/project **exceeds 750 kg**, performance tests shall be witnessed as per governing standards and approved QAPs and other relevant documents and tender specifications.

- **TESTING, ERECTION, AND COMMISSIONING**

TESTING - GENERAL

Tests of the plant at the manufacturers' premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate standards.
Testing and inspection at manufacturers' works of all major items viz. **pumps, motors, valves, sluice gate, grit mechanism, EOT crane** shall be conducted at manufacturers' works' in presence of third party inspection agency appointed by Client/Engineer-in-charge or representatives of Client.
All the charges for third party inspection shall be included under the scope of contractor. All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 6 months prior the test in which they are used. The Engineer's representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the contractor prior to carrying out every test showing the readings obtained, calculations and full details of the calibration certificates referred to.

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

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

INSPECTION AT MANUFACTURERS' PREMISES

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

For meeting these requirements of inspection, testing (including testing for chemical analysis and physical properties) shall be carried out by the contractor and certificates submitted to the Engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Calibration certificates or test instruments shall be produced for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the

commencement of the test. Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and the Contractor.

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

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

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

One pump of each rating shall be tested with job/shop motor at rated speed in the presence of Client's representative. In case shop motor is used if allowed by the Client/Engineer, shop motor efficiency and rating shall be submitted to client for approval prior to inspection call.

TESTS AT MANUFACTURERS' PREMISES

SEWAGE/WATER PUMP SET

Pump testing and inspection shall confirm to the latest standards.

(a) **Hydrostatic Test**

A standard hydrostatic test shall be conducted on all the pressure parts of the pumps at 1.5 times the shut-off head of the pump or twice the rated head whichever is higher. The hydrostatic test shall be conducted for a minimum duration of 30 minutes.

(b) Balancing Test

Impeller and pump rotating assembly shall be dynamically balanced.

(c) Performance Test

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

MOTORS

Motors shall be offered for routine and type tests in accordance with IS: 996 (1979) and IS: 325 (1978) at the manufacturers' works. Test certificates shall be endorsed to the effect that the motors are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

PIPE WORK

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

VALVES

(a) All valves shall be hydrostatically tested close ended. Body, seat/door and back seat-test pressures shall be as per relevant standards applicable to PN ratings as per tender specifications/BOQ.

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

HOISTS/CPB

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

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

GATES

Seat Clearance Check

With the gate fully closed, the clearance between seating faces when checked with thickness gauge, shall not exceed 0.1mm.

Movement Test

Each gate shall be shop operated three times from the fully open position to the fully closed position and return to fully open, under no flow conditions to demonstrate that the assembly is workable.

Leakage Tests

With the gate in the closed position design pressure shall be applied for a period not lesser than 10 minutes to the unseating side of the sluice gate and the leakage shall not exceed the maximum leakage permissible as per AWWA C-501, for the head applied on the unseating side.

Hydrostatic Tests

Finally a differential of one and half times the design pressure shall be applied to the unseating side of the gate. Under these tests no part shall show any deflection of deformation.

ERECTION – GENERAL

The Contractor's staff shall include at least one competent erection engineer with proven suitable, previous experience on similar contract to supervise the erection of the works and sufficient skilled, semi-skilled and un-skilled labour to ensure completion of the works in time. The contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the Engineer's representative.

One erection engineer who shall be deemed to be the Contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more that one erector, one shall be in charge and the contractor shall inform the engineer's representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manger.

The Contractor's erection staff shall arrive on the site on date to be agreed by the Engineer's representative before they proceed to the site, however, the contractor shall

first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on site so that there will be no delay on this account.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labour in connection therewith. The checking of setting out of any line or level by the Engineer or Engineer's representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

Erection of plant shall be phased in such a manner so as to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the contractor shall check the dimensions of structures where the various items of plant are to be installed and shall bring any deviations from the required positions, lines or dimensions to the notice of the engineer. Plant shall be erected in a net and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing plant or buildings or any part thereof, the Contractor shall, at no additional cost to the employer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer's satisfaction.

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

RECORD, PROCEDURES AND REPORTS

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

All the above mentioned records shall be submitted in the final form duly countersigned by the Engineer's representative attesting conformity to specifications and is approval of installation and duly incorporating all the additions, alternations and information as required by the Engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding any records submitted earlier with bill of supply/progress etc. shall be duly bound and submitted to the engineer in six copies by the contractor on his notification of the mechanical completion of erection.

COMPLETION OF ERECTION

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

(a) Plant in the scope of the Contractor has been erected, installed and grouted as per specifications.
(b) Installation checks are completed and approved by the Engineer.

The erected plant are totally ready for commissioning checks.

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

Upon achieving the completion as described above, the Contractor shall notify the Engineer by a written notice intimating such mechanical completion of units and notify the Engineer for inspection and acceptance of mechanical completion. The Engineer/Engineer's representative shall proceed with the inspection of such units within 14 days of such a notice.
Thereafter,

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

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

(c) The Engineer may inform the Contractor that the works are accepted with the 'punch' list (Items which do not hamper operability, safety or maintainability) and allow the Contractor to proceed with the pre-commissioning checks followed by Test on Completion when the Contractor undertakes to complete such outstanding works within an agreed time frame during first three months from the day plant becomes operational.

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

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

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

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

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

SETTING TO WORK

On completion of erection the contractor shall request the Engineer's representative to carry out the installation inspection.

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

INSTALLATION INSPECTION

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

PUMPS, PIPING AND VALVES

(a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapings etc. for carrying out these tests shall be include in the contract.
(b) Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.
(c) Operating tests shall be conducted on valves.
(d) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specified limits.

PUMP MOTORS

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

HOISTS

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

SLUICE GATE

Leakage test shall be performed by the Contractor after installation of the sluice gates.

(a) Under the design seating head and unseating head the leakage shall not exceed the limit specified in AWWA C501/IS: 13349, class 1 for shop testing.

INSTRUMENTATION

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

COMMISSIONING

SCOPE

At the time of commissioning, the Engineer will appoint his representative as Commissioning Engineer. The Contractor shall carry out commissioning tests in the presence of the Commissioning Engineer. Though the mechanical completion may have been checked and clarified by the site Engineers, the Commissioning Engineer may verify any mechanical completion checks to satisfy himself that the plant is fit and sound, if such checks had not been witnessed by him. It will be the responsibility of the Contractor to make all arrangements for carrying out these tests. The evaluation of test results and decision passed by the Commissioning Engineer regarding the test results

will be final and binding on the contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the contractor at no extra cost.

MISCELLANEOUS

Completion checks and commissioning tests on items not covered under above, shall be carried out by the Contractor as per the instructions of the Engineer/Engineer's representative.

TAKING OVER

No item of plant will be certified for taking over by the Client/Employer/Purchaser unless it has successfully passed all the tests called for under the contract. If nevertheless the Client/Employer uses any part of the works, that part which is used shall be deemed to have been taken over at the date of such use.

Taking-Over Certificate for plant shall not be issued unless the following documentation are duly compiled and submitted in final formats in duly bound volumes.

(a) A compilation of all shop inspection results/reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (5 copies).

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

TECHNICAL DATA SHEETS FOR MECHANICAL EQUIPMENT

(TO BE SUBMITTED DURING EXECUTION STAGE)

GENERAL NOTES / GUIDELINES FOR BIDDERS / VENDORS

1. The technical vendor data sheets for various electro-mechanical items shall be submitted by contractor during execution/respective equipment approval stage as per provided format as a minimum (and with additional details as required separately) for review and approval.

2. The design ambient temperature shall be considered as 5^0 C Minimum and 50^0 C Maximum.

3. The specific gravity of various service fluids shall be considered as under.

Service Fluid	**Specific Gravity, g/cc**
Clear / Potable Water, Tertiary Treated Sewage	1.00
Raw Water (river, Canal, etc.), Sec. Treated Sewage	1.01
Sewage	1.02
Sec. / Return Activated Sludge	1.03
Primary / Thickened / Digester Sludge	1.05
Any other	As per fluid properties and concentration

4. For painting, document submission and inspection and testing requirements Bidder / Vendor to refer the "GENERAL REQUIREMENT FOR MECHANICAL ITEMS / EQUIPMENT" section provided with specifications or other as specified elsewhere in tender.

5. The selection of motor operating characteristics and its mounting to suit the equipment shall be responsibility of the Contractor / Vendor.

6. The data sheet shall be submitted separately for each type / capacity of pump for each size; type of valves and gates and its type of operation for each equipment etc. as applicable.

DATA SHEET OF NON-CLOG SEWAGE SUBMERSIBLE PUMP-MOTOR SET

Sr. No.	Particulars	Data To Fill By Contractor/ Vendor
1.0	**Liquid Data**	
1.1	Liquid Handled	Sewage
1.2	Specific Gravity	1.02
1.3	Temperature ^{0}C (Ambient)	
2.0	**Pump Data**	
2.1	Make	
2.2	Pump Type	Sewage Submersible CF pump with Dry Type Motor
2.3	Pump Model	
2.4	Quantity (Nos.)	
2.5	Type of Duty	Continuous
2.6	Design Capacity (m^3/hr.)	
2.7	Head (m)	
2.8	Shut Off Head (m)	
2.9	Rated Speed of Pump (RPM)	
2.10	Pump Efficiency at Duty Point (%)	
2.11	Pump Input (Max. BKW) for Rated Impeller (kW)	
2.12	Recommended Drive Motor Rating (kW)	
2.13	Efficiency of Pump Set (%) @ Duty Point (Without Coating & Without Negative Tolerance)	
2.14	Full Load Motor Efficiency (%)	
2.15	Guaranteed Overall Efficiency of Pump-Motor Set @ Duty Point	
2.16	Full Load Speed of Motor (RPM)	
2.17	Minimum Submergence Required (m) (Measured from bottom to impeller for cavitation free operation of pumps (m) **1.** for Solo Operation and **2.** for Parallel Operation	
2.18	Maximum Permissible Size of Solids (mm)	
2.19	Guide Pipe, Size and Thickness/Schedule	
2.20	Length of Each Guide Pipe (m)	
2.21	Lifting Chain: Construction Details	
2.22	Lifting Chain: Length (m)	
2.23	Weight of Pump Motor Set (kg)	
2.24	GD^2 value of Pump-Motor Set	
3.0	**Constructional Features**	
3.1	Number of Stage	Single
3.2	Casing Type	Volute Type
3.3	Impeller Type (Enclosed/Semi Open)	Non-Clog Single Suction
3.4	Impeller Diameter (mm) Max./Rated/ Minimum	
3.5	Shaft/Drive Transmission	Direct Uni-Built (On Common Shaft)
3.6	Shaft Seal	Double Mechanical Seal
3.7	Mechanical Seals: Make, Type and Size Faces: Pump Side Motor Side	

3.8	Mounting Orientation	Vertical
3.9	Nozzle Orientation and Size (mm) Suction (Bottom/As per Application) Discharge (Side/As per Application)	
3.10	Flange Drilling	As per IS: 1538, FF with off center bolt holes/IS: 6392/BS EN 1092 FF
3.11	Direction of Rotation	CW when viewed from Top
3.12	Type of Starter (DOL/Star-Delta/Soft/VFD)	
4.0	**Motor Data**	
4.1	Motor Rating (kW)	
4.2	Voltage/Phase/Frequency and % Variation	
4.3	Combined Voltage and Frequency Variation	
4.4	Design Ambient Temperature/Temperature Rise ^{0}C	
4.5	Insulation Class	
4.6	Duty	
4.7	Full Load Speed (RPM)	
4.8	Full Load Torque (FLT) (kgm)	
4.9	Starting Torque as Percentage of FLT (%)	
4.10	Full Load Current (FLC) (Amps.)	
4.11	Locked Rotor Current (Amps.)	
4.12	Starting Current as % of FLC	
4.13	Break Down Torque (POT) as % of FLT	
4.14	Starting Time at 80% V/100% V (Seconds) with Load Coupled	
4.15	No Load Starting Time	
4.16	Locked Rotor Withstand Time Hot/Cold (Seconds)	
4.17	Overload Capacity (%)	
4.18	Number of Permissible Cold/Hot Starts	
4.19	Starting Power Factor	
4.20	Motor Power Factor @ 50%, 75% and 100% Load	
4.21	Motor Efficiency @ 50%, 75% & 100% Load (%)	
4.22	Protection Class	
4.23	Provision of Thermistors	Yes
4.24	Winding and Moisture Protection Details	
4.25	Bearing Type/Number DE: NDE:	
4.26	Winding Insulation Class	
4.27	Motor Seal Cooling Details	
4.28	Winding Temperature Detector	
4.29	Seal Leakage (Moisture) Detector	
4.30	Cable Type	Dual PVC Sheathed, Round, Copper Conductor
4.31	Details of Power Cable: Run, Core & Size	

4.32	Details of Control Cable: Run, Core & Size	
4.33	Length of Pair of Cables offered with Pump Set (Power and Control) (m)	
5.0	**Materials Of Construction**	
5.1	Pump Casing (M)	
5.2	Casing Wear Ring (if provided)	
5.3	Suction Cover/Oil Chamber/Motor Casing	
5.4	Shaft (M)	
5.5	Shaft Sleeve (if required) (M)	
5.6	Impeller (M)	
5.7	Impeller Wear Rings (M)	
5.8	Impeller Nut (M)	
5.9	Mechanical Seal Faces: Pump Side Motor Side	
5.10	Stator Housing	
5.11	Stator	
5.12	Rotor	
5.13	Auto Coupling Unit (Pump Connector Unit)	
5.14	Guide Pipe	
5.15	Lifting Chain	
5.16	T Bracket	
5.17	Hardware – Bolts, Nuts, Anchor Fasteners etc.	
6.0	**Accessories Required**	
6.1	Auto Coupling Unit	Yes
6.2	Dual Guide Pipe with Support (SS)	Yes
6.3	Lifting Chain (SS)	Yes
6.4	Set of Foundation Bolts and Nuts	Yes
6.5	SS Suction Strainer with Details of Size and Area of Opening	Yes
6.6	PMU/Pump Monitoring-Safety Unit	Yes
6.7	Non-Standard/Special Tools	Yes
7.0	**Drawings and Documents Submission**	As per Specifications
7.1	Performance Curves (Capacity i.e. Flow Vs Head, Capacity Vs Efficiency and Capacity Vs Power)	
7.2	GA Drawing of Pump	
7.3	Cross Sectional Drawing of Pump	
7.4	Catalogue of Products	
7.5	QAP	
8.0	**Painting**	Refer General Requirement for Mechanical Items/Equipment Section /Tender Specifications
9.0	**Testing**	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each duty.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

3. Test certificates for hydrostatic test, static and dynamic balancing of impeller and rotating assembly are required for review and acceptance.
4. Bidder shall refer electrical specifications for motor requirement and shall offer accordingly.
5. Bidder shall have to submit completely filled data sheet in above format certified by approved pump manufacturer along with certified pump characteristic curves and offer pump model with guaranteed minimum acceptable pump and overall (pump and motor combined) acceptable efficiency.

DATA SHEET FOR SLUICE VALVE (ELECTRIC ACTUATOR OPERATED)

Particulars	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing and Testing Standards	
Size (mm)	
Quantity	
Pressure Rating	
Type (Rising)/Non-rising	
Type of Operation: Motorized Electric Actuator	
Ends - Flanged	Flanged, FF as per IS: 1538 having off center bolt holes
Body/Bonnet	Bolted
Disc	
Maximum Valve Torque (Nm) with Factor of safety (FOS)	
Stem Diameter (mm)	
Number of Turns	
Seat Body and Disc	Renewable
Direction of Closing	CW Marked on Hand Wheel
Materials Of Construction	
Body/Bonnet (M)	
Wedge (M)	
Stem/Spindle (M)	
Seat Rings (M)	
Back Seat Bush (M)	
Channel and Shoe Lining	
Stem Packing	
Bonnet Gasket	
Bolts, Studs and Nuts	
Hand Wheel	Required
Details of Electrical Actuator	
Actuator Make and Model	
Actuator Torque Capacity (Minimum and Maximum)	
Actuator Speed (RPM)	
Power Supply	
Valve Opening/Closing Time (seconds)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.

Drawings and Document Submission	As per Specifications
GA and Cross Sectional Drawings of Valve	
QAP	
Actuator Details including Wiring Diagram	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.
3. Bidder shall refer relevant specifications for electric actuator requirement and shall offer appropriate model accordingly.

DATA SHEET FOR SWING CHECK TYPE REFLUX (NON RETURN) VALVES

Particular	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing and Testing Standards	IS: 5312
Size (mm)	
Quantity	
Pressure Rating	
Ends	Flanged, FF as per IS: 1538 part IV and VI having off center bolt holes/IS: 6392 Raised face
Materials Of Construction	
Body and Cover (M)	
Door and Hinge (M)	
Body and Disc/Clamping Rings (M)	
Disc Seal	
Hinge Pin (M)	
Bearing Bushes	
Gasket	
Bolts, Studs and Nuts	
Accessories Required	
By Pass	Required for size **≥ 300** mm
Drain Plug	Required for size **≥ 300** mm
Support Foot	Required for size **≥ 450** mm
By Pass Gate Valve (If Applicable)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA and Cross Sectional Drawings of Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

DATA SHEET FOR DUAL PLATE CHECK VALVE

Particulars	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing Standards	API 594
Testing Standards	API 598
Size (mm)	
Quantity	
Pressure Rating	
Ends	Flanged, FF as per IS: 1538 having off center bolt holes
Materials Of Construction	
Body (M)	
Door (Disc/Closure Plate) (M)	
Door Face (Body/ Plate Seat) (M)	
Bearing Bush	
Hinge Pin and Stop pin (M)	
Springs (M)	
Body Seat Ring	
Bolts, Studs and Nuts	
Accessories Required	
Lifting Eye Bolts	Required for size **≥ 150** mm
Support Foot	Required for size **≥ 600** mm
By Pass Arrangement	Required for size **≥ 600** mm
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

DATA SHEET FOR KNIFE GATE VALVE

Particulars	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing and Testing Standards	MSS SP 81
Type: Rising/Non-Rising	
Size (mm)	
Quantity	
Pressure Rating	
Ends	Wafer Lug Type **≤** 150 mm and Flanged **>** 150 mm FF as per IS: 1538, Table IV and VI
Body (Bonneted/Bonnet Less)	
Gate	Beveled Knife Edge
Seat (Specify Resilient (Soft)/Metal)	Renewable

Particulars	**Data To Fill By Contractor/Vendor**
Type of Operation (Manual/Electric Actuator)	
Maximum Valve Torque (Nm)	
Type of Gear Box (If Applicable)	
Details of Gear Box (If Applicable)	
Direction of Closing	CW Marked on Hand Wheel
Materials Of Construction	
Body, Bonnet, Housing (M)	
Gate (M)	
Stem/Spindle (M)	
Stem Nut	
Stem Yoke	
Gland Follower	
Adapter Plate and Supporting Bracket/Pillars	
Seat (M)	
Seat Retainer Ring (M)	
Gland/Stuffing Plate and Housing (M)	
Gland Packing/Stuffing Seal	
Position Indicator and Indicator Plate	
Bolts, Studs and Nuts	
Accessories Required	
Hand Wheel	Required
Support Foot	Required for size **≥ 600** mm
By Pass Arrangement	Required for size **≥ 600** mm
Details of Electrical Actuator	
Actuator Make and Model	
Actuator Torque Capacity (Min. and Max.)	
Actuator Speed (RPM)	
Power Supply	
Valve Opening/Closing Time (seconds)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Valve	
QAP	
Actuator Details including Wiring Diagram	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.

2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

3. Bidder shall refer relevant specifications for electric actuator requirement and shall offer appropriate model accordingly.

DATA SHEET FOR KINETIC AIR RELEASE VALVE (With Isolating Sluice Valve)

Particulars	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing and Testing Standards	AWWA C 512
Type	Double Acting, Triple Function, Tamper Proof, Bi-Stream
Size (mm)	
Quantity	
Pressure Rating	
End Connection	Flanged, FF as per IS: 1538 having off center bolts
Materials Of Construction (For ARV As Applicable)	
Air Valve Body and Cover (M)	
Air Valve Float and Cage for Float (M)	
Valve Hood and Guide for Hood (M)	
Float (Low Pressure Orifice)	
Float (High Pressure Orifice)	
ARV Seat	
ARV Seal (Soft)	
Body Cover Gasket	
Linkages for ARV	
Float Stem	
Float Stem Guide Bush	
Float Cushion Seat	
Bolts, Studs and Nuts	
Isolation Sluice Valve	**1)** As per Standards/Specifications/Data Sheet given above of Required Size and MOC with Hand Wheel. **2)** All required details to be given in combined data sheet and assembly drawing.
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Assembly Drawings of Air Release Valve and Isolating Sluice Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

DATA SHEET OF METALLIC EXPANSION BELLOWS

Particulars	**Data To Fill By Contractor/Vendor**
Make	
Manufacturing Standards (EJMA/ASME)	
Type	Corrugated Design Single Metallic
Size Range and Quantity	
Overall Length (mm)	
Pressure Rating	
Axial Expansion (mm)	Minimum 20 mm
Axial Compression (mm)	Minimum 10 mm
Fatigue Life Expectancy	Minimum 3000 Cycles
Overall Length of EB	
Mode of Installation (Horizontal)	
Ends Flanged, FF as per IS: 1538 having off center bolt holes	
Number of Convolutions	
Thickness of Weld End	
Thickness of Internal Sleeve	
Quantity and Position of Rods Minimum 2 Nos. up to 200 NB Minimum 3 Nos. from 250 to 450 NB Minimum 4 Nos. from 500 to 900 NB Minimum 6 Nos. above 1000 NB	
Materials of Construction	
Bellows (M)	
Internal Sleeves (M)	
Flanges (M)	
Lugs	
Rods	
Hardware	
Painting	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Bellows	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.

DATA SHEET FOR EOT CRANE

Particulars	**Data To Fill By Contractor/Vendor**
General	
Make	
Model	
Capacity in Metric Ton (MT)	
Location	Indoor
Quantity	
Crane	
Design and Construction Standards	
Class and Duty	
Type: Single/Double Girder	
Method of Operation	By Pendent Push Buttons @ Floor Level
Lift (meters)	As per Actual Requirement
Span (meters)	As per Actual Requirement
Bay Length (meters)	As per Actual Requirement
No. of Falls	
Operating Travel Speed (meter/minute) • Hoist • Cross • Longitudinal	
Creep Speed (meter/minute)	
Main Girder Details	
Type of Suspension	
Track (For Long and Cross Travel)	Straight
Long Track Rail Size	Minimum 40 mm Square Bar
Type of Gear Box For LT	
Brakes • Hoisting • CT • LT	
Brake Type	
Brake Size (mm)	
DSL	
Materials of Construction	
Main Girder	
End Carriage (M)	
Bridge (M)	
End Stopper (Required on Either Side of Bridge)	
Wheel Base	
Gears and Pinions (M)	
Wire Rope (M)	
Hook (M)	
Rope Drum and Sheaves (M)	
Rope Guide (m)	
Wheels (M)	
Shafts (M)	
Bearings	
Maintenance Platform/Access Walkway	

Electrical Details	
Power Supply	
Motor Standard	
Control Voltage	
Class of Insulation/Degree of Protection	
Ambient Temperature	50 ^{0}C
Type of Motor (Hoist Duty)	
Make	
Motor Ratings (kW) For • Hoisting (Vertical) • Cross Travel • Long Travel	
Method of Starting	
VFD for Hoist Motor • Make • Model • Type	
Total Connected Load (kw)	
Accessories Required	
Mechanical Stopper (For LT and CT)	
Pendant with Hanging Chain/Rope	
Limit Switches for • Over Hoisting • Over Lowering • Over Cross Travel • Over Long Travel	
Trailing Cable System	
Control Panel	
Isolation Switch for Electric Power	
Weight	
Weight of Hoist (kg)	
Weight of Bridge (kg)	
Painting	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings showing complete details of span, height, bay length, overhead and end clearance, hook approach, wheel base, overall width, power and control circuit diagram, control panel details, terminal diagram, push button station etc.	
BOM	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/supplier shall submit separate data sheet for each size.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.
3. Contractor shall visit the site(s) and obtain accurate data for **span, lift, bay length** etc. suitable for proposed/existing pump house or location of installation as applicable and shall furnish all details accurately in data sheet.

DATA SHEET FOR ELECTRIC CHAIN HOIST and ELECTRIC TROLLEY

Particulars	**Data To Fill By Contractor/Vendor**
General	
Make	
Model	
Capacity in Metric Ton (MT)	
Location	Indoor
Quantity	
Chain Hoist	
Design and Construction Standards	
Class and Duty	
Mono Rail Girder	
Type	Electrically Operated
Maximum Lift (meters)	As per Actual Requirement
Number of Falls	
Operating Speed (meter/minute)	
Type of Gear Box	
Type of Hook	
Brakes For Hoisting	
Brake Type	
Brake Size (mm)	
Load Chain Size	
DSL	
Electric Travelling Trolley	
Design and Construction Standards	
Class and Duty	
Operating Speed (meter/minute)	
Type of Gear Box	
Bay Length	As per Actual Requirement
Lubrication	
Materials of Construction	
Main Girder (Mono Rail Beam)	
Gears and Pinions (M)	
Wire Rope (M)	
Hook (M)	
Load Chain (M)	
Trolley Wheels (M)	
Trolley Shaft (M)	
Bearings	
Plates	
Electrical Details	
Power Supply	
Motor Standard	
Control Voltage	
Class of Insulation/Degree of Protection	
Ambient Temperature	50 ^{0}C
Type of Motor (Hoist Duty)	
Make	
Motor Ratings (kW) For	

• Chain Hoist • Trolley	
Method of Starting	
Accessories Required	
P. B. Station	
Festoon Cable System	
Control Panel	
Weight	
Weight of Hoist (kg)	
Weight of Trolley (kg)	
Painting	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings showing complete details of span, lift, power and control diagram etc.	
BOM	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/supplier shall submit separate data sheet for each size.
2. For components (marked-M) MTC **(of Laboratory accredited with NABL)** as per relevant standards shall be furnished.
3. Contractor shall visit the site(s) and obtain accurate data for **span, lift** etc. suitable for proposed/existing pump house or location of installation as applicable and shall furnish all details accurately in data sheet.

APPROVED VENDOR LIST FOR MECHANICAL ITEMS and EQUIPMENTS (as applicable)

ITEM / EQUIPMENT	APPROVED MANUFACTURERS and MAKES
SUBMERSIBLE CENTRIFUGAL NON-CLOG SEWAGE PUMPS	AQUA / KIRLOSKAR / KISHOR / KSB / ABS / ITT-FLYGHT / GRUNDFOSS / XYLEM / WILO (MATHER & PLATT) / JASCO
DRAIN / DEWATERING / DESILTING PUMPS (SUBMERSIBLE / HORIZONTAL)	AQUA / KIRLOSKAR / KISHOR / KSB / ABS / ITT-FLYGHT / MBH / WILO (M & P) / SU / PULLEN / GRUNDFOSS / JASCO
SLUICE VALVES	IVI / IVC / KIRLOSKAR / UPADHYAY / KEYSTONE / R & D MULTIPLE / FOURESS / DALUI / DURGA / KEJARIWAL / HAWA / VAG /AVK / G M ENGINEERING
BUTTERFLY VALVES	IVI / IVC / KIRLOSKAR / UPADHYAY / KEYSTONE / R & D MULTIPLE / FOURESS / DALUI / DURGA / KEJARIWAL / HAWA / VAG / AVK / G M ENGINEERING
DUAL PLATE CHECK VALVE / NRV	IVI / IVC / KIRLOSKAR / UPADHYAY / KEYSTONE / R & D MULTIPLE / FOURESS / DALUI / DURGA / KEJARIWAL / HAWA / VAG / AVK / G M ENGINEERING
KINETIC AIR VALVE	IVI / IVC / KIRLOSKAR / UPADHYAY/ KEYSTONE / R & D MULTIPLE / FOURESS / DALUI / DURGA / KEJARIWAL / HAWA / VAG / AVK / G M ENGINEERING
ELECTRICAL ACTUATOR	ROTORK / AUMA / EMERSON
EXPANSION BELLOWS	DHRUV / PRECISION / TECHNOFLEX / PRECISE ENGG. / FLEXICAN BELLOWS & HOSES / FLEXPERT BELLOWS / SUR INDUSTRIES (SURFLEX) / ATHULYA BELLOWS
EOT CRANE and ELECTRICAL HOIST	WH BRADY / SAFEX / INDEF/ MORRIES / JAPS / ANKER / MEEKA / HITECH / KHODIYAR ENGINEERING
SLUICE GATES / OPEN CHANNEL GATES	JASH ENGINEERING / IVC / IVI
BEARINGS	SKF / SCHAEFFLER FAG / NTN / NSK-ABC / FUJITSU-NACHI / TIMKEN / KOYO / IKO / NRB / NBC
MECHANICAL SEALS	EAGLE BERGMANN / FLOWSERVE / AESSEAL / CHESTERTON / FLEXASEAL/ JOHN CRANE
D I PIPES and FITTINGS	ELECTRO STEEL / KEJRIWAL / LANCO (KALAHASTHI) / KISWOK / JINDAL / ELECTROTHERM / TRUEFORM
M S / G I PIPES	ARCELOR MITTAL (ESSAR) / TATA / JINDAL / SAIL / ZENITH / ASIAN / ANY REPUTED MANUFACTURER Using APPROVED MAKES OF MS / GI PLATES and SHEETS
M S / G I PLATES and SHEETS	ARCELOR MITTAL (ESSAR) / TATA / JINDAL / SAIL / ASIAN
uPVC / cPVC PIPE	ASTRAL / ASHIRWAD / DUTRON / SUPREME / PRINCE

MECHANICAL COARSE BAR SCREEN	JASH / HUBER (ATE) / BILFINGER (JOHNSON) / EKOTON / SAVI, ITALY
BELT CONVEYOR	JASH / JAPS / APOLLO SCREENS / HUBER (ATE) / BILFINGER (JOHNSON) / EKOTON / SAVI, ITALY
MANUAL SCREEN	JAPS / JASH / TRIMURTHI
OFFICE FURNITURE	BLIND MEN'S ASSOCIATION / GODREJ

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

SPECIFICATIONS FOR ELECTRICAL WORKS

A GENERAL REQUIREMENTS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian and International Standards except where modified and/or supplemented by this specification. Only in absence of Indian standards, International standards shall be followed.

The equipment shall meet the requirements of Indian Electricity Rules, CEA Notification, CPWD guidelines as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

Completeness of Supply

It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship. The following shall be considered in the scope of work as a minimum.

Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment shall be furnished without any extra charge.

SITC of Electrical Equipment with all necessary erection accessories and materials, all steel members (angle, channel, plate, steel sheet etc.) for installation of electrical equipment, GI pipes, GI/PVC conduits, bends, clamps, nut, bolts, hot dipped GI/FRP ladder type cable trays, tray installation materials and accessories, cable supporting structures, flexible metallic hoses, sealing materials for openings/conduits, single/double compression cable glands, cable lugs, cable tags, cable fasteners, insulating tapes, ferrules, RCC slabs/checker plates, GI/RCC pipes for protection of cables at road crossings and other places, cable markers, cable jointing and termination kits and materials, earthing strips of different sizes, junction boxes, pull boxes, epoxy paints and all consumable materials for complete laying and termination of cables, earthing system and erection of electrical equipment etc.

Obtaining license/certificates/clearances etc. from appropriate Govt. statutory authority/body for installation and energizing the complete electrical system and necessary liasoning work for the same (Necessary statutory fees only shall be paid by client).

The quantity/number of items, weight and length of cables/earthing strips etc. mentioned in tender documents are tentatively taken, however the payment will be given as per items installed, works done and actual length of cable/earthing strips etc. actually used and installed.

Submission of all engineering documents, drawings, data sheets, earthing system, layout etc. for review and approval. All manuals, catalogues, characteristic curves etc. for various electrical equipment/components shall be submitted.

Contractor shall verify the quantity of cable or such material required as per site condition against quantity specified in BOQ/SOQ and for procurement and place order as per actual site requirement.

All Drawings/Datasheets/Technical Catalogues/Documents for various electrical works/items shall be submitted by bidder as under.

Number of copies for Submission for various Drawings/Documents shall be as under.

a) In four sets (minimum) by successful bidder in hard copy for review and approval including revisions, if any. The approved drawings for execution purpose shall be retained in Two Sets by Client, One Set by Client's Consultant and One Set shall be returned to Contractor. The contrctor must ensure that copy of approved drawings are kept readily available at site.
b) In four sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings.
c) In three sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of Operation and Maintenance (O and M) manual including manufacturers' O and M and preventive maintenance schedule, recommended spares list etc.

All above final documents and drawings incorporating modifications, if any, done during erection/ commissioning shall be furnished.

SITE/AMBIENT CONDITIONS

All electrical equipment and installation shall be for the tropical climatic conditions and be suitable continuous operation under the site conditions as described below.

Maximum Ambient Temperature	:	47 ^{0}C
Minimum Ambient Temperature	:	5 ^{0}C
Design Ambient temperature	:	50 ^{0}C (Unless otherwise specified for Specific Components/equipment in the Tender)
Relative Humidity	:	95 %
Climate	:	Tropical, Dusty, Corrosive

If not specifically mentioned, an altitude not exceeding 1000m above mean sea level shall be taken into consideration for design purpose.

Where the equipment is installed outside and exposed to direct sun, these shall be suitable for operation at higher ambient temperature and rigorous weather conditions under which they are required to operate.

CODES AND STANDARDS

The electrical equipment and complete installation offered shall comply with the relevant Indian Standards/Codes of Practices, this specification, statutory regulations and sound engineering practices.

The complete system shall conform to the latest revisions of the following.

- The Indian Electricity Act & Rules 2003
- The Indian Electricity (Supply) Act, 1948
- Regulations laid down by local statutory authorities and CEA, CPWD, Electrical Inspectorate.
- The requirement of GETCO/Power Utility Company ie Discom viz PGVCL etc.
- Fire advisory Committee Insurance Act / Fire Insurance Regulations
- Indian Petroleum rules and any other regulations laid down by the Chief Controller of Explosives
- The factory act and any other regulations laid down by factory inspectorate.

Wherever Indian Standards do not exist, the relevant IEC, British or German (VDE)/IEEE/NEMA standards shall apply. Any other Standard which is considered equivalent to or superior than applicable Indian Standards may also be acceptable. The bidder however, shall have to substantiate equivalence or superiority.

- Applicable standards govern the materials and workmanship in the manufacture of all equipments/ items of Electrical Equipment.

Codes	**Description**
IS: 731, BS 137, IEC 383	Pin and Disc Insulator
IS: 2544, IS: 5350, BS 3297, IEC 168	Porcelain post insulators for systems with nominal voltage greater than 1000V
IS 5621	Hollow insulators for use in electrical equipment
IS: 398 (Part-I & II) 1996	ACSR conductor
IS: 9920, Part 1 to 4 (2002)	Specification for High Voltage Switches for rated voltage above 1 kV and less than 52 kV (First Revision)
IS: 9921	Alternating current dis-connectors (isolators) and earthing switches for voltages above 1000 V
IS: 9385 (1983)	Governing spec. for GOAB switch
IS: 3070	Lighting arresters for alternating current systems
IS: 15086	Surge arresters
IS: 8828	Electrical Accessories -Circuit Breakers for Over Current Protection for Household and Similar Installations
IEC 60529	Enclosure degree of protection IP-5X
IS: 3231	Electrical relays for power system protection
IS: 4047, IEC-408	Air Break Switches
IS: 2208, IEC 259-1	Fuses
IS: 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2419	Dimensions for panel mounted indicating and recording electrical instruments
IS: 2705	Current transformers
IS: 3156	Voltage transformers
IS: 2026, IEC 60076	Power transformers
IS: 11171	Specification for Dry Type Power Transformers
IS: 335	New insulating oils
IS: 1180 Part-1 (2014)	Outdoor Type Oil Immersed Distribution Transformers up to and including 2500 kVA, 33 kV Specification
IS: 8468	On-load tap changers
IS: 2099	Bushings for alternating voltages above 1000 Volts
IS: 6600	Guide for loading of oil immersed transformers
IS: 4237	Switchgear General Requirements

IEC 60947	Low voltage switchgear and control gear
IS: 375	Panel Wiring
IS: 3427	AC Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV
IS: 2516	Moulded Case Circuit Breakers
IS: 3842	Application guide for electrical relays for ac systems
IS: 13925	Shunt capacitors for ac power systems having a rated voltage above 1000 V
IEC 60831(1 and 2)	Shunt capacitor of the self- healing type for AC systems having rated voltage up-to and including 1000V
IEC 61921	Power capacitors -Low-voltage power factor correction banks
IS: 16636	Automatic Power Factor Correction (APFC Panels for voltage Rating up-to and including 1000V
IS: 2959, IEC 158-1	Contactors
IS: 1822, IEC 292	Starters
EN 50081-1, 50082-2 and 60204-1	Microprocessor Soft Starter
IEC 61800 and/or IEEE 519 1992	Harmonics Control & Reactive Compensation Of Static Power Converters
IEC 721-3-3, Class 3C1	Maximum Corrosion Level of the Cooling Air
IEC 721-3-3 Class 3C2	Maximum Corrosion Level of the Chemical Gases
UL 508C	Solid state thermal protection of AC Drive
IS: 722	Specification for AC Electricity Meters
IS: 12615 (2018)	Energy efficient induction motors-three phase squirrel cage
IS: 15999 (Part 1)	Rotating electrical machines: Part 1 Rating and performance
IS: 15999 (part 2)	Rotating electrical machines: Part 2 Method of tests, standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 2253	Designation types of construction and mounting arrangement of rotating electrical machines
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 9283	Motors for submersible pump sets
IS: 9334	Electric motor operated actuators
IS: 8130	Conductors for insulated electric cables and flexible cords
IEC 228	Conductors of Insulated Cables
IEC 230	Impulse tests on cables and their accessories
IEC 502	Extruded solid dielectric-insulated power cables for rated voltage from 1 kV up to 30 kV
IEC 540	Test methods for insulations and sheaths of electric cables and chords
IEC 229	Test on cable over sheaths which have special protective functions

	and are applied by extrusion
IEC 287	Calculations of continuous current rating of cables (100% load factor)
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61537	Cable management - Cable tray systems and cable ladder systems
IS 1554 part1	PVC insulated (heavy duty) LT electric cables up to 1.1 kV
IS: 7098 Part I	XLPE Insulated LT Electric cables (heavy duty) up to 1.1 kV
IS: 7098 Part II	XLPE insulated PVC sheathed cable for voltage from 3.3 kV up to 33 kV
IS: 5831 (1984)	PVC insulation & sheath of electrical cables
IS: 694	PVC Insulated cables for working voltage up to and including 1100 V
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables
IEC 885-2 (1987) (Part II)	Electrical test methods for electric cables partial discharge test
IS: 10810	Methods of test for cables
IEC 811	Common test methods for insulating and sheathing materials of electric cables
IEC 230	Impulse test on cables & other accessories
IEC 859	Cable termination for gas insulated switchgear
IS: 3961	Recommended current ratings for cables
IS: 3043	Code of practice for earthing
IS: 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS: 2633	Methods for testing uniformity of coating of zinc coated articles
IS: 1897	Copper strip for electrical purposes – Specification
IEC 62305	Code of practice for protection of buildings and allied structures against lightning
IS: 732	Code of practice for electrical wiring installations
IS: 1646	Code of practice for fire safety of buildings (General) Electrical installation
IS: 2509	Rigid non-metallic conduits for electrical wiring
IS: 6946	Flexible (Pliable) non-metallic conduits for electrical installation
IS: 9537	Conduits for electrical installations
IS: 3854	Switches for domestic purpose
IS: 3415	Fittings for rigid non-metallic conduit
IS: 3837	Accessories for rigid steel conduits for electrical wiring
IS: 14927	Cable trunking and ducting systems for electrical installation
IS: 4648	Guide for electrical layout in residential building Indian electricity act and rule
IS: 1293	3 pin plugs and sockets
IS: 4795	Holders for Indicator Lamps for Electronic and Telecommunication Equipment

IS: 3646	Code of practice for interior illumination
IS: 1913	1969 General and Safety requirements for Electric lighting fittings
IS: 1239, IS: 2713	GI Lighting Poles
IS: 1944	Code of practice for lighting of public thoroughfare
IS: 374	Electric ceiling type fans and regulators
IS: 1293	Plugs and socket-outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes – Specification
IS: 6665	Code of practice for industrial lighting
IS: 8224	Electric lighting fittings for division 2 areas
IS: 9583	Emergency lighting units
IS: 9974	High pressure sodium vapour lamps
IEC 62305	Protection against lightning Part 4: Electrical and electronic systems within structures
IS: 1271	Thermal evaluation and classification of electrical insulation
IS: 1544	Cotton calico
IS: 1868	Anodic Coatings on Alluminium and its Alloys – Specification
IS: 2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers -code of practice
IS: 2546	Specification for galvanized mild steel fire bucket
IS: 5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS: 9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS: 9678	Methods of measuring temperature rise of electrical equipment
IS: 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS: 15652	Insulating mats for electrical purposes – Specification
IS: 5424	Rubber mat
IS: 4770	Rubber Gloves -Electrical Purposes – Specification
IS: 2551	Danger notice plates
ISO 3046	Diesel Engine
IS: 4722, BS 2613	Alternator
IS: 16101	General lighting LED and LED modules
IS: 16102 (Part 1)	Self ballasted LED lamps for general lighting service-Safety Requirement
IS: 16102 (Part 2)	Self ballasted LED lamps for general lighting service-Performance Requirement
IS: 16103 (Part 1)	LED modules for General lighting-Safety Requirement
IS: 16103 (Part 2)	LED modules for General lighting-Performance Requirement

IS: 16107 (Part 10)	Luminaries Performance-General Requirement
IS: 16108	Photo biological safety of lamps and lamp systems

DESIGN BASIS

The Electrical equipment system shall be in accordance with project specifications and shall ensure continuity/reliability of supply, flexibility of operation and safety.

The Basic Design Data to be considered as follows.

Incoming Supply Conditions	11kV ± 10%
Frequency	50 Hz ± 5%
Voltage and Frequency Combined Variation	± 10%
Fault Level at 11 kV	500 MVA symmetrical (1 second) or higher as per Statutory requirement
System Grounding	Solidly Earthed
Fault Level at 415V (Design)	50 kA Symmetrical (1 second)
Control Circuit Voltage	230V AC via Constant Voltage Transformer for LV Panels and 110V DC for HV Panel via Power Pack
HV Cabling	3C XLPE, 11 kV (E), Extruded Inner Sheath
LV Cabling	Copper/Alluminium Stranded Conductor XLPE/PVC insulated, Extruded Inner Sheath
Earthing	Earth Pit: Cu Bonded Electrode (Pipe in Pipe Technology)/GI Pipe electrode (Maintenance free Chemical Type) as per IS: 3043 (2018)/Specifications/ Drawings
Induction Motor	/ Efficient Design of IE3 Class as per IS: 12615 (2018) amended up to date
Soft Starter	DOL starting, Soft Starter De-rated current for 50 ^{0}C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/BOQ, with in-built or external bypass contactor, with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/BOQ/ Specifications
Variable Frequency Drive (VFD)	VFD De-rated current for 50 ^{0}C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/BOQ with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/BOQ/ Specifications

As the load demand is less than 100 kW/125 KVA, it is proposed for LT power supply system.
415V Power is expected from local Power Supply Company (PSC).

Power Supply Company (PSC) will provide their L.T metering panel at pumping station / plant. The LT power from Power Supply Company's LT Metering Panel shall be fed to Power obtaining MCCB near the PSC metering panel.

This LV panel shall in turn feed downstream APFC/MCC/LDB/PDBs etc. for feeding various loads.

Motors shall be started and stopped by push buttons at Local Control Stations located near respective motors as per specifications/SLD/SOQ. Starters shall be housed in MCCs with STOP/START (where ever LCS is not applicable)/RESET Push Button.

In outdoor areas cables shall be mostly buried directly underground with mechanical protection wherever applicable. In indoor areas, cables shall be laid in trenches through Hot Dip Galvanized Iron /FRP cable trays as per SOQ.

Earthing system design and installation shall be generally as per IS: 3043 (2018). Earthing system shall be carried out by pipe-in-pipe technology and maintenance free UL listed chemical earthing system as per SOQ by hot dip galvanized GI strips, Cu strips, maintenance free UL listed Cu bonded earthing electrodes, GI pipes, earth enhancement materials ie back filling compounds for chemical earthing etc. as per actual requirement of the entire Plant. All equipment shall have two separate and distinct earth points. Earth resistance shall not exceed one ohm at any point.

Notwithstanding anything mentioned in this tender specifications and Schedule of Quantities (SOQ), contractor shall be responsible to provide all equipment and material to complete the electrical installation in all respects at no extra cost. Bidder is responsible to study the technical specifications/SOQ in entirety and understand the requirements prior to bid submission and shall bid/quote accordingly.

GENERAL INSTRUCTIONS

UNIT RATE

The unit rate of all the item of works as per BOQ shall include the following job as a minimum.

- Delivery of the Equipment at site.
- Unloading at site store/proposed area.
- Storage and security of supplied materials and equipment till installation at site and handing over to client.
- Power and Control cabling work between equipment.
- Assembling various item as per requirement.
- Checking of operation and wiring before commissioning.
- Testing and commissioning of equipment.
- Supply of necessary spares required for commissioning.

DRAWINGS/DOCUMENTS

Successful bidder shall submit documents, **Technical data sheets in the formats given in the tender**, all manuals, catalogues, characteristic curves etc. for various electrical equipment/components for review and approval.

Detailed documents to be prepared in line with recommended specifications/details and submitted to client in a timely manner to allow for review and approval.

The bidder shall furnish following required drawings/documents for each item for review and approval as a minimum.

a) List of Drives/Loads with Quantity/Ratings/Specifications along with power load statement.
b) Transformer, DG Set and Capacitor Sizing Calculations.
c) SLD and control diagram of complete electrical system.

d) GA drawing, SLD, Sectional drawings, BOM, Wiring/Schematic Drawings etc. as applicable for complete electrical system (HV and LV Panels, LVDB, Lighting Panels, PDBs etc.)
e) Overall Cable Layout and Unit Wise Cable Tray layout.
f) Earthing Layout with Earthing Calculations.
g) Internal Lighting Layout with Calculations.
h) External Lighting Layout.
i) Cable Schedule with voltage drop calculation/sizing calculations.
j) Interconnection Schedule.
k) GA Drawings for all equipment including sectional drawing wherever necessary and specifying recommended installation, weight, clearances requirements etc.
l) Filled in Data Sheets.
m) Schedule of quantities along with brief specifications.
n) Design/sizing calculations for equipment as applicable.
o) O and M manual for all equipment.

VENDOR DATA REQUIREMENT

Following minimum documents shall be submitted by contractor along with the bid/offer for review and approval during detailed engineering, as indicated.

VENDOR DATA REQUIREMENT FOR ELECTRICAL WORKS				
Sr. No.	**Description**	**With Bid/ Offer**	**For Review/ Approval**	**As Built**
1	Technical Details for Major Equipment		*	*
2	List of Recommended Spares		*	*
3	Data Sheet/GA drawing/BOM/SLD/Wiring and Schematic Diagram for Power and Control Circuit/Data sheet of Relay for 11 kV HV VCB Panel/Transformers/Motor/Bus Duct/DP Structure as applicable		*	*
4	GA Drawings with sectional view, door open view, top and bottom view, Rear view, Mounting plate details etc./BOM/SLD/ Wiring and Schematic Diagram for Power and Control circuit for LV Panel/Starter/ APFC Panel/Bus Duct		*	*
5	Technical Data Sheet/ Catalogue of ACB, MFM, Soft Starter, VFD, APFC Relay, Detuned Reactor		*	
6	GA Drawing/BOM/Technical Details for LCS/Indoor and Outdoor Light Fixtures /LDB/Switch Board/Safety Equipment		*	*
7	Data Sheet and BOM for Cable Tray		*	*
8	Cable Schedule/Data Sheet/Make and Type for HV/LV Power and Control Cables.		*	*
9	Earthing (Grounding) System Calculation and Details		*	*

10	Lightening Protection System for Buildings and Structures (If and as Applicable)			
11	RCC Foundation Details for various Electric Equipment.		*	*
12	Inspection Schedule and QAPs for Major Equipment		*	
13	Test Certificates		*	*
14	O and M Manual (If and As Applicable)		*	*

4.1 LV PANEL – PCC / PMCC / MCC / APFC / OTHER LT SWITCH BOARDS

- Panel shall confirm to Indian Electricity Act and rules CEA Notification/Guidelines, CPWD guidelines 2019 as amended up-to date and shall be as a minimum.
- The MV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP-52 or better degree of protection for indoor unit & IP-55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.
- Panel construction shall be complying to Form-3b type as per IS/IEC 61439. (i.e. Separation of busbars, all functional units & of terminals and external conductors, etc. shall be as per Form-3b type as per IS/ IEC 61439). Only metallic sheet shall be used for compartment separations/partitions, Hylam/PVC sheets shall not be allowed.
- MV switch boards sheet steel shall be CRCA minimum 2.0 mm for load bearing members, mounting plate, partition, doors/covers, Canopy. Gland plate shall be CRCA sheet min. 3.0 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.
- All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.
- Suitable lifting arrangement with L angle welded at top for PMCC/MCC/APFC etc. shall be provided on each panel or on each shipping section for ease of lifting of switchboard.
- A base channel of 100mm x 50mm x 5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.
- Overall height of Panel shall not exceed 2300mm (For VFD, Soft Starter panel height up to Max.2500mm can be accepted) including min. 100mm ISMC base frame.. However, in case of panel mounted on floor without cable trench shall be mounted at least 500mm above the floor level to provide adequate bending radius for in & out cables. Folding type stand of minimum height 500mm with folding CRCA cover/sheet of 1.6mm thick all around the stand shall be provided. Operational height of starters and control switch gear shall not exceed 1800/1900 mm above FFL (irrespective of overall height of panel) for ease of operation.
- Shipping section length shall be maximum 2500mm. Each shipping section shall have full side sheets of 2mm thick on both the sides. Vertical partition of Incomer/Bus coupler/ Outgoing feeders etc. shall be of full depth of the panel. Detachable gland plate shall be provided at the top on both the ends of the shipping sections for connecting/joining of bus-bars.
- Minimum dimension of Incomer, Bus-coupler, Starter , MCCB cubical compartment shall be as per the Table. Height of Main Horizontal Bus bars chamber shall be minimum 300mm upto 630A rating and 350mm or higher for 800A and Above, Vertical bus bar shall be Minimum 300 mm or higher as per KA level and temperature rise required. Minimum width of cable alley shall be 350mm or higher as per number of cable.

- All type of meters shall be digital type. Ampere meter and Voltmeter shall be single phase and Separate selector switches shall be provided. Meter with inbuilt selector switches is not acceptable.
- Control MCB shall be provided for control wiring circuit. Panel shall be of Fuse less design.
- CT on Y phase with Ammeter to be considered for 7.5 kW to less than 15 kW starter feeder. 3Nos. CTs with Ammeter and ASS to be considered for motors rated 15 kW & above and less than 30 kW. For 30 kW and above MFM shall be provided.
- LV Panel shall be of fixed type, single/double front. LV Panel shall be single tier for incomers and bus coupler feeders rated 500A and above. VFD and Soft starter feeder rated 22 kW and above shall be in single tier only and less than 22 kW shall be in single tier or two tier.
- Outgoing ACB feeder above 1000A shall be in single tier only.
- Vacant space on incomer and bus coupler panel shall not be used for mounting the starter, switch gear modules, MCB feeder. Fixed capacitor/reactor may be housed below buscoupler with steel sheet separation/barrier. VFD starter panel shall be stand-alone panel with minimum height of panel – 1800mm.
- All auxiliary devices for control, metering, protection, indication & measurement such as push-buttons, control and selector switches, indicating lamps, Ammeters, Voltmeters, kWh meters and protective relays shall be mounted on the front side of respective compartment, for easy operation without opening the door. Metering cubicle shall be separate/independent of ACB/ MCCB incomer feeder.
- Circuit breakers capability/suitability to interrupt applicable capacitive current shall be specifically verified/supported by manufacturer recommendation.
- The switch board components, Bus bars etc. shall be designed to withstand the maximum Designed short circuit level for minimum 1 sec.
- MCCB shall be TPN/4P, Microprocessor based release/TM release as specified elsewhere. All MCCB's shall be suitable for Ics= 100% Icu. The rated service short-circuit breaking capacity (Ics) of MCCBs shall be more than or equal to the specified fault level. MCCB shall be supplied with Extended rotary handle, Terminal spreader, Auxiliary C/O + Trip contact as applicable.
- Rating of MCCB/MPCB, Contactors, relay etc. of motor feeders as recommended by Equipment manufacturer and shall comply with Type-2 Coordination as per IS: 60947.
- Panel shall have Main horizontal and riser bus bars air insulated, with coloured Heat shrinkable sleeves, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers, sufficient louvers with wire mesh for air circulation.
- The LV panels shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.
- All control wiring except CT secondary wiring shall be carried out with minimum 1.0 mm^2 FRLS PVC copper flexible wires (Grey). CT secondary wiring shall be carried out with 2.5 mm^2 FRLS PVC copper flexible wires (Color coded).
- Adequately rated anti-condensation heater with porcelain connectors shall be provided in each breaker panel and in cable alley to maintain inside temperature 5 ^{0}C above outside ambient temperature. It shall be supplied from 240V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having variable setting of 30 to 70^{0}C and manually operated switch fuse and link for phase and neutral respectively.
- All starters shall be provided with Auto-Off-Manual and Local-Remote selector switches (where Start PB provided at Panel End), to monitor & operate MCC or LCS, ICP/PLC.
- All ACBs, MFM, VFD, Soft Starters where provided shall have inbuilt RS 485 port to communicate with PLC/SCADA for monitoring and control. RS 485 terminal shall be wired upto External TB with shielded wire.

- 240V AC control supply shall be fed from 440/240V AC Constant Voltage/control voltage Transformer, one number on each bus of minimum 1.5 KVA rating or higher suitable for connected total working load. Suitable control logic through contactors shall be provided such that Control supply is available to all feeders based on Incomer -1 and Incomer-2 status. Only one control transformer shall be ON at a time. Separate control transformer 440/240 V of suitable VA rating shall be provided for Incomers. DP MCB of suitable rating shall be provided on both Incoming as well as outgoing side of control transformerAll CTs, PTs and Constant Voltage/Control transformer shall be cast resin type with terminals. CT shorting link type control terminal shall be provided. Only Ring type lugs shall be used for CT termination.
- 2Nos. auxiliary contactors to be considered for PLC interface.
- All capacitors generally shall be at 440V or 525V if provided with detuned reactor or as specified in SOQ, Heavy duty type with discharge resistors and with dielectric losses ≤ 0.2w/kVAR.
- Following Communication RS 485 Modbus, DI, AI and DO, AO to be considered for various type of feeder for PLC/SCADA interface.

	INCOMER (ACB/ MCCB)	SOFT/ VFD/ SD STARTER (MPR)	MOV
Communication	Inbuilt Modbus RS 485 (only for ACB) for (1) Control (2) Monitoring Metering, energy & protection parameter	Modbus RS 485 Monitoring and control (SS & VFD) & MPR –Only monitoring & Trip. In VFD: PF, energy saving also to be monitored.	-
Digital Input (DI)	Breaker ON/OFF/TRIP	Motor Run	Valve Open
		Motor Trip	Valve Close
	Auto/ Manual	Auto/ Manual	Local/ Remote
		Local/Remote	Trip/ Fault
Digital Output (DO)	Breaker ON/OFF (latched type)	Start/Stop(latched type)	Valve Open
			Valve Close
Analogue Input (AI)		Speed Feedback (only for VFD)	Valve Position feedback
Analogue Output (AO)		Speed Reference (Only for VFD)	Valve Position Reference (only for VFD)

In addition to above MFM and Temperature scanner with RS 485 Communication MODBUS shall be taken for interfacing with PLC/SCADA for Monitoring and for controlling further as required.

Bus Bar

- Busbars shall be of high conductivity, electrolytic aluminium (E91E), suitable for carrying the rated and short time current without overheating supported on insulators made of non-hygroscopic, non-flammable material to ensure free thermal expansion. With tracking index equal to or more than that defined in IS.
- Aluminium bus bars shall be sized for maximum 0.8 A/mm² current density only.
- Whenever Incoming supply is through BUSDUCT, Incoming Bus-bar of Incomer shall be extended till the top end of panel and phase positioning/ orientation of bus bars shall be suitable for Transformer LV terminal arrangement to avoid additional Phase cross over chamber.
- Bus bars for risers shall be rated to carry minimum 80% or higher of the rated current of all feeders connected to the risers as per the design of the system/loading.

- The current rating of neutral shall be min. half that of phase busbars. For LDB neutral rating shall be equal to that of phase busbar
- Both horizontal and vertical TP & N, bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second.
- Only **High Tensile Steel Bolts, Nuts and Washers duly** zinc passivated or cadmium **shall be used for all bus bars joints and supports.**
- The hot spot temperature of bus bars including joints at design temperature shall not exceed 85 ^{0}C for normal operating conditions.
- All bus bars shall be insulated with heat shrunk PVC sleeves of 1100V grade.
- The bus bars shall be arranged such that minimum clearance between the bus bar for 50KA fault current shall be maintained as below:
    - Between phases : 27 mm minimum
    - Between Phase and Neutral : 25 mm minimum
    - Between phase and Earth : 25 mm minimum

For the requirement of 65 KA for 1 sec, necessary clearance as per the relevant IS shall be maintained.

Auxiliary Supply Bus-bars

- Auxiliary busbar of Tinned copper EC grade of suitable size shall run through-out the length of the Main bus-bar alley/Vertical bus-bar alley and supply shall be tapped to individual feeder directly from the Bus and shall not be looped between the feeders. Control MCB shall be provided for individual feeder. Auxiliary bus shall be provided for following application. Exact size/capacity of bus bar shall depend on various controls, metering and auxiliary power distribution requirement.
    - Panel space heater supply and motor space heater supply.
    - Control supply for breaker tripping, closing and indication circuits.
    - Control supply for breaker spring charging motors, motor starter control and indication circuits.
    - AC potential supply for MFM, Meters, starter, and voltage operated relays, etc.

Power and Control Wiring and Terminal Blocks

- All wiring shall be done with IS approved FRLS PVC copper flexible wires. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.
- Control circuit wiring shall be FRLS PVC copper flexible wire of minimum 1.0 mm² size and CT circuit wiring shall be minimum 2.5 mm² size. CT wiring shall be R Y B BK colour coded and Terminals shall be CT Shorting link type only. Power wiring inside the starter module/MCCB/MCB shall be rated for full current rating of Feeder MCCB/MCB.
- All feeder modules shall be provided with neutral link. Suitable size and Rating Terminal blocks shall be provided for all outgoing feeders in the cable alley for connecting Power and Control cables. Cable shall never be connected directly to MCCB/MCB terminal.
- Flexible wire shall be used only upto & including 100A MCB/MCCB, above 100A bus bar shall be used. Minimum size of FRLS Copper wire shall be up to and including 16A: 2.5 mm²; 20A: 4 mm²; 32A: 6 mm²; 40A: 10 mm²; 50A: 16 mm²; 63A: 25 mm².; 100A: 35 mm².
- Each wire shall be identified at both ends by PVC ferrules.
- Inter panel wiring shall be done through rubber grommets.
- A minimum of 2 nos. or 20%, whichever is higher, spare terminals shall be provided on each terminal block.
- Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

Earthing

- The minimum earth bus size shall be minimum **65 x 10mm (Hot dip galvanised strip) or 40 x 10 mm (Aluminium) or** higher to suit the Fault Level/KA requirement.
- All doors and movable parts shall be earthed using minimum 1.5 mm² FRLS Copper flexible wires (Green colour) to the fixed frame of the switch board. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos., 10mm diahole shall be provided on the earth bus for termination of earth strip / wire.

Name Plate

- Nameplates shall be provided as per standard.
- LV Panel shall be with details like name of client (on first row/top row), project name (second row), name of contractor (third row) and panel manufacturer (in fourth row) all with equal of descending order letters size on top of front side of panel.
- LV Panel shall be with name plate (on front side of door of I/c) having minimum details like (1) Power supply voltage (2) control supply voltage (3) frequency (4) Panel fault level (5) Panel protection class (6) Panel manufacturing IS standard considered etc. details.

Painting

- The LV Panel shall be treated with seven tank/Nine tank process with Degreasing, Water rinsing, De-rusting, Water rinsing, Phosphating, Water Rinsing, Passivation.
- After seven tank process the external paint shall be powder coated with Siemens grey RAL-7035 for inside and outside of LV Panel.
- Mounting plate shall be painted Glossy white.
- Thickness of paint shall be between 100 Micron to 120 Micron.

Switchgear Modules

Air Circuit Breakers

- Circuit breakers shall be air break, Electrical Draw Out type for feeders 630A and above. All ACB shall be with Microprocessor based release with Overload, Short circuit and inbuilt Earth Fault protection. Only for APFC incomer Thermal Magnetic type can be accepted.
- The ACB shall be minimum 50 kA (1 Second) or higher as per fault rating, I_{CS} = 100% I_{CU} = Icw. All ACBs shall comply and tested as per IS: 13947 / IEC 60947-1 and IEC 60947-2 standards.
- ACB for all Incoming, Bus coupler should be Four Pole Type. PCC outgoing feeders shall be Four Pole/Three Pole + Solid Neutral (TPN) Type.
- ACB for Incoming and Bus-coupler shall be identical and interchangeable.
- ACB Models shall be : Schneider - Master pact NW or Siemens -3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list. Data sheet with parameter comparison shall be submitted for approval.
- ACB shall be with **inbuilt Communication Module** RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.
- Electrical and Mechanical interlocking shall be provided between ACB Incomers and Buscoupler with required Key Locks, Undervoltage coil, auxiliary contactors etc. as per the system requirement.

ACB Trip Release LSIG (Micro Processor based)should have Minimum following.

- Overload with time delay
- S/C with time delay and Inst. Trip Setting
- Earth Fault with Time Delay.
- Under/over Voltage for incomer

- LSIG Fault record Display (ONLY FOR INCOMER & Bus-coupler)
- Metering & Energy display (ONLY FOR INCOMER & Bus-coupler)
- Ammeter display (For Outgoing feeders)

ACB shall be fitted with following.

- Heavy duty switches having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device.
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.
- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

Moulded Case Circuit Breakers (MCCB)

- All MCCBs shall be comply and tested as per IS: 2516/IEC 60947-1 and IEC 60947-2 standards.
- Incomer MCCB's shall be 4P, 50 KA or higher (and Ics = 100% Icu) with Micro-processor based release with in-built O/C, S/C and E/F protection.
- Outgoing MCCB TPN for power feeders up-to and including 200A shall be with thermal magnetic release with adjustable O/L and Adjustable/Fixed S/C protection. Outgoing MCCB's from 250A & above shall be with Microprocessor based release with in-built Adjustable O/C, Adjustable S/C and Adjustable E/F protection.
- All MCCBs shall be 50 KA or higher, Ics = 100% Icu and with Extended Rotary Handle and Terminal Spreader. Auxiliary change over contact 1 No + 1 NC and Trip Contact shall be provided as per the requirement.
- MCCB of Soft Starter/VFD feeder shall be TPN with Microprocessor release with overload/ short circuit and inbuilt Earth fault release. VFD starter panel shall be Stand Alone panel.
- MCCB as part of DOL/Start Delta motor starter module shall be current limiting type, TPN, (rating and protection type as indicated above) and type tested for Type-2 co-ordination as per IS: 13947/IS/IEC: 60947.
- MCCB Models shall be: Schneider NSX / CVS (for ≥ 250A) & CVS (for ≤ 200A) or Siemens 3VL or L&T D Sine or ABB T-Max; or Equivalent model from Vendor Approved list.
- Electrical interlocking shall be provided between MCCB Incomers and Buscoupler with required Undervoltage coil, auxiliary contactors as per the system requirement.

Switches/Fuses

- The switches or fuse switches shall be load break, heavy duty / motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch. Fuses shall be non-deteriorating HRC cartridge link type.
- Rating of heavy duty switches or motor duty starter modules shall meet the requirement of AC23 duty as per IS: 13947.

Contactors

- The contactors shall be air break type, equipped with three main contacts and minimum (2NO + 2NC) auxiliary contacts. All contactors shall be 3 Pole, AC3 duty except for lighting feeder where-in the contactor shall be 4Pole and AC1 duty. External Bypass contactor used for Soft Starter shall be AC1 or AC3 as recommended by Soft Starter manufacturer.
- Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1 Phase, AC supply and shall work satisfactorily between 65 to 110% of the rated value.

- Contactor used for capacitor feeder shall be Capacitor duty contactor with inbuilt leading contact with wiper function for limiting/damping the capacitor inrush current with NO NC Auxiliary contact.

Bimetal Relay

- All bimetal overload relays shall be with in-built single phasing prevention and with Manual/Auto reset type (selectable) with at least 1NO and 1NC contact with reset type push buttons in the front, mounted on door such that it shall be possible to reset the O/L relay without opening the compartment door.

Motor Protection Relay (MPR)

- Motor Protection Relay (MPR) shall be provided for 30 kW and above Star delta starters. MPR not required for VFD/Soft starter Motor feeders. Motor Protection Relay (MPR) shall be Numerical type with Overload, short circuit, Earth fault; under current, unbalance, Phase loss/reversal, Stall, Locked Rotor, No load running.
- Single Phasing prevention with adjustable Under/Over voltage protection shall be provided separately if the same is not inbuilt feature in MPR.
- MPR shall be Numerical with adjustable parameter with inbuilt MODBUS over RS 485 interface if specified in SOQ/elsewhere in the tender. MPR shall be Din Rail mountable Base Module and LCD Display module shall be Panel door Mountable. ZCT/CBCT shall be provided for Earth fault/ leakage protection (range 0.1A to 2A). Shall have Programmable 2 DI and 2 DO.
- MPR shall display 3 Phase current, Unbalance 9% as minimum and Earth current monitoring.
- MPR shall store Fault records/Start- Stop records/Motor run hours/Maximum starting current etc.
- For motors 30 kW and above external CT (3 nos) 5A, Resin cast of suitable VA shall be used
- Make: C&S mPRO 200 with ZCT or equivalent model of other approved make. Data sheet with parameters comparision shall be submitted for approval.

Motor Starter

DOL starter to be considered for rating less than 7.5 kW rating, Star-delta starter to be considered from 7.5 kW rating to less than 75 kW rating. Soft starter to be considered for 75 kW & above rating. VFD shall be provided for any rating if specifically asked for/as per the requirement/application. Soft starter shall be provided for lower ratings also if specifically asked for/as per the requirement. MCCB rating upto 800A as incomer for Starter/Soft Starter/ VFD starter is acceptable.

MPCB with overload protection, Short circuit protection and Single phasing protection, AC3 duty contactor for DOL feeders and Start Delta feeders up-to and including 15 kW.
All MPCB shall be with rotary switch.

MCCB (with adjustable overload, adjustable Short circuit, Earth Fault) Microprocessor release or Thermal Magnetic release (with adjustable overload, adjustable Short circuit)as per the MCCB rating , AC3 duty contactor Numerical Motor protection relay as applicable, A/M switch, L/R switch, indicating lamps, pushbutton etc. shall be provided.Provision for door mounting PMU shall be provided in the Starter of Submersible Pump motor. Wiring shall be done up to Terminal connector for PMU input from field.
Minimum 8 Channel or higher Temperature scanner shall be provided in starter feeder for 90KW and above rated feeder wherever motor is supplied with RTD and BTD. Temperature scanner/Thermister and PMU (as applicable) shall be interlocked with starter feeder with control/tripping Circuit of Starter feeder. Temperature scanner shall be door mounted. Soft starter/VFD shall be with input terminal for RTD (PT 100) and Thermistor for Motor Temperature (winding and Bearing) monitoring/protection.
Specification of Temperature scanner shall be as specified below.

Temperature Scanner

- Temperature scanner of required cahnnels with min. 2 spare channels shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signals to temperature scanner shall be derived from motor Industrial Type PT-100 resistance temperature detectors provided in the motor windings and bearing.

1	Service and type	Motor winding and bearing temperature measurements – microprocessor based
2	Range	0 to 200° C
3	Alarm Contacts	Adjustable 4 Nos. (High temperature and very high temperature) for motor winding and bearing
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor winding and bearing winding
6	No. of channels	6 Nos. for Winding + 2 nos. Bearing + 2 spare
7	Accuracy	± 1° C
8	Communication	RS-485 for Instrumentation panel interface if specified to be provided in BOQ / elsewhere in the tender.

Instrument Transformers (CTs/PTs)

- Current transformer & potential transformer shall generally conform to IS: 2705, IS/IEC: 60044-122 and any special requirement w.r.t. numerical relay shall be taken care of by contractor. All CTs shall be Resin cast type and secondary 5A. APFC feedback CTs, MFM CTs, MPR CTs shall be of Class-0.5 and 10VA. CT's (80A and above) of Digital Ammeter, APFC panel metering shall be Cl. : 1 and 5 VA. CTs less than 80A shall be Cl 1.0 and 2.5VA.
- The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for 1.0 sec.

Indicating/Measuring Instruments

- The meters shall be Digital type and generally of square pattern type of 96 x 96 mm suitable for flush mounting. Instrument shall generally conform to IS: 1248 and shall have accuracy class of 1.0 or better.
- Digital meters shall have 3 ½ Digit, LCD display as a minimum
- All auxiliary equipment such as shunt transducers, CT's, PT's etc., as required shall be included in the supply of switch board. The current coil of ammeters and potential coils of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.
- Digital Ammeter and Voltmeter shall preferably with separate Selector switches instead of meter with Inbuilt Selector switch. Wherever 3 phase Digital Ammeter/Voltmeter provided, same shall be with 3 line display.
- Digital type Multi-function Meter shall be with 3 line display, Accuracy Class: 0.5 Suitable for measuring and displaying the following parameters: A,V,F,PF,KW,KWH, KVA, KVAR, KVARh, Md (for PCC/PMCC incomer feeder MFM only), Harmonic and with inbuilt RS 485 communication port. (Schneider- EM 6400NG; L&T –MFM 4420; Secure – Elite 443; equi. model of other approved make). Data sheet with parameter comparison shall be submitted for approval.
- MFM shall be provided for all Incomers (PCC/PMCC), all Motor starter feeder Rated 30 kW and above and all outgoing power feeders of PCC/PMCC rated 100A and above. For motor starters and outgoing power feeders provided with MFM, separate Ammeter/ Voltmeter/PF meter is not required.

Push Buttons

- Pushbuttons shall have rated operational current of not less than 4A (AC-11)
- Pushbuttons for START, OPEN, CLOSE, LEFT, RIGHT, FORWARD, REVERSE etc. shall be flush type with spring aided self-reset contacts.
- Pushbuttons for STOP/EMERGENCY STOP shall be mushroom headed type with stay put contacts & shall be colored red. The operation of the button shall be press to lock and twist to release. The stop PB for each outgoing feeder/starter at MCC and for field LCS shall be EMERGENCY STOP push button. Push buttons shall be in compliance with IEC 60947-5-5
- Illuminated PB is not accepted.

Push button colours shall be as follows:

Stop / Open / Emergency	-	Red
Start / close	-	Green
Reset / Test	-	Yellow / White

Indicating Lamps

- Colour shade for the indicating lamps shall be as below LED type:

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow and Blue
TRIP circuit healthy lamp	:	Milky

FIXED COMPENSATION

- Fixed Capacitor bank for transformer compensation (for no load as well as leakage reactance) shall be provided. MCCB 50 KA or higher as per specification mentioned elsewhere along with Ammeter, CT 3 nos, Capacitor duty contactor, ON Delay timer, Heavy duty capacitor bank unit of suitable rating as per transformer KVA rating (Minimum 5% of transformer kVAR rating). Capacitor bank shall not be mounted below incomer feeder. Capacitor, if provided below buscoupler, capacitor housing/compartment shall be fully separated with steel sheet. Proper ventilation shall be provided.
- 7% Detuned Reactor with thermostat, 440V shall be provided in series with 525V capacitor or as per SOQ, if working VFD load is more than 50% of total load or if required as per SOQ. KVAr rating of capacitor shall be suitable for reactor rating.
- For Transformer Fixed compensation rating above 50 KVAr separate panel (instead of providing in PCC/PMCC panel) shall be provided. Only 4P MCCB power feeder shall be provided in PCC/PMCCpanel for the same.

Danger Notice Plates

- The danger notice plate shall be affixed in a permanent manner on operating side of the Panels. The danger notice plate shall indicate d.anger notice both in Hindi and English and local language with a sign of skull and bones as per IS: 2551.

SHOP DRAWINGS

- Prior to fabrication of the Panels the supplier/contractor shall submit for consultant's approval the shop/vendor drawing consisting of Technical data sheet duly filled in (as per Annexure-1) GA drawing, GA drawing with front door open with mounting plate details and equipment, sectional elevation, single line diagram, Power/Wiring drawing, bill of material etc. and design calculations indicating type, size, short circuiting rating of all the electrical components used, bus bar size and calculation, Power/control wiring size, Panels dimension, colour, mounting details etc. in 6 sets..
- The contractor shall submit manufacturer technical catalogue of major equipment like ACB, Soft Starter/VFD, MPR of offered make/model for approval along with drawings.
- Soft starter/VFD selection indicating Rated FL current, Derated current for design Ambient temperature, Full load current of motor, 110% rated FL current of motor as

per IS 12615 shall be given by SS/VFD OEM. Derated current of SS/VFD shall be equal to higher than 110% FL current of motor as per IS: 12615/SOQ. Power drawing and control drawing of SS/VFD shall be got vetted from SS/VFD OEM before submission of drawings.

TEST CERTIFICATES

- Testing of Panels shall be carried out at factory as specified in Indian standards in the presence of by Client/Consultant. The test results shall be recorded on a prescribed form. All type test certificates and routine test certificate for the test carried out at factory and bought out material and at site shall be submitted in duplicate to the consultant for approval.

CUBILCE/FEEDER SIZE CRITERIA FOR LT PANELS

- **ACB MINIMUM Cubicle compartment size considering minimum height of 1800mm.**

ACB Rating	Width of Compartment (I/C or O/G in mm)	Width of Compartment (Buscoupler in mm)	Depth (mm)	Remark
630A -1250A 4P	800	900	1000	Cable entry
1600A 4P	900	1000	1000	Cable entry
2000-2500A 4P	900	1000	1200	Busduct entry
3200-4000A 4P	1100	1200	1300	Busduct entry

NOTE: Dimension mentioned above is minimum. Height of ACB feeder 1800 excluding main Bus bar chamber. Above 1000A ACB outgoing feeders shall be in single tier. Upto & including 1000A ACB outgoing Breaker Feeder shall be in Single/double Tier.

- **MCCB MINIMUM Cubicle compartment size**

MCCB Rating	Width of Compartment	Height	Remark
Up to 100A	350	300	Copper flexible shall be used
125A -200A	400	350(3P)/400(4P)	Bus bar/ strip
Above 200 to 400 A	500	450	Bus bar/ strip
Above 400 to 550A	600	500	Bus bar/ strip
Above 550A	600	600	Bus bar/ strip

NOTE: Dimension mentioned above is Minimum. Depth of panel as per required depending on cable size/ site condition and for ease of maintenance..

- **VFD and SOFT STARTER MINIMUM Cubicle compartment size considering minimum height of 1800mm**

Motor Rating	Min. Width of Compartment (For VFD and for S/S with Ext. Bypass Contactor)	Min. Width of Compartment (For S/S with Int. Bypass Contactor)	Depth of Compartment
Less than75 Kw	700	700	800
75kw to &incl 132 KW	800	750	900
Above 132 to &incl	900	800	900

250KW			
Above 250KW	1000	900	1000

NOTE: Dimension mentioned above is minimum. S/S &VFD Feeder for 22KW and above shall be in Single Tier only**.**

ANNEXURE 1: TECHNICAL DATA SHEET FOR MEDIUM VOLTAGE PANEL BOARD

SR. NO.	PARTICULAR	DETAILS
1.0	SITE CONDITION	
1.1	Type/Make	Indoor/As per tender
1.2	Mounting	Floor/Stand mounted as per SOQ/ site condition
1.3	Design Ambient Temperature	50 ^{0}C
1.4	Atmosphere	Corrosive, Humid and Dusty
2.0	CONSTRUCTION	
2.1	Housing	2.0 mm thick CRCA sheet for Body, Partition, Cover/door
2.2	Protection Class	IP-5X
2.4	Base channel	100 x50 x5 mm Channel
2.5	Shipping section length	2500mm (Max)
2.6	Side sheets for shipping section	Full side sheet on both side of shipping section
3.0	OPERATIVECONDITION	
3.1	Voltage	415 ± 10% V
3.2	No. of phase	3
3.3	System	3 Phase, 4wire
3.4	Frequency	50 ± 5% Hz
3.5	Fault Current	50 kA
3.6	Neutral Grounding	Solid
4.0	CONTROLSYSTEM	
4.1	Voltage	
	For Indication	240V AC
	For Metering	240V AC
	For Protection	240V AC
4.2	Control Supply Through control transformer/ Constant Voltage	240V AC for PMCC

4.3	Wiring	Control wiring: 1.0mm² FRLS PVC Cu flexible Wire (Grey); CT wiring 2.5 mm² FRLS, Color coded: Door earthing: 1.5 mm² FRLS (Green)
5.0	BUSBAR	
5.1	Phase Bus bar Material	EC grade Aluminium
5.2	Neutral Bus bar Material	Same as Phase Bus bar.
5.3	Earth Bus bar Material	65 x 10mm (Hot Dip Galvanised Strip) OR 40 x 10mm (EC grade Al)
5.4	Current density (minimum)	1 sq.mm = 0.8 A minimum. Size of busbar based on Design temperature, KA level and minimum Current density
5.5	Hard ware	High Tensile Steel Bolts, Nuts and Washers duly Zinc/Cd Passivated shall be used for all bus bars joints and supports.
6.0	PLC Based System	As per SLD/SOQ
7.0	**ACB**	
7.1	Type, Rating, No of poles	EDO, 50 KA, Rating and pole as per SLD
7.2	Protection	LSIG with Display and fault record display control and monitoring from remote location
7.3	Display of Metering	Basic (A,V,F) & Energy for I/C and Only current display of Outgoing.
7.4	Communication port	Inbuilt RS 485 (on MODBUS/ Ethernet)
7.5	Model	Schneider Master pact NW or Siemens 3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list
8.0	**MCCB (Ics= 100% Icu)**	
8.1	INCOMER & Bus-coupler MCCB	Microprocessor based release with Adjustable O/L, Adjustable S/C, inbuilt Adjustable E/F, 50 KA, 4 pole
8.2	Outgoing MCCB	
8.2.1	For rating above 200A	Microprocessor based release with Adj O/L, Adj S/C, inbuilt Adj E/F, 50 KA, 3/4 pole as specified in SLD

8.2.2	For rating upto& including 200A	Thermal Magnetic based release with Adjustable O/L, Adjustable/fixed S/C, 50 KA, 3/4 pole
8.2.3	For SS/ VFD starter feeder MCCB	Microprocessor based release with Adjustable O/L, Adjustable S/C, inbuilt Adjustable E/F, 50 KA, 4 pole
8.2.4	Accessories	Extended Rotary Handle, Terminal spreader, Auxiliary change over contact + Trip Contact : To be provided
9.0	Electronic Motor Protection Relay	
9.1	Type	Electronic MPR with LCD display (3 phase current), Record storage, DI/DO interface etc. as per detailed specification give above
9.2	Protection/ interface	Confirm the following
		1) overcurrent 2) short circuit 3) Earth Fault 4) Current unbalance 5) phase loss/ reversal 6) under current (dry run) 7) stall (bearing broken) 8) locked rotor 9) Ground/Earth fault /leakage (ZCT) 10) Single Phasing with Under voltage and Over Voltage 11) Over temperature (With PTC Thermister) 12) 3Programmable DI & 2 Programmable DO 13) Fault record, Start/Stop , Run Hrs. Max Starting current record.
10.0	PAINTING	
10.1	Sheet should be 7 tank processed,	Required
10.2	Colour & Shade & thickness: Panel Exterior & Interior	RAL 7035 100 Micron – 120 micron
10.3	Mounting plate	Glossy white
11.0	**Current Transformer**	
11.1	Type	Resin Cast
11.2	Class of Accuracy	Cl : 0.5 for MFM, APFC load sensing, Summation, MPR Cl: 1 for Ammeter

11.3	Burden (VA)	As per specification
12.0	Hardware	YES. For bus bar joints High Tensile With Zinc passivation/Cd plated
13.0	Space Heater	230V AC with Thermostat
14.0	Pocket For Drawings at door	YES
15.0	Instrumentation compartment	Separate compartment for energy meter, Hour meter, level controller, etc. with necessary internal wiring
16.0	Panel Internal Lighting	1 ft long LED panel light 3W or higher with Auto NO contact/switch with Panel door and control MCB for VFD/SS/Starter feeder/Incomer/Cable alley

Note: Other specifications not mentioned in datasheet shall be considered as per tender specification/ SLD.

4.2 AUTOMAITC POWER FACTOR CONTROL PANEL (APFC PANEL)

- APFCpanel shall be floor mounting, free standing, compartmentalized, extensible, modular type suitable for indoor installation
- The panel shall be IP 52 for metering and switchgear module and shall be IP 42 for reactor/capacitor section. Full partition shall be provided between switchgear components and capacitor section. Each feeder module shall be fully compartmentalised. Capacitor/reactor shall be mounted in separate vertical section/cubicle adjacent to switchgear cubicle instead of mounting at the rear end/backside of switchgear module as per availability of space .
- The control equipment including capacitors shall be mounted in a panel made of 2 mm CRCA sheet. Panel shall be fully compartmentalised, extensible and with main bus bars in horizontal bus bar alley.
- Capacitor feeder rating shall not exceed 100 kVAr rating.
- Ammeter, ASS and CT shall be provided in 50 kVAr and above rating feeder to measure capacitor current.
- APFC panel control logic shall be such that when DG is ON, APFC panel is OFF and shall become automatically ON when the Grid power/utility power is restored.
- APFC panel shall be operated on AUTO and MANUAL mode. Individual capacitor feeder shall be possible to be operated on AUTO/MANUAL mode even when A/M switch in incomer feeder is on AUTO Mode.
- All capacitors shall be heavy duty MPP/Heavy duty Gas filled with discharge resistor and as per the technical data sheet provided here in.
- For capacitors **≤ 5** KVAr ratings ONLY, all types, viz. APP/MPP/Gas Filled capacitors are acceptable.
- Heavy duty exhaust fan 6”/8” (shall be continuous duty, metal housing with metal impeller) with canopy shall be provided at the top. Louvers with wire mesh (up to maximum 1 mm opening) shall be provided at the bottom end of capacitor section. Minimum 1 number of fan shall be provided per meter length of panel or part thereof or more numbers as required.
- Minimum distance between two capacitors and from all sides of panel enclosure (including terminal) shall be 25 mm.
- Earthing terminal of capacitor shall be connected to earth bus bar.

The Automatic control panel/Fixed Capacitor panel (for Transformer compensation) shall comprise of the following.

- MCCB for protection of each capacitor bank (MCCB should be suitable for capacitor switching and kA rating shall be as per main panel kA rating).
- Incomer MCCB shall be TPN, Microprocessor based/Thermal magnetic (adjustable O/L and Adjustable S/C) as per LV panel specifications.
- APFC relay shall be microprocessor based with inbuilt RS 485 for sensing and correcting the power factor of the system with required number of steps to achieve the specified power factor. Minimum operating current/sensing current shall be 10 mA/10% of load. Minimum 2 numbers additional spare relay contact shall be available for future use.
- Two numbers vacant feeders with mounting plate and cutouts shall be provided for future use.
- A/M switch with Auto/Manual indicating lamps shall be provided in addition to R Y B indicating lamps.
- Each outgoing capacitor feeder shall be provided with suitably rated MCCB, capacitor duty contactor with inrush damping resistor, A/M switch, 'ON' and 'OFF' push with ON, TRIP, AUTO indication lamp, ON delay timer (only for Manual mode of individual feeder), 440 V capacitor unit with discharge resistor. Control circuit of individual feeder shall have control MCB for protection and indicating lamp shall be only through auxiliary contact.
- All outgoing MCCB feeders shall be 50 kA, Ics = 100% Icu, with Trip indication/Fault signal contact, with extended Rotary Operating Handle, Any other components required for satisfactory and safe operation shall be provided.
- Capacitor shall be compact in size and hermetically sealed. In built fuses and surge suppressors shall be provided for protection of each capacitor element.
- Capacitor banks shall comprise identical delta connected three phase units. Capacitor banks shall be non-flammable, non-toxic, Non-PCB, Dry Technology, Inert Gas (N_2)/PU resin impregnated, MPP heavy duty type/Gas filled.
- Only one wire shall be connected to each contactor terminal i.e. whenever more than one capacitor is controlled from contactor suitable size bus bar strip shall be provided and power shall be tapped. Else separate contactors shall be used for each capacitor unit.
- **If load is VFD driven and working VFD driven load is more than 50% of total load or if required as specified in BOQ, then APFC panel shall be with detuned reactors. 7% detuned reactor, 440 V, Al wound with thermostat shall be provided in series with capacitor unit. Capacitor voltage shall be 525 V or as specified in BOQ and kVAr rating suitable for reactor kVAr rating. Filter rating (Reactor + Capacitor) shall be rating of APFC panel.**
- Except for the specific requirements of APFC panel specified here in, rest all specifications shall be as per LV panel/MV switchboard specifications specified above.
- Capacitor rating generally shall be at 525 V if provided with detuned reactor or as specified in BOQ and APFC Panel shall conform to IS: 16636 (2017).

Three Phase Filter Reactor

Anti resonance three phase filter reactor, Aluminium wound, 440 V detuned reactors (5.67% or 7%) as required are to be used in series with shunt capacitors to prevent harmonic resonance and harmonic overloading of capacitors, transformers, whenever power electronic equipment (Drives, UPS etc.) producing nonlinear currents are used. Detuned systems shall be such that the self resonant frequency is below the lowest line harmonic.

Features of Reactors

- High linearity, low losses and noise level
- High over loading capability
- Inbuilt temperature micro switch

Micro switch potential free contact shall be used in control circuit of respective capacitor feeder to trip the contactor in case of high temperature.

Reactor shall be kept in independent cubicle and adequate ventilation shall be provided.

Power Factor Correction Thyristor Switch Module

Thyristor switching instead of contactor switching shall be used when load variation is rapid. Semi conductor fuses shall be used for protection of Thyristor switches in addition to MCC BHRC fuses shall not be used. Discharge reactors shall be used for fast discharge for fast reconnection of capacitor.

Technical Features

- Suitable for real time power factor correction
- Switching time less than 5 milli seconds
- PIV: 2200
- Permanent self controlling of Voltage parameter, capacitor current, temperature of the thyristor switch
- Suitable for manual operation also
- Automatic switch off in case of over current and over temperature
- Display of: Operation, Faults, Activation.

APFC Controller with RS 485

Microprocessor based intelligent control, menu driven, single/3 CT sensing, 5 A CT selectable with RS 485 communication port and features as below.

- Display: LCD illumination, large and multi functional characters. Parameters: Voltage, monitoring of individual capacitor currents, Real time PF, Power kW, kVA, kVAr, Temperature, Energy KWh, KVAh, KVARh
- Steps: 4, 6, 8, 12,16 as required
- Mounting: Panel mounting (size: 144 x 144 mm)
- Current input: 1 A or 5 A selectable
- Operating temperature: 0 to 60 ^{0}C
- Supply voltage: 230V AC
- Target PF: 0.8 inductive - 0.8 capacitive.
- Minimum operating current: 10/50 mA
- Sensing: Single/3 CT, 3 CT sensing for unbalanced load.
- Dual target power factor setting: for utility and DG mode operation.
- Facility of including "Fixed capacitor bank" for purpose of transformer compensation. This can be set such that the controller doesn't 'see' this capacitor.
- Potential free contacts/alarm output: Insufficient compensation, over compensation, under current, over current, over temperature, harmonics exceeded.
- Suitable for Thyristor switching if Thyristors are used instead of contactor.

- **Minimum rating of MCCB, Cable/flexible wire size for capacitor feeder shall be as below.**
- **Cable Size Selection Chart (Minimum)**

Sr. No.	Capacitor Rating (KVAr)	MCCB Rating (Amps)	FRLS Copper Cable/Wire size (mm²)
1	Up to and including 5	16	2.5
2	10	32	4
3	12.5	32	6
4	15	63	6
5	20	63	10
6	25	63	16
7	30	100	25
8	40	125	35 mm²/Busbar from bus to MCCB
9	50/60	160	50 mm²/Busbar from bus to MCCB
10	75	200	70 mm²/Busbar from bus to MCCB

CAPACITOR DATA SHEET

Sr. No.	PARAMETER	Unit	
	Capacitor Type		Heavy duty MPP/Heavy Duty Gas Filled
1	Conformance to Standards		IS: 13340/IEC 60831
2	Rated Voltage	V	440/525 as required/Applicable
3	Inrush Current	A	Up to 200 Ir
4	Maximum Permissible Current/ Over Current	A (Imax)	1.5 Ir
5	Maximum permissible Voltage/ Over Voltage	V (Vmax)	1.1 Vr
6	Temperature Class	^{0}C	60
7	Losses (per phase)	W/kVAr	Dielectric: less than 0.2 Total : less than 0.5
8	Capacitance Tolerance		-5% / + 10%
9	Dielectric		Poly Propylene
10	Impregnation		Non-PCB PU Resin/Inert Gas Nitrogen
11	Number of Switching Operation		5000 as per IEC 60832
11	Useful Life	Hours	125000 Minimum
12	Maximum THD in Voltage		3%
13	Maximum THD in Current		15%

Note: Rest all construction features and other requirements shall be as per the specifications of LV Panel.

Test and Test Reports

- All tests shall be conducted in accordance with the latest edition of IS: 2834 and as applicable for controls.
- Type test certificates for similar capacitor units shall be furnished for review and acceptance.

Drawings to be submitted for the approval of the Client/PMC/TPI

- GAD of APFC panel with elevation side view, sectional view and foundation details.
- Complete schematic and wiring diagrams for capacitor control panel.
- Detailed BOM and GTP.
- Manufacturer technical data sheet of capacitor and APFC relay.

4.3 INDUCTION MOTOR

Scope

This specification covers the design, manufacture, inspection, testing at works, supply, delivery to site, installation, testing at a site and commissioning of three phase, squirrel cage, solid shaft induction motors with all accessories for driving various pumps/equipment required for the complete operation of the plant as per the scope of this work. All motors shall be as per these specifications unless for any other more stringent requirements mentioned elsewhere.

Codes and Standards

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the IS: 12615 (2018)/IEC 60034 amended up to date.

General Design and Constructional Requirements

Motors shall be continuous maximum rated as per IS: 12615 (2018) and IS: 4722 (latest edition) and preferably be designed for low starting current and smooth acceleration except for cases where the driven equipment characteristic demand otherwise. Motors shall be of 4/6/8 pole design as required and provided with terminal box large enough to accommodate armoured PVC/XLPE insulated Aluminium conductor cable of appropriate size/ratings. Motors shall be of energy efficiency class IE3 as per IS: 12615 (2018).

All motors shall be foot/flange mounted or as per pump/driven equipment coupling requirements and squirrel cage induction type and shall be capable of developing at least minimum 10% more power than demanded by the Pump/Submersible Pump or driven equipment over its duty point of operation.

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

Required BKW of Pump/Submersible Pump/Driven Equipment	Minimum multiplying factor to arrive at motor rating
Below 7.5 kW	1.3
7.5 kW and above but below 15 kW	1.2
15 kW and above but below 75 kW	1.15
75 kW and above	1.10

Operating Conditions

1) Frequency and Voltage Variation

All LV motors shall be squirrel cage motor and the motor shall be suitable for the following.

Supply Voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage Variation	:	± 10%
Frequency Variation	:	± 5%
Combined Variation of Voltage and Frequency	:	± 10%
Design Temperature	:	50 ^{0}C

2) Starting

a) Unless otherwise specified, motors shall be designed for direct-on-line starting.
b) Motors shall be designed for re-acceleration under full load after momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of motor shall be less than the hot thermal withstand time to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.
d) The motors shall be suitable for starting under specified load conditions with 75% of rated voltage at the motor terminals.

3) Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. When a motor is provided with bi-directional fans, a double headed arrow should be provided.
Normally clockwise rotation is desired as observed from driving (coupling) end. Ample space shall be provided in terminal box for interchanging any two external leads for obtaining reverse phase sequence.

Perormance

Motors shall be rated for continuous duty (S_1) unless otherwise specified. For hoist/crane shall be S4 duty.

All performance characteristics shall be as per IS: 12615 (2018) or latest revision and the torque and other specific requirement shall be selected by the concerned equipment vendor to suit the application.

Construction Details

Motor Casing and Type of Enclosure

Motors for use in safe area shall be of industrial type meeting the specified ambient conditions, starting and operating requirements. Motors for use in hazardous areas shall have type of protection Ex-d or other as per area classification and to meet requirement of applicable Indian Standards.

The motor enclosure including terminal boxes and bearing housing shall have IP 55 degree of protection.

Motor casing shall be provided with a suitable drain for removal of condensed moisture for motors operating in safe area.

All vertical motors shall be provided with suitable canopies covering the motors fully. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the NDE.

Motors shall have standard frame sizes for various output ratings as per IS.

Motors installed in outdoor areas shall be provided with FRP type canopies/covers of 2 mm thick.

All external surfaces of the motor and its canopy shall be given a coat of epoxy based paint shade 632 as per IS.

Insulation and bracing

Unless otherwise specified, motors shall be provided with class F insulation with the permissible temperature rise above the specified ambient temperature shall be limited to that of class class B. **VFD operated motor shall be with Class H insulation with temperature rise limited to Class F.**

The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmosphere.

Windings shall be adequately braced to prevent any relative movement during operation. Overhung of winding shall be double coated with epoxy gel.

However, motors operating with Variable Frequency Drive shall have winding and other features as follows.

- Winding shall be double insulated, vacuum impregnated.
- Winding shall have class H insulation.
- Motors rated 90 kW and above shall have forced cooling arrangement and for motors rated less than 90 kW, frame size shall be suitably selected for effective heat dissipation.
- Motors shall be suitable to continuously operate within 30% to 100% speed range variation.

Phase Connections and Terminal Box

The windings shall be connected in Delta. The ends of the windings shall be brought out into a terminal box. All motors shall be with six terminals and suitable links to connect them in star or in delta. Motors rated up to and including 2.2 kW which may be accepted with three terminals. The terminal box shall be located on the RHS as viewed from driving (coupling) end (for motors above 3.7 kW). The terminal box shall be rotatable in steps of 90 degree to allow cable entry from any direction. An adequately sized earth terminal shall be provided in the motor terminal box. Terminal box shall be provided at the side of the motor.

Bearing and Lubrication

Motors shall have grease lubricated ball or roller bearings with minimum L-10 rating life of 5 years (40,000 hours) at rated operating condition. Bearings shall be capable of grease injection from outside without removal of covers with motors in running condition. Necessary seal to prevent entry of dust/moisture and loss of grease shall be provided. Grease nipples shall be provided with appropriately located relief devices which ensure passage of grease through the bearings.

VFD operated motor shall be considered with insulated bearings for motor rating 90 kW and above (not applicable for package product like turbo blower etc.).

Cooling System

All motors shall be self-ventilated, fan cooled. VFD operated motors shall be VFD duty.

Rotor

The motor shall be squirrel cage type, dynamically balanced to provide a low vibration level and long service life of the bearings.

Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

Lifting Hook

All motors weighing more than 30 kg shall be provided with lifting hook of adequate capacity.

Earth Terminals

Two earth terminals of adequate size, located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

Accessories

- Anti condensation heaters of 240 V, single phase, shall be provided for motors rated 30 kW and above. Heaters shall remain ON when the motor is not in service and as such shall not cause damage to the windings. Heaters shall be metal encased with a low surface temperature.

- RTD/BTD: 2 number per phase and for bearings both drive end and non driven end shall be provided for motors rated 90 kW and above, suitably terminated in auxiliary terminal box. Separate terminal box shall be considered for space heater and RTD/BTD.

- **Name plates shall be provided on each motor as per IS/IEC.**

- **Noise level and motor vibrations shall be within the limits as laid down in IS.**

- **Special application motor for higher pump RPM than motor: For special applications like high pressure RO pumps etc. where in the pump RPM selected are more than motor RPM, such motors shall be driven by VFD only**

to achieve higher motor RPM as per pump RPM and the de rated motor torque at such higher RPM shall be more than pump torque requirement with minimum 10% safety margin or higher as recommended by pump vendor. The motor for such application shall be de rarted and offered with required higher frame size/rating a recoomnded by motor vendor and shall be sutiable for VFD duty requiremnts specified.

Notes:
The motor and make of motor as per manufacturer standard shall be acceptable for following

- The TEFC squirrel cage induction type drive (motor) for imported equipment coming as part of equipment from outside country. However same shall be generally meeting the IE 3 efficiency class requirements.
- DC motors (e.g. Turbo Blowers etc.)
- Motor for special applications: Braking application like mechanical screens, EOT Crane Hoist/Electric Hoist, Electric Actuators, SBR Decanter etc.

Motor Testing

Testing of motors shall comply with the requirements of IS: 4029/IS: 15999.

Motor shall be subjected to all routine tests as per IS: 12615 (2018)/IS: 15999 applicable standard with latest amendments internally and the required routine test certifictes shall be provided to Client/PMC/TPI agency for review and acceptance. Type test certificate of identically rated motor (not older than 2 years) shall also be furniehd by OEM/manufacturer to Client/PMC/TPI agency for review and acceptance.

One job motor of each rating shall be subjected to performance testing with pump/driven equipment for rating as specified in mechanical specifiaitons for witness of pump/blower or other applicable equipment.

Drawings
The contractor/manufacturer shall submit the following documents for review and approval.

- GAD and Preliminary outline dimensional drawings showing details of motor, Terminal box etc.
- Typical cross sectional drawing showing constructional details with complete bill of materials and relevant standards.
- QAP, Performance curves, Marking and labeling plate details..
- Data Sheets/Guaranteed Technical Parameters.

4.4 CABLES

All power and control cables for use on medium/high voltage shall be heavy-duty type, multi strand aluminum/copper conductor. PVC/XLPE insulated, Extruded inner sheathed, armored and overall PVC sheathed as described below.

The Power and Control cables shall have the following minimum overall cross sectional areas.

a.	Meduim Voltage Power	6 sqmm (Aluminium) / 2.5 sqmm (Copper)
b.	Control Cables	2.5 sqmm (Copper)
c.	Lighting Cables	2.5 sqmm (Copper)/6 sq mm aluminium

Cables shall be sized based on the maximum continuous load current and the voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other etc. shall be taken into account.

All power and control cables shall be of continuous lengths without intermediate joints. Where joints are unavoidable, these shall be provided with the permission of Engineer-in-charge. All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible.

Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per IS.

A Deleted.

B LV POWER and CONTROL CABLES

- The scope shall cover supply, laying, testing and commissioning of medium voltage XLPE cables.
- All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

XLPE Insulated Power/Control Cables (Medium Voltage)

1.1 kV grade Stranded Alluminium/Copper conductor, XLPE insulated, Extruded Inner sheath, GI Strip/wire armoured (Aluminium armoured for Single core cable) LV XLPE cable as per IS: 7098 (part I) with latest amendment.

RTD/BTD/Signal Cables

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between Panel/Control Room and the Units/Motors. Specifications for cables for RTD/BTD/Analog signals shall be as follows:

Cables shall be of 660V/1100V grade, single/multi-pair/Triad/Core cables as per requirement. Triad/Multi Core Signal cables shall be annealed, tinned, high conductivity 0.5/1.0/1.5 sq.mm stranded copper conductor, Polyester tapped PVC insulated nos. of cores twisted into pair, laid up collectively, individual pair/triad shielded and overall shielded with aluminum mylar tape, armoured with galvanized steel wire/strip, overall sheathed with PVC, conforming to IS: 1554 and IEC:189 Part II.

Splicing and Termination

- Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved polycarbonate type connectors. No joints shall be allowed within the conduit pipes, cable entry pipes or ducts for cable laying and wire pulling.

Testing:

Cables shall be tested in accordance with IS: 7098.

Finished Cable Tests at Manufacturers' Works

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of Client's representative.

1. **Voltage Test**

   Each core of cable shall be tested at room temperature at 3 kV AC RMS for duration of 5 minutes.

2. **Conductor Resistance Test**

   The DC Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20 ^{0}C to check the compliance with the values specified in IS: 8130 (1976).

Cable Test before and after laying of cables at site:-

1. Insulation Resistance test between phases, phase to Neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Sheathing continuity test.
4. Earth resistance test of all the phases and neutral.

Sealing and Drumming

- Cable shall be supplied in non-returnable drums as per IS: 10418 standard. Cable identification details like Voltage, size, name, etc. shall be written on Drums also as per IS.

C Cable Accessories

All accessories like cable glands, lugs and terminal markings etc. shall be used conforming to relevant standards/as specified. The end termination for HV cables shall be heat shrinkable type. For 1100 V grade cables, Ni-Plated Brass Double Compression type glands WP to IP-65 as a minimum and tinned copper crimping type lugs shall be used.

D Cable Laying

HV, MV and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cable trays depending on location and area of laying.

Below ground cables in paved areas shall be in brick lined trenches with concrete covers having proper slope and suitable drainage arrangement to avoid water collection. In unpaved areas cables shall be in lined trenches or directly buried in gound. In hazardous areas and transformer bays, trenches shall be completely filled up with sand. Concret lined cable trenches shall be sealed against ingress of liquids or gases wherever the trenches leave a hazardous area or enter control room or substation. The cable trenches shall be sized depending upon the number and voltage grade of cables. Where underground cables cross roadways, pipe sleepers at grade, etc., they shall be protected by being drawn through PVC/RCC/DWC pipes of suitable size to provide a permanent crossing. Pipes laid for mechanical protection shall be sealed at both ends.

High voltage, medium voltage, control and signal cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays as applicable. Cable trays, racks and trenches shall be sized to allow for 20% future cables. Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.

Cable route markers shall be installed at every 30m interval all along the routes of directly buried cable trench and also at locations where the direction of cable trench changes.

Cable Laying and termination shall be such that chances of cable getting damaged are remote. LV cable shall be laid on tray racks or burried underground with appropriate protection depending on location and area of laying them.

Black shall indicate the neutral, while red, yellow and blue for three different phases. All LV cables when laid on the cable trays and racks shall be properly dressed and clamped as required without crisscrossing and unnecessary overlapping. Cables shall be properly dressed and clamped.

Laying of HV and LV under ground cables

Minimum depth of cable trench shall be 750mm for LV cables and 900mm for HV cables. The width of cable tranch shall be as per actual site requirement ie depending on number of runs, outer dia. of cables, separation bricks for HV/LV power, control and instrumentation cables alongwith wall (edge) clrearance. The cables shall be protected by filling trench bottom with a layer of sand after clearing the bottom from all rocks, stones and sharp objects, before the cables are placed. The sand shall be leveled and cables laid over it. Such laid cables shall be covered with minimum 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective cover of second class red bricks **{standard dimensions: 225 mm (L) x 112.5 mm (D) x 75 mm (H)}** shall then be laid and compacted and then remainder of the trench shall then be backfilled with soil, rammed and leveled.

In routing, necessary barriers and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angles and these two shall not run in close proximity.

LV cables shall be bent in radius not less than 12 times their individual overall diameters, while HV cable shall have bends not less than 15 times their individual overall diameter.

Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 Deg to the trench wall. Bending radii of pipes shall not be less than 8D. It is ensured that both ends of the GI pipe sleeves shall be sealed with approved WP sealing plastic compound after cabling. In places where it is not possible, cables shall be laid on smaller branch trays.

All cable shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tags shall be punched on aluminium straps (2mm thick, 20mm wide of enough length) securely fastened to the cable and wrapped around it.

Routes of these cables shall be arrived at on the basis of the relevant drawings and after consulting the Engineer-in-charge.

E Drawings and Schedules

Size of cables shall be given in singe line power diagrams. A cable schedule shall be prepared on the basis of relevant drawings. All cables and wires shall be adequately sized to carry continuously the normal currents expected on the relative circuits. All trenches for electrical cables shall be separate from water or sewage pipe line trenches.

F Splicing and Termination

Straight through joints shall be avoided. In case, these are absolutely necessary they shall be made at convenient locations suitably protected as approved and sanctioned by the Engineer in charge but in no case within the conduit pipes or ducts. Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved porcelain connectors.

Cables shall be tested in accordance with IS: 1554 (7098).

4.5 SPECIFICATION FOR OTHER EQUIPMENT AND ACCESSORIES

This defines specifications and requirements mainly for the equipment and accessories, which are generally supplied by the erection agency.

All materials, accessories, consumable to be supplied by the contractor shall be selected from the list of specified make and shall conform to the specification given here under.
The equipment shall be manufactured in accordance with current Indian Standard specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification, the materials shall be as approved by the Client/Consultant.
All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be approved vender list of tender.

Cable Trays

These shall be channel type, fabricated from structural steel, hot dip galvanised, complete with all accessories such as bends, tees and reducers.
MS/Aluminium flat clamps with GI/Chrome plated bolts, nuts/screws to be used for clamping cables.
Sizes of these trays shall be as specified in SOQ/drawings or approved by client.
Size 150mm and above shall be ladder type and below 150mm shall be perforated type.
Collar size of the ladder type cable tray shall be 100mm and 50mm for perforated type.

Cable Glands

Cable glands shall be heavy duty double compression type of Ni-Plated brass. These shall be suitable for armoured/Unarmoured cables, which are being used.

Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/aluminium alloy, suitably tinned, solder less, crimping type.

These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

Cable Indicators

All cables shall be identified by cable tag of 2mm thick, 15mm wide of enough length of Aluminium straps securely fastened to the cable. PVC identification number, ferrules shall be used for each wire.

GI Pipe for Cables

For laying of cables under floor, Medium Duty GI/uPVC/RCC pipes shall be used.
Pipe shall be laid at on angle of maximum 45 degree to trench wall. Both ends of pipe shall be sealed with approved WP Sealing plastic compound after cabling work.
Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe.
To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

4.6 INTERNAL AND EXTERNAL ILLUMINATION

General

The illumination system shall consist of lighting poles, lighting distribution boards, lighting panels/power panels complete with FSU/ELCB/MCB, fixtures, cables, junction boxes, terminal blocks, cable glands, 3 pin 5 A/15 A convenience socket outlets, conduits and accessories and supporting and anchoring materials, lighting fixtures with LED/fluorescent tubes, sodim vapour lamps, wires etc. All materials, fittings and appliances use in electrical installation shall conform to the relevant IS specifications, required area classification and environmental conditions and shall be anticorrosive painted/FRP enclosures.

The wiring for lighting circuits shall be done by wires run in PVC conduits for indoor areas. For outdoor lighting, wiring shall be done by armoured cables.

Illumination Level

The following minimum levels of illumination (average lux level) shall be provided in the respective areas.

	Area/Building	Illumination Level
a)	Pump House/Centrifuge or Press Area/ Sheds/Blower Room	150 Lux
b)	Control Room/Laboratory	300 Lux
c)	Office	200 Lux
d)	Switchgear/MCC Rooms	200 Lux
e)	Sub Station (Switchyard)	50 Lux
f)	Toilet Block/Wash Room etc.	100 Lux
g)	Roads/Walkways	10 Lux
h)	Yard/Outdoor Area	10 Lux
i)	General Process/Outdoor Equipment Area	100 Lux

The lighting fixtures offered shall comply with the following requirements.

a) Luminaries shall have high efficiency Lumen Output/Watts.

b) Enclosures shall preferably be FRP/Cast Aluminium with corrosion resistance paints.

c) All indoor and outdoor lighting fixtures shall be power saving long life LED type only.

All lighting fixtures shall be supplied complete with control gear and lamps. Special fixtures, wherever required to meet operational requirements, aesthetics etc. shall also be provided by the Bidder. Make of lighting fixture shall be embossed on each lighting fixture.

Lighting wiring between LDB/SB and lighting fixtures shall be done by PVC insulated, Copper wire (phase, neutral and earth) for non plant buildings which shall be through surface run/concealed conduit. All lighting cables shall be 3C x 2.5 sq mm, 660/1100 V grade, Copper conductor, PVC insulated, armoured type. Conduit wiring shall be done in 25 mm dia. minimum 16 gauge black enameled steel structure conduit or PVC concealed conduit with 1100V grade PVC insulated copper wire of minimum size 2.5 sqmm for fixtures/5A receptacles and 4 sq mm for power sockets. Not more than 7 wires shall be accommodated in each conduit. All lighting fittings/convenience outlets shall be earthed through the third wire/separate core in conduit/cable.

On walkway, platforms and other outdoor areas, lighting fixtures shall be nearer to landing of stairs or ladders, gauges, flow meters, panel boards or other equipment requiring good illumination. In outdoor equipment area at ground level, lighting fixtures shall be mounted preferably 4 meter above floor level. Where this is impractical, the minimum height of any lighting fixture shall not be less than 2.5 meter. Socket outlets in process plant areas shall be approximately 1200 mm above floor level and 300 mm above floor level in office area. Lighting/power panels shall be mounted such that the top of the panel ie 1800 mm above finished grade. Control gears of lighting fixtures with separate control gear shall be mounted at suitable height from ground/platform for easy access/maintenance.

All lighting circuits and convenience receptacles shall be fed from lighting/power panels. Main/Lighting Distribution Board (MDB/LDB) shall be dust and vermin proof and shall be provided with SFUs (HRC)/MCCB as incomer and outgoing feeders where fault level is more than 9 kA.

Main and Branch Distribution Boards

Each main DB should be provided with 4 pole isolator as incomer and DP ELCB+MCB as outgoing circuit in each phase and all sub DBs should be with Isolator + ELCB as in comer and MCB as outgoing to control and for protection of lighting circuits. All DBs should be double door type – a hinged door to cover the operations knobs shall be provided. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% MCB in each panel shall be kept as spare. Power and lighting panel shall be of 16 gauge sheet steel construction and shall be suitable for surface or flush mounting.

All outdoor lighting shall be automatically controlled by means of synchronous timers with manual override control. Normally about 8-10 fixtures shall be wired in each circuit. Lighting feeders requiring automatic control shall be provided with contactors of suitable rating.

Sufficient number of three pin type 5 A/15 A receptacles as per IS: 1293 shall be provided. Flush mounting type receptacle shall be used where concealed wiring has been adopted and surface type shall be used for other areas. For exhaust fans and wall mounted air cirucaltors, socket and switch enclosure shall be separate whereas for rest receptacle and controlling on/off switch shall be mounted in the same enclosure. In building such as sub station, DG shed, workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. The sockets shall be supplied complete with plugs.

Adequate number of ceiling fans of 1200 mm sweep (with double ball bearing and regulator) shall be provided in offices and rooms allocated to operating and maintenance personnel etc. In places where ceiling fans are provided, lighting fixtures shall be suspended below fan level with the help of conduits/chains to avoid shadows on the floor.

Minimum 2 number or sufficient exhaust fans as required during detailed engineering/ recommended by equipment manufacturer shall be provided at battery room, laboratory room, sub station/switchgear-MCC room, DG room, all pump houses, filter house etc. The exhaust fans shall be provided with louvers/net to prevent insects. For pump house below ground level, suitable GI ducts for exhaust shall be provided as decided during detailed engineering and instructed by Engineer-in-charge.

Lux levels shall be maintained at various locations as indicated above and shall be backed up by calculations from manufacturer.

Switch Box

Switch Box shall be made of metal on all sides, except on the front.

In the case of cast boxes, wall thickness shall be at least 3mm and in case of welded mild steel sheet boxes the wall thickness shall not be less than 18 gauge for boxes, up to a size of 20 cm x 30 cm and above this MS boxes having minimum sheet thickness of 1.6 mm shall be used. Switch boxes shall be galvanized after fabrication. Except where otherwise stated 3mm thick phenolic laminaged sheets like summica shall be fixed on the front with brass screws. Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators inflush pattern. All fittings shall be flush pattern. It shall be provided with adequate number of knock outs on all sides for ease of wiring either with conduits or without conduits.

Wiring/Conduit System

Surface Conduit Wiring System

PVC conduits pipes of approved minimum 1.6mm wall thickness shall be used. The minimum PVC conduit diameter shall not be less than 25mm. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sq mm/1.5 sq mm respectively.

In long distance straight run of conduit, inspection type junction box at reasonable intervals shall be provided.

Fixing of Conduit

Conduit pipes shall be fixed by heavy duty GI pressure saddle with screws in an approved manner at an interval of nore more than one metre but on either side of the couplers bends, or similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddle should not be less than 20 gauge for conduits.

Where conduit pipes are to be laid along the trusses, steel joints etc. the same shall be secured by means of ordinary clips or girder lips as required by the Engineer-in-charge. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girders clips and clamps shall not be less than as stated below.

Recessed Conduit Wiring System

Recessed PVC conduit wiring system shall comply with all the requirements of surface conduit wiring system specified in clauses above and in addition to the requirements specified in the following clauses.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, fixed work, specials care shall be taken to fix the conduit and accessories in position along within the building work, to avoid damage to the finished wall etc.

All outlets such as switches, wall sockets etc. shall be flush type.

The outlet box shall be same as above and shall be mounted flush with the wall. The metal box shall be efficiently earthed with conduit by an approved means of each attachment.

To facilitate drawings of wire in the conduit. GI mesh wire of 10 SWG shall be provided while laying of recessed conduit.

Lighting Poles

Steel Tubular swaged type

Street light poles shall be steel tubular swaged type made from GI pipe conforming to IS: 1239 medium class and made as per IS: 2713.
Street light pole, steel tubular swaged type, 9 / 7.5 / 6 meter long (6/4.5/3.0 m x 1.5 m x 1.5 m) 139.7 mm, 114.3 mm, 88.9 mm dia. respectively and 4.85 mm, 3.65 mm, 3.25 mm thick respectively, with MS base plate.

Steel Octagonal Type

Steel octagonal pole with base plate made from CR sheet steel. The pole should be made as per IS and shall be coated with hot dip galvanizing as per IS: 2629/4759 with required base plate and suitable to sustain local wind speed.

Lighting poles shall be of octagonal poles made from sheet steel confirming to BSEN 10025. Internal and external surface of octagonal pole shall be hot dip galvanized to minimum 65 micron DFT. Octagonal poles shall be provided with base plate and provision for fixing foundation bolts. Base plate shall be as per IS: 2062. All poles are tapered octagonal and shall be in single section.

The street light poles shall have minimum 6.0 m height, Top dia. – 70 mm, Bottom dia. – 130 mm and 3 mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 200 mm x 200 mm x 12 mm.

The Flood light poles shall have minimum 9.0m height, Top dia. – 70 mm, Bottom dia. – 155 mm. and 3 mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 260 mm x 260 mm x 16 mm.

All poles shall be supplied along with pipe cap, single/double arm of 1/0.5 m height and over hung 1/1.5 m long GI pipe having dia. to suit the socket of 250/150/70 W etc. 240V, HPSV/LED/MH/HPMV lighting fixture as applicable and with

1. PVC junction boxes on pole with 8 way connector and 1 no. 4 A SP MCB.
2. Street light pole shall be as per approved drawings.
3. Internal pole wiring with 3 core 1.5/2.5 sq mm flexible stranded copper conductor, FRLS insulated wire from junction box to up to Street light/Flood light/fixture as required.

Balancing of Circuits
The balancing of circuits in three phase installations shall be arranged before hand to the satisfaction of Engineer in charge.
Drawings

All wiring diagrams shall indicate clearly in plan, the main switch board, the distribution fuse board, the run of various mains and sub mains and the position of all points with their classification.

Rating of Lamp, Fans, Socket Outlet Points and Exhaust Fans

Lamps installed in pump house and other means shall be LED Type only.

Table fans and ceiling fans shall be rated at 60 watts. Exhaust fans shall be rated according to their capacity.

5 amps. socket outlet points and 15 amps. socket outlet points shall be rated at 100 watts and 1000 watts respectively, unless the actual values of load are known or specified.

Capacity of Circuits

Lights and fans may be wired on a common circuits, such circuit shall not have more than a total of ten points of light, fan and socket outlet or a load or 800 watts whichever is less.

Power circuits on buildings shall be designed with a maximum of two outlets per circuit, based on the loading.

Where, not specified the load shall be taken as 1 kW per outlet. Wherever the load to be

fed is more than 1 kW it shall be controlled by an isolator switch or miniature circuit breaker.

Indoor and Outdoor Light Fixtures/Lightings (LED LIGHTING)

LED fixtures shall be generally having following.

- LED luminous Efficacy lumens/watt : 100% minimum
- Efficiency of Electronics System : 80% - 85% minimum
- LED Lamp/Light Efficiency : 85% - 90% minimum
- Total Harmonic Distortion : For Outdoor Fittings: ≤ 20%
  For Indoor Fittings: ≤ 20%
- Power Factor : ≥ 0.85
- Colour Rendering Index (CRI) : ≥ 70
- Colour Temperature/Apparent : ≥ 5700K (Cool day light)
- Radiation : No Ultra Violet (UV) or Infra Red (IR)
  : No RF to interfere with radio equipment
- LED Life : Long Life, generally 50,000 Hrs.
- RoHS compliant, Eco Friendly green technology, Mercury free.
- Outdoor LED fixtures must be fully enclosed with minimum IP Rating of IP 66/65 (Weatherproof). LED optical system must be gasketed (enclosed) to minimize light dirt depreciation.
- Electrical safety for outdoor LED Lights shall be of Class I.
- Luminaries must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable - CSA, UL etc.).

Industrial Luminaire

Indoor LED wall mounting Industrial Luminaire shall be LED Type minimum 10 watt to 48 Wattage.

Each fitting shall be required LM 79 and LM 80 Certificates.

Tube light shall be 20 Watt or higher wattage with integral/non integral driver, Surge 4KV, IP 20, 4 feet with LEDs of wattage 0.2 Watt to 0.5 Watt assembled on single MCPCB with housing used as a heat sink shall be made of thick sheet steel conforming to IS: 513/CRCA polyester powder coated and high UV and corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name.

120 to 300 V, Power Factor more than 0.9, THD < 20%
CCT 4000 K to 6500K, Uniformity Ratio > 0.7,
Luminaire Efficacy > 85 lumens/watt ,
LED Driver Efficiency > 85 %

Fixtures shall be with earthing arrangement facility suitable for ceiling or pendant mounting suitable for 19 mm conduit with stove enameled reflector gray outside and white inside which can be installed without aid of any tools, complete in all respects and ready for use.

Emergency Light

Emergency light unit working on 230 volts AC supply shall be self containing LED type of minimum with 20 watts 600 mm long type 'SWITCH ON MAIN FAILTURE. It shall be electronic automatic type which incorporates a unit trickle charge circuit, which shall prevent over charging or battery The battery shall be maintenance free. The unit shall provide 4 hours illumination following power failure. The units shall generally conform to IS: 9583.

Gate Lights

The gate lights shall be post top lantern LED type, weather proof and shall be suitable for use with one number 40 watt LED and asthetics appearance shall be as per approved by Client/PMC/TPI.

Post Top Lantern LED fitting comprises of Copper dust finish cast aluminum spigot and spun aluminum canopy fixed with opal polycarbonate, pipe arrangement for vertical mounting,open construction driver and accessories wired upto terminal block.

The post top lantern shall be suitable for use with one number 40 watt LED.

GI pipes of suitable dia. shall be provided at gate concrete pillar as conduit for wiring and fixing post top lantern luminaire

Outdoor Yard/Road Lighting

Outdoor Luminaire

The luminaire shall be LED type with minimum 40 watt to 240 watt LED complete with all accessories and each street light/flood light industrial luminaire shall be IP 65 and Surge 4KV and shall be required LM 79 and LM 80 certificates.

LED outdoor street light/flood light/well glass industrial luminaire shall be with high power white LEDs wattage of 1 watt and above assembled on single MCPCB, efficiency more than

130 lm/w and corrosion free high pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/lenses with company mark/name engraved or embossed.

120 to 300 V, Power Factor more than 0.95, THD < 20%, CCT 5000 K to 5700 K,

Uniformity Ratio > 0.45, Luminaire Efficacy > 85 lumens/watt,
LED Driver Efficiency > 85 %.

The required parameters of LED fixtures have been enumerated above.

4.7 EARTHING SYSTEM

1 Earthing system design and installation shall generally be as per IS: 3043. All metallic non current carrying parts of electrical apparatus, current and potential transformer secondaries, columns, vessels, towers, stacks, storage tanks etc. shall be earthed at least by two distinct separate earth conductors from the earth plate connected to main earthing loop.

2 The main grid conductor shall be hot dip galvanized MS flat. The amount of galvanizing shall be minimum 610 gm per sqm. The main earth loop shall be laid at a depth of 500mm below grade level.

Earthing conductor shall be laid around the battery limit of the plant. Horizontal conductors shall be laid in both longitudinal and transverse direction to facilitate earthing of various equipment in most economical and reliable manner.

Cable trays in process areas shall be earthed with the help of risers emerging from main earthing conductors laid below/adjacent to structures carrying cable trays. Trays shall be earthed at an interval of approx. 30m and in any case shall be connected to the earthing grid at minimum two points.

Joints and tappings in the main loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape.

3 Adequate number of min. 65mm dia. or higher size as per IS: 3043, 3 meter long GI pipe earth electrodes with earth pit shall be provided. All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil.

4 Multiple earth connection shall be taken from suitably located earth plates connected to earth loop. All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment. Unless otherwise specified, earthing connections to individual equipment shall be done in accordance with standard equipment earthing schedule.

5 Lightening protection shall be provided for equipment, structures and buildings as per IS: 2309. Self conducting structures may not be provided with aerial rod and down conductors but shall be connected to the earthing grid at minimum two points of the base. An independent earthing network shall be provided for lightening protection and this shall be bonded with the main earthing network minimum at two points at the buried electrodes.

6 The resistance value of an earthing system to the general mass of earth for the electrical system and equipment shall be as follows.

a) For the electrical system and equipment a value that ensure the operation of the protective device in the electrical circuit but not in excess of 5 ohms. However, for generating stations and sub stations this value shall not be more than 1 ohm.

b) For lightening protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

7 **Connection**

The earth system connection shall generally cover the following.

Equipment earthing for personnel safety
System neutral earthing
Static and lightning protection
System neutral
Current and potential transformer secondary neutral
Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.
Steel structures/columns etc.
Cable trays and racks, lighting mast and poles
Storage tanks, vessels, and all other process equipment
Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)
Cable shields and armour
Shield wire

All main earthing shall be used for earthing of equipment to protect against static electricity.

All medium (LV) and high voltage (HV) equipment (above 250 V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.

All earthing connections for equipment earthing shall preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing.

Earth connections shall be made through compression type cable lugs/by welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

The reinforcements of sub station building and sub-station floor shall be connected to main earth grid.

The earth electrodes shall be situated at a distance not less than 3.0 m from the building fencing structure and equipment foundations. The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal. The distance between two electrodes shall not be less than twice the depth of electrode.

Minimum requirement of earth pits as per I. E. rules are as under.

Two numbers independent for transformer body.

Two numbers independent for transformer neutral.
Two numbers independent for four pole structure.

One number for lightning arrestors.

Two numbers for LV panel at sub station and at pump house.

The main earth electrodes after being driven into the ground shall be protected at the top by constructing a concrete or block masonry chamber of size 300 mm x 300 mm x height 300 mm shall be provided with CI cover. The resistance of any point in the earth continuity system of the installation to the main earth electrode shall preferably not exceed 1.0 ohm. The remaining space in the bore hole shall be filled with bentonite. The bentonite will hold the earth road in position. The neutral conductor shall be insulated throughout and shall not be connected at any point to the consumers earthing system.

It shall not be allowed to use the armour of the incoming feeders cable to the sub-distribution board as the only earthing system.

Sheathed lugs of ample capacities and size shall be used for all underground conductors for sizes above 3 mm^2 whenever they are to be fitted on equipment of flat copper conductor.

The lugs shall be fitted on equipment body to be grounded or flat copper only after the portion on which it is to be fixed is scrubbed, cleaned or paint or any oily substance on a subsequently tinned.

No strands shall be allowed to be cut in case of stranded ground round conductors. GI embedded conduits shall be made electrically continuous by means of good continuity fixing and also rounding copper wires and approved copper clams.

8 Earthing of Lighting Poles

All external poles are to be looped together with continuous 8 SWG GI earth wire clamped a dollies provided on every fuse box of poles and looped onwards to the other pole. Every fifth pole shall be connected to earth through an earth electrode.

9 Recommended Size of Earthing Conductors

Below mentioned are the recommended minimum sizes of earth conductors. However, Earthing strips/conductors, if required of higher size as per Ground Fault Calculations, should be laid as per BOQ or as per site requirement.

Type of Equipment	**Earth Conductor (See Note)**
Motors upto 3.7 kW	8 SWG solid GI wire
Motors from 5.5 kW to 30 kW and welding receptacles	10 mm dia GI wire rope
Motors above 37 kW	16 mm dia GI wire rope or 40 x 5 mm GI strip
Building columns, fencing	40 x 5 mm GI strip
Storage Tanks (Vert./Hor.)/Vessels	40 x 5 mm GI strip
Small equipment and instrument	8 SWG GI solid wire
Lighting, Power and Instrument Panels	10 mm dia GI wire rope
Main Earth Bus/LV and HV Switchgear Interconnections/Power Transformer	75 x 8 mm GI strip
HV Sub stations	50 x 6 mm Cu for Neutral 75 x 8 mm GI strip for rest
Push Button Stations (LCS)	8 SWG GI solid wire
Street Light Poles	8 SWG GI solid wire
Lighting Transformer	16mm dia GI rope
Pipe Rack	40 x 5 mm GI strip
Bonding of pipe flexible	25 sq mm insulated Cu cable

Notes:

1) Earth connection to individual equipment from nearest earth plate/grid may also be done alternately using aluminium/copper conductor PVC insulated core of size note less than half the cross section of the respective power cable to equipment (motor, panel etc.). Connections shall be made using crimpt type lugs.
2) Number of runs of Cu/GI earthing strips shall be as per ground fault calculations.
3) The size of strip mentioned may be changed as per availability meeting the minimum area requirement of specified size of strip/conductor.

Maintenance Free Safe (Chemical Type) Earthing System

- Chemical type earthing electrode shall be used for equipment body earthing. It shall be made with steel core and a copper exterior to provide increased conductivity and corrosion resistance. The electrodes shall be minimum 3 meter length, 17 mm diameter with 99.9% pure electrolyte copper coating of minimum 250 microns and ANSI/UL 467 approved. Adherence of copper to steel rod is achieved through a pioneered bright acid copper plating process using 14 stations using proper current densities, temperature and brightener additives to achieve copper plating with finer grain structure and a smoother, harder and more uniform surface. It shall have minimum tensile strength of 80,000 PSI and straightness tolerance 0.01" per linear foot and shall meet the requirement of ANSI/UL 467, CSA and ANSI/ NEMA. UL logo and control number where applicable shall be stamped on each rod for easy inspection after installation. The rod shall be tested according to IEC 62561-2 and comply to the requirements of IEC 60364-5-54.The rods also should withstand short circuit currents. All fasteners used should confirm to the requirements of the above standards.

- Back filling compound used shall have resistivity less than 20 ohm-cm in its set form. Earth resistance shall be remained same over a wide temperature variation of -60 ^{0}C to + 60 ^{0}C. It shall be suitable to absorbs and retains moisture for long time and shall reduced soil resistivity, Dissipate fault current very fast, Eliminate needs of salt and chemical around electrode and maintain compatibility of soil and rod contact. Earth enhancing compound (Soil conductivity improver) used should be tested

according to IEC 62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

Construction Procedure of Chemical Type Earth Pit

- A hole of 100 to 125 mm dia. shall be augured/dug to a depth of about more than 3 meters or as per instruction of Engineer-in-charge.
- Earth electrode of minimum 3 meters length shall be placed into this hole.
- It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be available at the bottom of the electrode so that min 150 mm of the electrode shall be inserted in the natural soil.
- Earth Enhancing material (minimum 20 kg) shall be filled in to the augured/dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100 mm dia. covering entire length of the hole.
- Remaining portion of the hole is filled with backfill soil which is taken out during auguring/ digging.
- Construction of masonry earth chamber and cast iron cover with earth resistance result with date or as per instruction of Engineer-in-charge.
- For interconnection to the main earthing grid, 40 X 5 mm thick copper clamp shall be provided.

A) PIPE-IN-PIPE Technology Safe earthing

- Two pipes of Coaxial diameters joined together for enhancing the service life and performance of the overall earthing system.
- The cavity in between the electrodes shall be filled with crystalline conductive compounds for current dissipation and anti corrosive properties.
- The electrode cross section shall be circular for the uniform distribution of fault current all around from electrode to earth.
- Inner pipe of length 3 meter shall be hot dip galvanized/zinc coated with minimum galvanizing thickness 80 - 100 micron or Copper plated (minimum 250 mm) as per Drawing/BOQ. Minimum size of pipe as per Drawing/BOQ.
- Outer pipe of length 3 meter shall be hot dip galvanized/zinc coated (minimum 150 micron) or Copper plated (minimum 250 mm) as per Drawing/BOQ. Minimum Size of pipe as per Drawing/BOQ.
- A hole of 200 mm - 225 mm dia. shall be augured/dug to a depth of about more than 3 meters or as per instruction of Engineer-in-charge.
- Earth enhancing compound of minimum 50 kg shall be filled. **Earth enhancing compound shall be filled till top of Earthing Pipe electrode.**

B) Plate Type Earthing Stations

- The earthing station shall be as per drawing/IS: 3043. The equipment neutral earthing shall be with copper plate earthing station.
- The plate electrode shall be 600 x 600 x 3.15 mm copper plate for neutral earthing.
- The earthing conductors shall be of copper strip in plate type earthing.
- GI pipe with funnel of good quality shall be used for watering the earthing electrodes/ stations.
- The brick masonry chamber with chequered plate shall be provided for housing the above referred funnel and pipe.

Earthing Unit Measurement

- Earthing station/pit complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. as per tender specifications/drawings shall be treated as one unit.

- Different sizes of strips/wires per unit length covering/including cost of interconnection the earthing station to earthing grid, and to respective equipment with fixing accessories like earthing clamps, saddle, labour etc. shall be traded as unit length.

- The earth system connection shall generally cover the following.
    1. Equipment earthing for personnel safety
    2. Transformer, DG and System neutral earthing
    3. Static and lightning protection
    4. Current and potential transformer secondary neutral
    5. Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures ceiling fan and exhaust fan, street light, flood light pole circuit/cable.
    6. Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)
    7. Cable shields armour and shield wire.

The scope of work shall also cover supply, laying, installation, connecting, testing and commissioning of following.

- Plate (600 x 600 x 3.15 mm Copper plate)/Pipe type (Chemical type) earthing station with GI pipe/Copper plate of size as per tender/IS.
- Earthing Copper strips from Plate earthing station and hot dipped GI strip for pipe earth to equipotential bar/earth grid.
- Earthing GI/Copper strips/wires from earth grid/equipotential bar to power panels, DBs, motors, indoor/outdoor lighting systems etc.
- Bonding of non current carrying parts, and metallic parts of the electrical installation.
- Quantity of pits mentioned are minimum or higher as per soil resistivity. Measurement of soil resistivity to be carried out by contractor at no extra cost.
- All the earthing material and installation and construction of earth pit, chamber etc. shall be as per IS: 3043 and tender.
- Galvanising thickness shall be 86 micron and 610 g/m^2 as a minimum.

4.8 SAFETY EQUIPMENTS TO BE PROVIDED

The contractor shall provide safety equipment for HV panels, Generator panels, LV/Control panels etc. as per statutory requirement. Generally following shall be provided as a minimum (forming part of scope of this work):

- Supply and spreading Synthetic Rubber mat, 1 mtr wide, 2mm thick, conforming to IS: 15652 Class-A for 1.1 kV LV voltage in front of LV Panel/APFC/MCC etc.
- Supply and spreading 1 mtr wide 2.5mm thick synthetic insulating mat as per IS: 15652 (Class-B) suitable for operation of 11 kV equipment in front of all the HV panel for their entire length. The insulating mat should have ISI mark on every one meter.
- Pairs of electrically tested 22 kV rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in English and local language duly framed as detailed in IS: 1355. Detail of the nearest medical facility available with phone number shall also be kept.

- First aid box containing First aid kit for treatment of electrical burns in the main switch room.
- ABC powder type 'Ceasefire' portable type Fire Extinguishers as per IS: 13849 or suitable Kg capacity with necessary clamp for erection on wall for the individual substation, panel rooms requirement and fire safety guideline.
- Danger/Caution notices in English shall be fixed permanently on the equipment, LV/HV panel room, Switch yard etc to comply the requirement of IE rules.
- Safety posters for vigilance against electrical accidents as detailed in IS: 1255.
- Fire buckets with MS angle stand and with 4 Nos. round bottom fire buckets marked fire shall be provided in the LV panel room, HV sub station and at Transformer yard (Stand shall be with canopy). Stand shall be grouted in RCC.
- 3 Mtr & 6 Mtr. long folding aluminium ladders for safe maintenance of lighting system, etc.
- SLD and Earthing layout of suitable size duly framed/ laminated shall be fixed on the wall near the entrance.

4.9 DIESEL GENERATOR SET

- Supply, Installation, Testing and Commissioning of DG Set KVA as per SOQ rating at 0.8 PF 415 V ± 1% and 50 ± 1% Hz or better, 3 Phase, 4 Wire Diesel Generating Set complete control panel, Controller, Cabling etc. as applicable, and necessary controls and safety devices in panel confirming to relevant IS specification. The set must be continuous operating with a speed regulation of ± 1% or better. Diesel engine shall be conforming to relevant ISS/BSS/ISO with latest amendments and as per latest prevailing CPCB norms. It must fulfil all norms, provisions and conditions set by concerned and relevant Statutory Authorities.
- DG set rating shall be for prime rating power (PRP) in accordance with BS 5514/IS/ ISO 3046. DG set engine shall be as per latest prevailing norms of CPCB. DG set shall comply latest emission norms effective of Ministry of Environment & Forest (MOEF) by Government of India.
- DG Set shall meet all latest statutory/pollution control regulation requirement and applicable safety codes. It must fulfil all norms, provisions and conditions set by concerned and relevant Statutory Authorities.
- Foundation as per OEM recommendation.

GENERATING SET

- The DG set shall be Prime Duty, comprising diesel engine of adequate capacity directly coupled to an alternator mounted on a common base frame. The rated capacity shall be as per tender specifications/SOQ.
- DG set is required to function at places situated at an altitude up to 1000 M and relative humidity up to 95%.
- DG set should be able to start by push button starting.
- The controller of DG panel shall be with RS 485 port (Modbus protocol) for remote data monitoring and logging.
- COP (confirmation of Product) of Nodal/Statutory authority shall be provided by manufacturer for noise and emission levels.
- Shall comply Noise level and emission levels as per latest revised norms of MOEF, GOI.
- Shall be with suitable Accoustic enclosure to meet MoEF/CPCB norms. Enclosure shall be made of CRCA sheet and high quality noise absorbent and fire- retardant grade acoustic insulation material to IS: 8183.

A. ENGINE

- Diesel Engine shall have constant speed, water cooled, suitable for generating set application 1500 RPM, powered by multi cylinder, turbo charged after cooled, cold

starting, heavy duty type rated in accordance with ISO 3046/IS with latest amendments.

- Engine cooling system shall be designed and tested to 50^0C ambient temperature.
- The noise level should not be more than 75 dB at 1m distance and engine exhaust smoke emission level shall comply latest revised emission norms of MOEF, CPCB, GOI.
- Diesel Engine below 140 kVA rating shall have mechanical governing system and 140 kVA and above rating shall be with Electronic governing system.
- The engine should have automatic belt tensioning arrangement for battery charging alternator system.
- The engine should have facility for the indication of oil level in oil sump during running of the engine.
- The engine water circular pump should be directly driven by engine gear system. V-belt driven system will not be adopted/accepted.
- The engine should have equipped with the following accessories.
  - ✓ Fly wheel to suit flexible coupling with guard
  - ✓ Dry type air cleaner
  - ✓ Corrosion inhibitor liquid
  - ✓ Fan blower type with guard
  - ✓ Radiator with guard
  - ✓ Water pump, centrifugal type, engine mounted
  - ✓ Fuel pump PT type, Fuel filter
  - ✓ Governor –Electronic type to meet test requirements as per ISO 8528
  - ✓ Fuel injection equipment
  - ✓ Exhaust silencer, Hospital Grade type with spark arrestor. Height of exhaust pipe above DG room height shall be as per pollution control regulation and supported with M S angle iron supports and stay wires. The exhaust pipe to be wrapped with asbestos rope till the end point.
  - ✓ Electric starting equipment comprising starting motor with soft start engagement feature on 12/24 V DC supply.
  - ✓ Lub oil cooler, Lub oil pump, Lub oil filter
  - ✓ Turbo charger
  - ✓ Solid state potentiometer for increase or decrease of speed which can be wired with remote operation. (For DG with synchronizing only, not applicable for solo application)
  - ✓ Any other as required.

B. Power Control Unit

- Micro-processor based power control unit for monitoring, metering, protection and control system with LED Backlit-LCD display of DG Set. Shall have Modbus interface.

Engine Metering	**Alternator Metering**	**Engine Protection**	**Alternator Protection**	**Operator Interface**	**Data logging**
Speed of Engine in RPM	3 Phase voltage (phase to phase & phase to neutral)	Low lube oil pressure	Over/under Voltage	Manual stop/start	Engine hours
Lube oil pressure	3 Phase current	High/Low coolant temperature	Over current, short circuit	Remote start / stop	Engine starts
Coolant temperature	Frequency	Over/under DC voltage	Over/under frequency	---	Up-to 10 recent fault records
Battery Voltage	kVA	Fail to Crank/start	Loss of AC sensing		
Running hours		Weak Battery	Field overload	---	
---	---	Over-speed		---	
		Sensor failure			

C. ALTERNATOR

- Alternator shall be rated for 40 ^{0}C design ambient temperature, altitude up to 1000M, relative humidity 95%. It shall be based 0.8 P.F. Short time overloading of alternator shall be as per OEM standards. Alternator shall be brushless, self-excited, Digital automatic voltage regulator, class 'H' insulation, single bearing ACgenerator in accordance with IS: 4722 with latest amendments with screen protected drip proof enclosure and damper winding on pole faces.
- Insulation class of alternator shall be of H but temperature rise shall be limited B. Space heater shall be provided for 250 kVA and above rated alternator. 2Nos/Phase Thermisters with temperature scanner shall be provided for 500 kVA and above rated alternator. Terminal box shall be suitable to terminate number of cables for respective rating, necessary terminal extension box shall be considered as per requirement.

D. BATTERY

- Set of staring batteries consisting of required nos. of 12/24 V and of required AH capacity VRLA SMF (Valve regulated lead acid, sealed maintenance free) batteries connected in series with first charge of electrolyte with leads, lugs and terminals etc. duly installed on MS frame near the Engine.

BATTERY CHARGER

- DG set shall be with offline battery charger and suitable to charge the battery when DG is on.
- Battery Charger consisting of:
    - Transformer & rectifier with surge protection network
    - D C Voltmeter
    - D C Ammeter
- Selector switch for Trickle, off and boost and current adjustment

E. BASE FRAME

- The Engine and Alternator should be assembled on a sturdy fabricated, adequately machined base frame, made out of high quality MS channels.The base frame should be provided with lifting facilities and drilled foundation holes suitable for installation in concrete foundation with anti-vibration mounting. DG set is to be supplied with anti-vibration mountings pad suitable for the DG set load.

F. FUEL TANK

- Day fuel tank of adequate liters capacity with inlet and outlet pipe connections, filling cap, drain plug, level indicator and floor mounting pedestal along with hand operated fuel transfer pump and suitable hose.
- The fuel tank shall be inbuilt part of the DG set. The fuel tank shall be suitable for minimum 8 hours of operation of DG set on full load. However, maximum fuel tank capacity shall be 990 liters.

G. CONTROL PANEL

- The MV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP 52 or better degree of protection for indoor unit and IP 55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.
- Panel shall confirm to Indian Electricity Act and rules CEA Notification/Guidelines, CPWD guidelines 2019 as amended up-to date and shall be as a minimum.
- MV switch board sheet steel shall be CRCA minimum 2.0mm for load bearing members, mounting plate, partition, doors/covers, Canopy. Gland plate shall be

CRCA sheet min. 3.0 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.

- All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.
- Suitable lifting hooks and jacking pads shall be provided on each panel or on each shipping section for ease of lifting of switchboard.
- A base channel of 100mm x 50mm x5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.
- Current density of aluminum bus bar shall be max. 0.8 Amp/Sq. mm.
- All wiring shall be done with IS approved FRLS PVC copper flexible wires. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.
- Control circuit wiring shall be FRLSPVC copper flexible wire of minimum 1.5 mm² size and CT circuit wiring shall be minimum 2.5 mm² size. CT wiring shall be R Y B BK color coded and Terminals shall be CT Shorting link type only.

Painting

- The LV Panel shall be treated with seven tank/ Nine tank process with Degreasing, Water rinsing, De-rusting, Water rinsing, Phosphating, Water Rinsing, Passivation.
- After 7 tank cleaning, the surfaces shall be given 2 coats of epoxy primer.
- After seven tank process and primer coating the external paint shall be powder coated with Siemens grey RAL-7035for inside and outside of LV Panel.
- Mounting plate shall be painted Glossy white.
- Thickness of paint shall be between 100 Micron to 120 Micron.
- Panel shall be suitable for auto start/auto changeover functions.

Panel shall be consisting of the following accessories.

Air Circuit Breakers

- Circuit breakers shall be air break, Electrical Draw Out type for feeders 630A and above. ACB shall be 4P with Microprocessor based release with Overload, Short circuit and inbuilt Earth Fault protection.
- The ACB shall be 50kA (1 Sec.)(or as specified in SLD) ICS = 100%ICU= Icw. All ACBs shall comply and tested as per IEC 60947-1 and IEC 60947-2 standards.
- ACB Models shall be : Schneider - Master pact NW or Siemens -3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list. Data sheet with parameter comparison shall be submitted for approval.
- ACB shall be with inbuilt Communication Module RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.

ACB Trip Release LSIG (Micro Processor based) should have Minimum following.

- Overload with time delay
- S/C with time delay and Inst. Trip Setting
- Earth Fault with Time Delay.
- Under/over Voltage for incomer
- LSIG Fault record Display
- Metering & Energy display

ACB shall be fitted with following.

- Heavy duty switches having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device.
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.

- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

Moulded Case Circuit Breakers (MCCB)

- All MCCBs shall be comply and tested as per IS: 2516 / IEC 60947-1 & IEC 60947-2 standards.
- MCCB's shall be 4P, 50 KA or higher (and Ics = 100% Icu) with Micro-processor based release with in-built O/C, S/C and E/F protection.
- All MCCBs shall be with Extended Rotary Handle and Terminal Spreader. Auxiliary change over contact 1 No + 1 NC and Trip Contact shall be provided as per the requirement.
- MCCB Models shall be : Schneider NSX or Siemens 3VL or L&T D Sine or ABB T-Max; or Equivalent model from Vendor Approved list.

Other DG control panel accessories shall be minimum as below.

a) TNC/ Breaker control switch (for ACB incomer)
b) 0 – 500 Volts Digital Voltmeter with Selector switch
c) Digital Ammeter with selector switch
d) Current transformers Resin cast for metering and protection. Cl 0.5, 10 VA.
e) Digital type Multi-function Meter shall be with 3 line display, LCD, Accuracy Class: 0.5 Suitable for measuring and displaying the following parameters: A,V,F,PF,KW, KWH, KVA, KVAR, KVARh, Md, Harmonic & with inbuilt RS 485 communication port.(Schneider- EM 6400NG; L&T –MFM 4420; Secure – Elite 443 ; eqv model of other approved make). Data sheet with parameter comparison shall be submitted for approval.
f) Power factor meter.
g) Freuqency meter
h) Auto/Manual, Local/Remote selector switch.
i) Emergency stop Push button.
j) LED Indicating lamps
k) Battery Charger consisting of
   - Transformer and rectifier with surge protection network
   - D C Voltmeter
   - D C Ammeter
   - Selector switch for Trickle, off & boost and current adjustment
l) Electronic AMF/AMF Cum Synchronizing Logic relay (Nb2 Or Equivalent) to cover the following functions as a minimum:
   - Mains supply failure monitor
   - Supply failure timer
   - Restoration timer
   - 3 impulse Automatic engine Start/Stop attempts
   - Failure to start indication
   - Off/Manual/Auto/test Selectors
   - Power On/Off Switch
   - Synchronizing relay with load sharing arrangement with arrangement to change over MASTER (for AMF cum Synchronizing Panel)

Sr. No.	Condition	Indication	Alarm	Trip Annunciation
	Phase Indicating lamp			
	ON,OFF,TRIP			
1	Mains on	Yes		---
2	Generator on	Yes		---
3	Load on Mains	Yes		---
4	Load on generator	Yes		---
5	Auto/ Manual	Yes		

6	Common Fault		Yes	
7	Over & Under Voltage		Yes	
8	Battery charger fault		Yes	
9	Low fuel oil level		Yes	
10	Over load		Yes	
11	Low Lub Oil Pressure	Yes		Yes
12	High water temperature	Yes		Yes
13	High Lub Oil temperature			Yes
14	Set fails to start (with alarm)	Yes	Yes	Yes

Construction parameters, accessories etc. shall be as per LV panel specifications.

SPECIAL NOTES

- Up to 70 kVA rating the engine can be Air cooled type and above 70 kVA rating engine shall be water cooled type.
- 70 kVA and above rating, the engine shall have turbo charged aspiration.
- Above 500 kVA, the engine shall have turbo charger with after cooling.
- The diesel engine generator set shall be with acoustic enclosure.
- The diesel engine can be naturally aspirated, turbocharged type or turbocharged with after cooler arrangement type as per respective manufacturer's standards.

H. ACCEPTANCE TEST

Following tests shall be carried out for DG set and control panel by the vendor to the entire satisfaction of the purchaser at manufacturer's works.

a) PHASE-I TEST

- Insulation resistance test.
- Continuity test.
- High voltage test on power wiring of control panel
- Visual examination to ensure that the DG set, accessories, control panel etc. are provided for the finish and general appearance of the work as per specification / tender.
- Dimensions and alignment.
- A no load test for a period of five minutes to see that the engine, alternator and other accessories are functioning normal.

b) PHASE – II TEST

- On successful completion of the phase I tests a full load test will be carried out for 30minutes continuously by loading artificially.
- The overall efficiency of the DG Set at ¼ load, ½ load and full load shall be worked out.
- All necessary arrangements for testing under artificial load conditions such as cables, electrodes, load and consumable like diesel, lubricating oil etc. shall be provided by the vender.

c) Documents Requirements

- Alternator manufacturer's routine test certificate/prime power rating documents as per tender.
- Engine manufacturer's routine test certificate/MoEF certified power (BHP) documents as per tender.
- Calibration/Test certificates with setting manuals of manufacturer's of ACB/MCCB, Meters, all instruments and relays shall be presented for review during inspection and shall be part of dispatch documents.

- Transient response test for sudden application and rejection of loads of 25%, 50%, 75% & 100% of rated capacity.
- Wave form test (type test results are acceptable)
- Vibration, Noise level test shall be provided after installation at site.

I. SPECIFIC REQUIREMENT

- The vendor should be in possession of type and routine test certificate as per IS, issued by CPRI or any other testing laboratories and ISO 9001 certificate.
- Vendor shall submit the following drawings as a minimum for approval before manufacturing:
  a) General arrangement drawing
  b) Foundation drawing.
  c) Termination details of cable.
  d) GTP, BOQ, GA drawing, Power and Control wiring drawing of control panel of DG Set.
  e) Specific Fuel Consumption
  f) Installation recommendations including required clearances on all sides
- All minor civil works like opening in wall for exhaust pipe & fuel pipe etc. required for installation of DG sets shall be included in the scope of the vendor.
- The work of installation, testing and commissioning of DG set shall be done by qualified competent Engineer/Supervisors and all instructions shall be strictly followed for the completion of work with good workmanship as required and as per the IE rules and regulation of statutory body and other mandatory requirements.
- The vendor has to supply the following items free of cost on commissioning of the DG set.
  - Technical literature, control and power circuit diagram, manufacturer's manual of engine, alternator, panel etc. in number of sets as specified.
  - List of essential spares,
  - One set of essential maintenance tools like grease gun, tool kit with Ratchet spanner set, torque wrenches, Allen keys etc.
- Bidder shall be responsible to obtain necessary approval of GPCB, Electrical Inspector, Power Supply Co. (PSC) including supply & testing of MFM, CT's as per requirement of PSC & as applicable statutory authority for DG set cum control panel after installation at site & before commissioning of DG set.
  - Vendor shall be responsible for obtaining necessary statutory approval for installation and operation of DG set (Electrical Inspector, Central/Local Pollution Control Board, etc.).

5.0 INSPECTION and TESTING

Inspection of offered equipment/items at manufacturers' works' shall be done by client/PMC/Third party inspection agency as specified here in tender as per relevant inspection and testing standards as well as approved quality assurance plans, technical data sheets, SLD, other approved documents and drawings. The items which are not inspected at manufacturers' works' shall be subject to third party inspection at site.

- Major electrical equipment, as indicated below shall be tested and inspected at vendor manufacturers' works as narrated prior to dispatch to ensure compliance with the specifications/requirements and applicable codes and standards and agreed quality assurance/testing plan.

- **Inspection Criteria of Various Major Equipment at Manufacturers' Premises.**

  - HV Panel (All)
  - LV Panels (Amperes rating **≥ 630 A**)
  - APFC Panel (KVAr rating **≥ 100 KVAr**)
  - Transformers and DG Sets (kVA rating **≥ 500 kVA**)
  - HV Cable (Length **≥ 250 meters**)
  - LV cables (Size **≤ 120 sq. mm** and Length **≥ 1000 meters** for each size; Size **> 120 sq. mm** and Length **≥ 500 meters** for each size)
  - **HV Motors**
    100% quantity of motors of each rating of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. Type test of one motor of each rating out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI.
  - **LV Motors** (Routine tests carried out internally and type test certificate of identically rated motor **≤ 45 kW** shall be submitted for review and acceptance by the Client/PMC/TPI.
    For motor ratings **> 45 kW**, **one motor** out of the lot shall be sent to pump manufacturer for performance testing of pump-motor assembly set, while all other motors in the lot shall be subjected to internal routine tests. Routine test certificates and type test certificate of identically rated motor shall be submitted for review and acceptance @ the time of pump-motor assembly performance test **OR**
    ` Out of all motors rated **> 45 kW to ≤ 150 kW**, **25% quantity of motors of each rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI and routine tests of all other motors carried out internally and type test certificate of identically rated motor shall be submitted for review and acceptance.
    For motors rating **≥ 160 kW, 25% quantity of motors of each rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. **Type test of one motor of each rating** out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI. Routine tests of all other motors carried out internally shall be submitted for review and acceptance.
  - All other minor items shall be cleared for dispatch based on review of material test certificates/manufacturers' test reports' by the Client/PMC/TPI.

- All the expenses like transportation, lodging and boarding to carry out inspection and testing shall be borne by contractor.

- The Client or his authorized representative may visit the works during manufacture of various electrical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out inspection. Client's representative shall be given minimum two weeks advance notice for witnessing of final testing.

- Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the electrical system/equipment before it is being put into service. All test equipment shall be arranged by the vendor. Test reports shall be approved by the Engineer-in-charge before acceptance of the complete plant and equipment.

- All the cost pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by contractor for minimum 2 representatives of Client/ PMC/Third Party Inspection Agency.

6.0 ELECTRICAL INSTALLATION

This specification covers the technical requirements for equipment, materials, and installation methods, testing and commissioning of electrical system.

The contractor shall possess a valid contractor's license for the state in which site is located and shall ensure it's validity during the duration of the contract.

The contractor shall employ adequate skilled and unskilled labour to complete all work accoriding to programme of work. Skilled workers shall possess the minimum qualifications stipulated by statutory or competent authorities.

The contractor shall employ adequate numbers of supervisor to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.

Various types of equipment shall be installed in accordance with approved drawings and/or manufacturer's instructions and good engineering practice. Particular attention shall be paid to lubrication of moving parts and bearings, alignment, tightness of all connections (mechanical and electrical) and wiring.

The transformers, DG sets shall be moved to its location and shall be correctly positioned on its base.

All parts of the transformers, which are supplied loose, such as conservator, radiator banks, buchholz relays, dial thermometers, bushings etc. shall be fitted onto the transoformers.

Transformer oil if supplied in drums shall be filled into the transformer after duly testing/filtering, upto the correct level required. The transformer may have to be dried out and oil filtered.

The contractor shall place the switchgear correctly on the base of foundation prepared for the same. If the switchgear consists of a switchboard with number of panels bolted together, he will place all the sections of the switchboard correctly, align them and bolt the sections together to form one continuous switchboard. The switchgear shall then be secured to the foundation by means of nuts and bolts or foundation bolts grouted in the base. The contractor shall also make inter-section bus/wiring connections.

In case of wall/structure mounted equipment, boards, the contractor shall fabricate and install the structural steel frame work suitable for mounting the various equipment boards. The contractor may have to prepare drawing showing the proposed general arrangement, of the structural frame which shall be subject to the approval of the Engineer. The fabrication and installation of the framework shall be recommended only after the approval of drawings. Various items of the equipment, board shall be mounted in accordance with the approved drawings.

Motor shall generally be installed by others, along with the driven equipment. The contractor may, however, be asked to install motors in specific instances.

Cable routes and mode of installation shall generally be as shown in the construction drawings.

Identification tags indicating cable designation, shall be affixed to each cable at ends and at an interval not exceeding 15 mtrs or at the location where cables change direction or elevation. Signboards with necessary indication/arrow mark with necessary structure/foundation shall be also be installed, of edquate size as approved by Engineer, for the enture cabling system buried underground.

HV XLPE/PVC armoured cables shall be terminated or jointed by means of cold setting epoxy based cast resin jointing system or heat shrinkable or push on type cold setting kit.

All cable glands should be of nickel plated brass, double compression type. All Alu/Cu cables shall be terminated through crimping type Alu/Cu lugs respectively.

All electrical ewuipment viz. transformers, switchgear, motor control centres, motors, control stations, switches, lighting, fittings and other electrical apparatus shall be connected to the main earth loop by means of two separate and distinct external earth conductors. The material, type and size of earth conductors will be as shown in the drawings or as specified.

Electrical installation in hazardous areas if applicable as defined in IS: 5571 shall be carried out with utmost care and special precautions shall be taken to ensure operational safety.

All personnel, especially supervisory staff, working on such installations shall be fully conversant with the applicable National Standards and Code of Practice and shall have previous experience of such work.

The contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:

a) To prevent any conductor or apparatus becoming accidentally or inadvertently charged.

b) Prior to electrical installation (or part there of) being connected to the main supply, the Contractor shall ensure that uncommissioned or incomplete circuits cannot be inadvertently energized and completed circuit cannot be used without the Engineer’s consent.

c) No hot work is carried out without work-permit issued by the Engineer in FLP zones (if stipulated by process application).

The tests specified below/elsewhere as part of this tender document shall be carried out on the electrical equipment and installation before commissioning the same. The tests shall be performed by or under the direct supervision of a competent person, qualified to carry out the tests. All tests shall be carried out in the presence of the authorized representative of the Employer/Owner and/or the Engineer, unless this stipulation is waived in writing.

7.0 PAINTING

All surfaces of equipment/structural steel shall be sand blasted, degreased and pickled in acid as required to provide a smooth & clean surface, free of rust / scale / grease.

After cleaning the surface shall be given one coat of high quality red-oxide or yellow chromate and baking in the oven (for equipment only).

All surfaces shall be then finished with 2 (two) coats of finished epoxy based paint of shade 631 of IS:5 or with a paint shade of purchaser's choice unless otherwise specified.

8.0 DETAILS OF TESTS

I POWER and DISTRIBUTION TRANSFORMERS

i) Check HV and LV cable terminations, ground connections, fittings and accessories, oil level and oil leaks at various joints. Check breather, thermometers and buchholz relay for proper functioning and operation. Check junction box, marshalling box etc. for correct wiring.

ii) Oil Test

Crackle test and dielectric test as per Clause 7.11 of IS: 10028. The oil shall withstand at least 40 KV with a gap of 4 mm.

iii) Insulation Resistance Test

This may be carried out on new transformer without drying out the transformer, provided the transformer has not been idle or stored for a long period. Otherwise, this test shall be carried out during drying out of transformers. Insulating resistance test shall be carried out between primary & secondary to ground as well as between primary and secondary. Windings not under test shall be grounded during the test.

A megger rated 1000 volts or higher shall be used for the test.

iv) Polarity and Phasing Out Test

Check external connection of the transformer in accordance with diagram of connection and phase sequence (anti-clockwise)

II HV AND MV SWITCH GEAR

i) Check proper mechanical operation of circuit breakers including alignment of trolleys in case of draw–out type circuits breakers, smooth operation of all mechanical parts, lubrication, mechanical interlocks etc.

ii) Check contact alignment and wipe, proper sequence of closing and opening of main and arcing contacts.

iii) Check electrical relays, instruments & controls for correct wiring.

iv) Insulating test on bus bars – phase to phase and phase to ground. This test will be carried out with circuit breakers in service position, but contacts remaining open.

v) Insulation test on relays and control wiring including current and potential transformers and wiring of CT and PT secondaries.

vi) Insulation test on circuit breakers in withdrawn position – phase to phase and phase to ground with contacts closed.

vii) Adjust correct settings of relays and/or direct acting trips - as specified.

viii) Operation test

Energise only control circuits and carry out closing and tripping operations (where AC supply derived from main supply is used for operation, the switch–gear bus may be energised). Check operations of electrical interlocks. Check tripping of circuit breakers by manual operations of protective relays contacts. Check operations of mechanical closing and tripping devices. Check lockout conditions for closing of circuit breakers by simulating the required conditions. Check control, indications, sequence interlocks and alarms.

ix) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary with ELV tester.

x) Check operation of instruments, meters, relays and tripping of circuit breakers by primary/secondary injections as specified.

xi) Check continuity of power circuits and earth continuity of all non current metallic parts with a low voltage a (6 volts or less) continuity tester.

III MOTOR CONTROL CENTRES, SWITCHGEARS

i) Check equipment, internal wiring, smooth mechanical operation, interlocks, etc.

ii) Check continuity of power circuits and earth continuity of all non-current carrying metallic parts with a low voltage continuity tester.

iii) Insulation test for power and control circuits between phases, between phases and neutral and between phase/neutral and ground.

iv) Check operation by energizing control circuits (without energizing power circuits) for correct functioning. Simulate eternal controls and interlocks for the same. Note chatter or humming of contactor and rectify, in necessary.

v) Check fuse ratings and adjust relay setting (overhead, single phasing preventers etc) in accordance with load ratings.

vi) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary circuits with ELV tester.

IV MOTORS AND ROTATING EQUIPMENT

i) Check equipment for free movement of rotor, and play, lubrication and for any other visual checks.

ii) Insulation test of motors – between winding and ground. Use 500 volts megger for MV motors and 1000 volts megger for HV motors.

iii) Check electrical continuity with ELV tester.

iv) No load running of motor noting down no load current and voltages in all three phases.

V CABLES

i) Insulation Test between each phase and neutral and between each phase / neutral and ground.

ii) DC High Voltage Test on HV cables in accordance with the relevant Indian Standards and Code of Practice. This test shall be carried out on cables installed in final positions, and all joints and terminations have been made. The cables, however, may not be connected to the equipment, so that the equipment may not be subject to the test voltage.

iii) In case of lighting wiring, insulating test shall be carried out on lighting feeders with branch circuits open. Branch circuits shall be tested separately with lamp holders, plug receptacles and lighting fittings in position, but without lamps. In case of lighting circuits will lamp ballasts and glow starters, insulation resistance may be measured between phase and ground only.

iv) In case of directly buried cables, insulate resistance of cables shall be measured before and after the back-fillings.

v) Test all receptacles for correct phase sequence.

VI EARTHING SYSTEM

i) Measure earth resistance of each electrode separately. If a number of earth electrodes are interconnected with one another, combined earth resistance shall also be measured. The earth resistance of each electrode and/or a group of electrodes shall not exceed the values specified.

ii) Carry out line earth loop impedance test. The loop comprises the line conductor from the point of fault, back to the supply transformer, the path through transformer winding, the earthed neutral point of the transformer and path for that point to the point of fault through the earthing system.

iii) Continuity test for earth continuity conductors with ELV tester.

9.0 STATUTORY APPROVAL

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation including DG Set carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. **The contractor shall liaison with local electric supply company for getting power supply and only necessary fees, if any, payable to supply company shall be borne by the Client.**

10.0 ACCEPTANCE OF INSTALLATION

On completion of the work the Engineer, together with the Contractor, will carry out an inspection of the Installion. The Engineer will issue a completed copy of the Purchaser's Acceptance of Electrical Installation to the Contractor as confirmation that the work has been accepted, subject to any matters noted on the form being attended to.

11.0 APPROVED VENDOR LIST – ELECTICAL EQUIPMENT / COMPONENT

ITEM DESCRIPTION	**APPROVED MAKE**
11KV FOUR POLE / TWO POLE STRUCTURE ACCESSORIES	NATIONAL/PSG/HI-TECH
DISTRIBUTION TRANSFORMERS	ABB / BBL / CGL / GEC / KEC / VOLTAMP / T & R
HV SWITCHBOARD & SWITCHGEAR PANEL (11/33 kV) - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / AREVA / BHEL / CGL / GEC / JYOTI / L & T / SCHNEIDER / SIEMENS / AUTH. SYSTEM INTEGRATOR FOR HERE IN APPROVED MAKE OF OEM
LV SWITCHBOARD - DRAWOUT / FIXED TYPE (PCC / PMCC / MCC / MLDB / MPDB / MOVDB)	ABB / ALPHA NIPPON / C & S / ELEMBICA / INDUSTRIAL CONTROLS / L & T / SUN AUTOMAT / SAMUDRA / G SONS POWER / ASCENT ENGINEERS
APFC PANEL	ABB / ALPHA NIPPON / C & S / ELEMBICA / INDUSTRIAL CONTROLS /L & T / SUN AUTOMAT / SAMUDRA / DATAR / G SONS POWER/ ASCENT ENGINEERS
AIR CIRCUIT BREAKERS	ABB / L & T / SIEMENS / C & S / SCHNEIDER / MITUBISHI
MCCB	ABB / C & S / L & T / SIEMENS / HAVELLS / SCHNEIDER / MITUBISHI
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB / C & S / L & T / SIEMENS / INDOASIAN
CHANGE-OVER SWITCH	BCH / C & S / GE POWER / HAVELLS / HPL / L & T / SCHNEIDER / SIEMENS
SOFT STARTER (MICROPROCESSOR BASED)	ABB / CG POWER (EMOTRON) / DANFOSS / L & T / SIEMENS / SCHNEIDER
VVVF DRIVES (VFD)	ABB / CG POWER (EMOTRON) / DANFOSS / L & T / ROCKWELL / SCHNEIDER / SIEMENS
MV CAPACITORS	ABB / EPCOS / SHREEM / UNIVERSAL/ VISHAY
LV CAPACITORS / POWER CAPACITOR	ABB / EPCO / KHATAU JUNKER / MADHAV / SIEMENS / L & T / SUBODHAN
APFC RELAY / CONTROLLER	ABB / DATAR / ENERCON / EPCOS / L & T / SIEMENS / SYNTEL / NEPTUNE / TRINITY /
CAPACITOR DUTY CONTACTOR	ABB / EPCOS / L & T / SIEMENS / C & S
MICROPORCESSOR BASED MOTOR PROTECTION RELAY WITH RS 485	C & S / ABB / L & T / SIEMENS
AC / DC POWER & AUXILLARY CONTACTOR	ABB / BCH / C & S / GE / L & T / SIEMENS / INDOASIAN
BI-METAL / ELECTRONIC / MICROPROCESSOR BASED OVERLOAD RELAY	ABB / C & S / GE / L & T / SIEMENS / CSPC / ALSTOM / CG / INDOASIAN
THERMISTER RELAY	ALSTOM / INSTA CONTROLS / MINILEC
SINGLE PHASING PREVENTER WITH UV/OV PROTECTION	ABB / C & S / GE / L & T / MINILEC / SIEMENS
TIME SWITCH	GIC / LEGRAND / SIEMENS / THEBEN
TIMERS / TIME DELAY RELAY	BCH / EAPL / L & T / LEGRAND / MINILEC / OMRON / PLA / SIEMENS / TEKNIC / THEBEN / ELICO / INDOASIAN
MOTORS	ABB / BBL / CGL / KEC / SIEMENS
LIGHT FIXTURES	BAJAJ / CGL / GE / HAVELLS / PHILIPS/ WIPRO
CABLES HV - XLPE INSULATED	HAVELLS / KEI / POLYCAB / TORRENT CABLES /

	GLOSTER
LV POWER & CONTROL CABLES / EARTHING CABLES	FINOLEX / HAVELLS / KEI / RR KABEL / TORRENT /POLYCAB / GLOSTER / AVOCAB
WIRES - FLEXIBLES FRLS (ALL TYPES)	FINOLEX / KEI / RR KABEL / HAVELLS / POLYCAB
LIGHTING / SMALL POWER DISTRIBUTION BOARDS / ENCLOSURES	ABB / C & S / HENSEL / INDO ASIAN / L & T / LEGRAND / SIEMENS / HAVELLS / ABOVE APPROVED LV SWITCH BOARD / PANEL VENDORS
MCB, RCCB, RCBO / MCB ISOLATORS	ABB / C & S / INDO ASIAN / L & T / LEGRAND / SIEMENS / HAVELL / INDOASIAN
MPCB	ABB / C & S / L & T / SIEMENS / INDOASIAN
DECORATIVE / MODULAR SWITCH & SOCKET	ABB / ANCHOR / CLIPSAL / CRABTREE / L & T / LEGRAND / MK - HONEYWELL / SIEMENS / INDOASIAN
CEILING / WALL MOUNTING / EXHAUST FANS	ALMONARD / BAJAJ / CGL / HAVELLS / KHAITAN / ORIENT / USHA
CABLE TERMINATION / JOINTING KITS	3M / ABB KABELDON / M SEAL / RAYCHEM / XICOM / CCI
CONTROL / SELECTOR SWITCH	ABB / ALSTOM / BCH / GE POWER CONTROLS / HAVELLS / KAYCEE / L & T / SIEMENS / SALZER
INDICATING LAMPS	BCH / L & T / SIEMENS / TEKNIC CONTROLS / VAISHNO
TERMINAL BLOCK / CONNECTORS	CONNECTWELL / ELMEX / PHEONIX / TELEMECHANIQUE / WAGO / GRIPON
CONSTANT VOLTAGE TRANSFORMER/ CONTROL TRANSFORMER	AE / ASHMORE / G & M / INDCOIL / NEC / PRAGATI / PRECISE / SILKAANS
SEMICONDUCTOR FUSE	BUSSMANN / FERRAZ / GE / SIEMENS
HRC FUSE (POWER & CONTROL)	ABB / C & S / L & T / SIEMENS / INDOASIAN
PUSHBUTTONS	BCH / L & T / RASS / SIEMENS / TEKNIC / VAISHNO
PUSH BUTTON STATIONS / JUNCTION BOX (CAST ALUMINIUM)	BALIGA / BCH / CEAG / EXPROTECTA / FCG / FLEXPRO / HANSU / HENSEL / PUSTRON / SIEMENS / SUDHIR / EXCEL
NON METALLIC ENCLOSURES (INCLUDING INDUSTRIAL RECEPTACLES)	BCH / HENSEL / LEGRAND / PUSTRON / RITTAL / SIEMENS / SINTEX
DIGITAL AMMETER / VOLTMETER / POWER FACTOR METER	AE / L & T / SECURE / SIEMENS / IMP / ABB
KWH / LOAD MANAGER / MULTI FUNCTION METER	ABB / L & T / SECURE / IMP/ / ENERCON / ABB
8/10 CHANNEL TEMPERATURE SCANNER WITH RS 485 MODBUS COMMUNICATION	MASIBUS / NIVAM / NISHKO / ELECTRONET / REDIX / MULTISPAN
ELECTROMECHANICAL METERS – AMMETER & VOLTMETER	AE / IMP / MECO / RISHABH
CABLE LUGS	3D / COMET / CONNECTWELL / DOWELLS / JAINSON / 3M
CABLE GLANDS (SINGLE / DOUBLE COMPRESSION, NI-PLATTED BRASS)	BALIGA / BRACO / COMET / ELECTROMEC / EX-PROTECTA / FCG / HMI / JAINSON / SIEMENS / SUDHIR
CABLE GLANDS – POLYAMIDE	FIBOX / GEWISS / HENSEL / LAPP
LIGHTNING ARRESTORS	CGL / ELPRO / JAYSHREE / OBLUM / WS / BIRLA NGK INSULATORS
SURGE SUPPRESSORS	ABB / EMERSON / ERICO / MTL / OBLUM /

	PEPPERL+ FUCHS / PHOENIX / SIEMENS / WEID MULLER
HOT DIP GALVANIZED CABLE TRAYS	GLOBE / INDIANA / JACINTH / LEGRAND / M.M. ENGINEERING / SHARDA / SILVERLINE POWER / VATCO / SUPER ELECTRO / POLYCAB
UPVC CONDUIT & ACCESSORIES (CABLE RACE WAY / CABLE DUCT)	AKG / CLIPSAL / L & T / POLYCAB / PRECISION / SALZER / GRIPON
MS / GI CONDUIT & PIPES	BEC INDUSTRIES / JINDAL / JK TUBE / SAIL / TATA STEEL / ZENITH
SMF / VRLA / NI-CD / LEAD ACID (PLANTE / TUBULAR) BATTERY	AMARA RAJA BATTERIES LTD / AMCO / EXIDE / HBL POWER SYSTEMS LTD / AUTOMATIC ELECTRIC
MS / GI LIGHTING POLES & BRACKETS (OCTOGONAL POLE)	CROMPTON / TRANSRAIL / VOLMONT / AMBICA ENGINEERING / BAJAJ / GAYATRI ELECTRICALS / SURYA
DIESEL ENGINES	CATERPILLAR / CUMMINS / KOEL / PERKINS / VOLVO (PENTA) / MITSUBISHI / BAUDOUIN
ALTERNATORS FOR DG SETS	BHEL / CGL / KEC / KOEL / STAMFORD / LEROY SOMER / NGEF
AMF RELAY, SYNCHRONIZING RELAY (WITH RS 485)	DEEP SEA / C & S / WOODWARD / DEIF
HANDHELD DIGITAL MULTIMETER / CLIP-ON METER / MEGGER	FLUKE / IMP / MECO / MOTWANE / RISHABH
ALUMINIUM BUSBAR MATERIAL	BANCO / HINDALCO / JINDAL / STERLITE
PANEL CRCA / MS / GI PLATES & SHEET	ESSAR / TATA / JINDAL / SAIL
CHEMICAL TYPE EARTHING INCLUDING COPPER BONDED ELECTRODE & BACK FILL COMPOUND	ASHLOK / CURSP / ECO TECHNOLOGY & PROJECTS / ERICO / ISG GLOBAL / PRAGATI ELECTROCOM / SAARA EARTHING
PVC CONDUITS & ACCESSORIES	PRECISION / CLIPSAL / L & T
MODULE TYPE PLUG SOCKET	ANCHOR / HAVELLS / CLIPSAL / TOYAMA / MDS
OVERHEAD CONDUCTOR (ACSR / AL59 ETC.)	JSK INDUSTRIES PVT LTD / APAR INDUSTRIES/ STERLITE TECHNOLOGIES LTD / JYOTI POWER TRANSMISSION PVT LTD / GALAXI TRANSMISSION PVT LTD / HIND AL INDUSTRIES

12.0 PRICE BREAKDOWN

12.1 Whenever requested by the engineer, the contractor shall furnish detailed price breakdown for supply and installation of each of the items of electrical works including for each type/size of applicable cable / light fitting / earth pit / earth stations.

12.2 This breakdown prices are required for the purpose of justification for progress payment and also for working out addition and deletion, if any, in the scope of work at a later date.

13.0 VENDOR DATA REQUIREMENT

Following minimum documents shall be submitted by contractor along with the bid as well for review and approval during detailed engineering, as indicated:

Sr. No.	Description	With Bid	Information / Review	As-Built
1	List of Deviations to the Specifications	*		
2	Electical Load Data	*	*	*
3	Guaranteed Power Statement	*		
4	Single Line Diagram		*	*
5	Motor Data Sheets		*	*
6	O & M Manual		*	*
7	Technical details for major equipment		*	*
8	Data Sheets of Distribution Transformer along with sizing calculations / Data Sheets of other Eqpt		*	*
9	List of Recommended Spares		*	*
10	Type Test Certificates		*	*
11	Equipment / Sub Station Layout		*	*
12	Bill of Material		*	*
13	GA Drgs of Switchgear / Distribution Transformers / Motors / etc		*	*
14	Interconnection / wiring Diagrams		*	*
15	Area Classification Drawings		*	*
16	Lighting Design Calculation		*	*
17	Test Certificates		*	*
18	Cable Layout / Earthing Layout / Lighting Layout / Equipment Layout		*	*

TECHNICAL SPECIFICATIONS FOR INSTRUMENTATIONS WORKS

Intent of Specifications

This specification along with specific job requirements (if any) is intended to cover the design, engineering, supply, installation, testing and commissioning of entire instrumentation equipment and items and accessories including consumable against price quoted for instrumentation works as indicated here in and else where covererd in the scope of this tender.

Compliance with this specification and/or review of any of the vendor documents shall not relieve the vendor of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the plant.

Applicable National and International Standards

AGA	American Gas Association, Gas Measurement Committee	
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers	
	B 1.20.1	Pipe Threads
	B 16.5	Steel Pipe Flanges and Flanged Fittings
	B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges
ANSI/FCI	American National Standards Institute/Fluid Controls Institute	
	70.2 Control Valve Seat Leakage Classification	
API	American Petroleum Institute	
	RP 520	Sizing, selection and installation of pressure relieving systems in refineries. Part I - Sizing and selection Part II - Installation
	RP 521	Guide for pressure relieving and depressurising systems
	RP 526	Flanged steel safety relief valves
	RP 527	Seat tightness of pressure relief valves
	MPMS	Manual of Petroleum measurement standards
	RP 551	Process measurement instrumentation Part - I Process Control and Instrumentation
	RP 552	Transmission Systems
	S 2000	Venting atmospheric and low pressure storage tanks
	S 670	Vibration, Axial-Position and Bearing Temperature Monitoring Systems
ASTM	American Society for Testing and Materials	
BS	British Standards	
	BS 1042	Measurement of Fluid Flow in Closed Conduits
	BS 5308 Part II	Specification for PVC insulated cables
	BS 7244	Breather Valves
DIN 43760	Temperature Vs. Resistance curves for RTDs	
DIN 19234	Electrical Distance Sensors, DC interface for distance sensors and signal converter	
DIN 50049	Document on Material Testing	

IEC	International Electrotechnical Commission	
	IEC 79	Electrical apparatus for Explosive Gas atmosphere
	IEC 85	Thermal evaluation and classification for electrical insulation
	IEC 332	Test on bunched wires or cables Part III Category A
	IEC 529	Classification of degree of protection provided by enclosures
	IEC 534-2	Industrial Process Control Valves - Flow capacity
	IEC 584-2	Thermocouples - Tolerances
	IEC 751	Industrial Platinum Resistance Thermometer Sensors
	IEC 801	Electromagnetic compatibility for industrial process measurement and control equipment
IS	Indian Standards	
	IS: 5	Colours for ready mixed paints
	IS: 319	Specification for free cutting brass bars, rods and sections
	IS: 1239	Mild Steel tubes, tubulars and other wrought steel fittings
	IS: 1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
	IS: 1554 Part-I	PVC insulated (heavy duty) electrical cables – working voltage upto and including 1100V
	IS: 2074	Ready mixed paints, air drying, red oxide - zinc chrome
	IS: 2147	Degree of protection provided by enclosures for low voltage switch gear and control gear
	IS: 2148	Flame proof enclosures for electrical apparatus
	IS: 3624	Specification for Pressure and Vacuum gauges
	IS: 5831	PVC insulation and sheath of electric cables
	IS: 7358	Specification for Thermocouples
	IS: 8784	Thermocouple compensating cables
ISA	Instrument Society of America	
	S-5.2	Binary logic diagrams for process operations
	S-7.3	Quality standard for instrument air
	S-75.01	Flow equations for sizing control valves
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits	
NACE	National Association of Corrosion Engineers - MR-01-75	
NEC	National Electric Code	
NEMA	National Electrical Manufacturer's Association	
	ICS-6	Enclosures for industrial control and systems
NFPA	National Fire Protection Association	
	NFPA-496	Purged and pressurised enclosures for electrical equipment
OSHA	Occupational Safety and Health Authority	

1. General

The Contractor shall obtain all instruments from manufacturers' of international standing.

The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application.

All instruments shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by MCBs in each unearthed phase of the circuit placed as close as practicable to the main connection.

Analogue signals shall be 4-20 mA according to BS 5862 Part I 1986 or its latest edition. They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument enclosure.

The contractor shall furnish technical details/catalogues/drawings for the instruments and panels offered for monitoring and control of the entire plant to Client/Consultant for their approval prior to procurement of the same. Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the Client/Consultant, necessary test certificates shall be submitted for approval of Client/Consultant before clearing the material for dispatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme (zone) in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust proof cases including those mounted in panels. All equipment shall be suitable for its environment.

Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless other wise stated.

Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales.

Instrumentation System shall be designed as per good engineering practice.

Power Supply To Package

Power Supply shall be made available by the Bidder at the following voltage levels, **unless otherwise specified**.

- For Instruments, Control Systems, Analysers : 230V AC ± 10%, 50 Hz±3 Hz
- Solenoid Valves, Relays, Lamps : 24V DC
- Input Interrogation Voltage : 24V DC
- Panel/Cabinets Lighting : 230V AC ± 10%

Client shall provide for a separate feeder in the Plant MCC of suitable current rating and at suitable locations to provide 230V AC ± 10%, 50 Hz ± 3Hz supply to instrument panel(s). Necessary cabling work shall be carried out by successful bidder for required power distribution.

24V DC required for input interrogation, relays and lamps etc. same shall be generated by the Bidder using SMPS. Power shall be suitably conditioned by providing UPS/Isolation Transformer-Voltage Stabilizer/CVT to prevent damage to instruments against power fluctuation/disturbances.

Instrument power circuits shall be individually protected from fault with the help of MCBs of adequate rating with overload protection. MCBs shall be two pole type.

Earthing (Grounding)

Vendor shall provide separate earth bus bar connections for shield and panel electrical earthing.

Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits shall be provided for the same by the vendor.

Enclosure

All instruments enclosure mounted in the field shall be weatherproof to IP 65/ NEMA4 as a minimum.

For Hazardous Areas

All electrical instruments except solenoid valves shall be intrinsically safe while solenoid valves shall be explosion proof. All such instruments shall be suitable for the applicable hazardous area classification. All intrinsically safe/explosion proof instruments shall be certified by any Statutory Body for use in specified hazardous area.

All electronic instruments like field transmitters shall be certified intrinsically safe.

All solenoid valves, field switches etc. shall be certified explosion proof to NEMA 7. Contacts shall be gold plated rated for 30V 1 Amp.

Interlocks/Loops

All plant interlocks shall be carried out using PLC/electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P & IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop.

The system shall be designed fail safe and shall meet the following requirements, as a minimum.

a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.
b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.

The system shall be designed using PLC/electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum.

a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
b) The relays shall be plug in type and their plug in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
c) Each relay shall have minimum two numbers of 'NO' and two numbers of 'NC' contacts as a minimum. Out of these, one 'NO' and one 'NC' contacts shall not be used.

Intrinsic Safety Barriers

Intrinsic safe barriers shall be provided for all analog signals coming from hazardous area. The following points must be taken into consideration while selecting intrinsic safety barriers.

a.) Safety barriers must be based on entity concept.
b.) Each instrument in the loop must be certified intrinsically safe by a statutory authority.
c.) Each input/output in the loop shall have a separate intrinsic safety barrier. No barrier shall be shared between two loops/inputs/outputs.
d.) All safety barriers shall be isolating type, as far as possible.
e.) All safety barriers shall be of MTL make or equivalent. The following barriers may be selected, unless otherwise necessary because of technical reasons.

Analogue Inputs	: MTL 3041 or equivalent (Repeater Power Supply for Transmitters)
Analogue Outputs	: MTL 3042 or equivalent (4-20 mA Repeater)
Contact Inputs	: MTL 3011/2210B or equivalent
Contact Outputs	: MTL 2241/3021 or equivalent (Solenoid Valves)

2. Control Panel

Control panels shall be prefabricated type, sourced from approved vendors.

Control panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 1.5 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. Anti vibration pad, pre-drilled base channel ISMC – 100 or equivalent for all sides. The instrument panel shall have dimensions as per system requirement. Overall height of control panel shall not exceed 2100mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800mm and 1300mm from floor level.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part I.

Control panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the Instrument panels. These shall be dispatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Instrument panels shall be provided with louvers along with washable micron filters AIR IN–AIR OUT fans will be provided.

No process fluid of any kind, except instrument air, shall enter the instrument cubicle. All cable entry shall be from the bottom of the panel. Also power supplies greater than 230V shall not enter the LCP.

The internal layout of the panel/cabinets shall be designed considering proper approach for each item for maintenance. Following point must be taken into consideration while deciding the internal layout.

a.) All wiring inside the panels shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance adjustment, repair and removal. No raceway shall be more than 70% full.
b.) Separate wiring raceways shall be used for power supply wiring and low level signal wiring.
c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals: Minimum 50mm.
d.) Distance between terminal strip and top and bottom of cabinet: Minimum 75mm.
e.) Distance between two adjacent terminal strips: Minimum 100mm.
f.) Distance between cable gland plate and the bottom of strips: Minimum 300mm.
g.) 20% spare terminals shall be provided as a minimum.

Control panel shall be provided with fluorescent type lighting fixtures controlled from totally enclosed door operated switches for internal illumination of the panel cabinets.

Contractor shall provide with necessary cooling fans and cut-outs covered with appropriate filters for necessary air changes to limit temperature rise within panel to 5 ^{0}C over ambient temperature.

Contractor shall consider necessary power conditioning unit (UPS) to prevent power fluctuation and surge to damage the instruments as well as other electronic components.

For cases where PLC is to be mounted, panel shall be deisnged suitably as per PLC manufacturers' recommendation. Necessary marshalling boxes may be considered if required as per design.

Mounting

All equipment on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

Earthing for Instruments

The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

Minimum two numbers of dedicated earth stations to be provided each for instruments/panel earthing and for Signal (Electronic) earthing. The earth station shall be of Copper plate type electrode or maintenance free pipe in pipe technology having earth electrode of 50mm dia. and length of 3000mm.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit as specified above.

Frame Earthing

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25mm x 3mm. 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

Space Heater

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

Interior Lighting and Receptacles

Each panel shall be provided with either a LED lighting fixture rated for 5 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 Amps and 15 Amps, 3 pin receptacle with a switch and neon indication. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

Labels

All the equipment mounted on the front facia of instrument panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

Switches and Miniature Circuit Breakers (MCBs)

Each instrument panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs.

Intra-Panel (i.e. Panel's Internal) Wiring

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 600V grade, multi stranded copper flexible conductor insulated with FRLS grade PVC and designed for a minimum conductor temperature of 70 ^{0}C. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Client and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.

Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always and hence easily readable.

Terminal Blocks

Terminal blocks for power connection shall be 600V grade, 20 Amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts

and identification markings. Terminal block design shall include white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type .

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal blocks.

Cable Supports

All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

Terminal/Identification

Every terminal plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

Painting of System Cabinet/Control Desk

All sheet steelwork shall be painted using seven tank processe in accordance with the following procedure.

i. The pre treatment shall be hot process with running water for rinsing.

ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.

iv. The control panel shall be powder coated. Thickness of coating shall be around 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.

Alarm Annunciator

(i) Microprocessor based alarm annunciators shall be provided, **if specified**, for generating audio-visual alarms for each abnormal condition. Alarms shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exist. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment. Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment. The sequence of alarm should be user selectable by dip switch.

(ii) The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a future alarm condition occurs.

(iii) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

(iv) Isolation facilities shall be provided for the hooter using MCB.

(v) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

i.	Top Line	:	Location
ii,	Middle Line	:	Parameter
iii.	Bottom Line	:	Status

e.g. RESERVOIR LEVEL: HIGH

The annunciator will be split/integral architecture type and the facia will have super bright LEDs.

Alarm annunciator shall be provided on instrument control panel for annunciation of alarms in control room. Minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.

The technical particulars of alarm annunciator are as follows.

(a) Technical Particulars

i	Type	:	Microprocessor based, split type/integral type with alarm windows mounted on front door and electronic modules inside panel
ii	Mounting	:	Flush with panel
iii	Construction	:	Modular
iv	Inputs	:	Potential free, NO/NC contacts
v	Size of Windows	:	60mm X 26mm
vi	Operating Sequences	:	First up (user selectable dip switch)
vii	Bulbs per Channel	:	2 (Cluster LEDs)
viii	Push Buttons	:	For Reset, Accept and Test
ix	Hooter	:	Required, electronic type
x	Power Supply	:	24V DC/240V AC
xi	Power Supply Status	:	Required indication
xii	Weather Protection	:	IP 52 of IS: 13947
xiii	No. of Windows	:	As per requirement + 20% spare windows

In case if hard wired annuciator is not specifed in detailed specifciaitons for instruments, then visual alarm shall be provided at HMI and audio alarm through panel mounted hooter along with rest push button shall be provided for all the required alarms as per specifications/approved P & ID/process requirement.

Annunciator, in general, shall be solid state type with plug-in modules, in a cabinet with backlighted engraved windows and integral power supply.

Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used.

Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area.

Annunciator alarm sequence shall be Automatic Reset Type/Automatic Reset First Out with First Out flashing and Reset Push Button as a minimum.

The design of alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

Analogue Signal Multipliers

They will provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20 mA one for the panel mounted indicator and other for PLC i/p. There will be total galvanic isolation between field I/Os and also between the 2 outputs.

Receiving Indicators/Controllers

All indicators/controllers shall be electronic (microprocessor based) programmable indicator and shall be mounted on the control panel located in the control room.

Notes:
Indicating instruments shall indicate various process parameters as per following measuring units, in general.

Flow	: M^3/Hr or MLD or LPS as per process requirement
Level	: m Meters
Pressure	: Meter head of water or Kg/Cm^2 as per process requirement
Temperature	: ^0C
Concentration	: ppm or mg/l (Parts per million or Milligram per litre)
Current	: A (Amperes)
Voltage	: V (Volts)
Power	: W (Watts)
Electrical Energy	: Whr (Watt-hours)
Frequency	: Hz (Hertz)
Speed	: RPM (Revolutions per minute)

Multiplying factors for flow scales shall be specified on manufacturers' name plate.

Field Mounted Instruments

Field mounted instruments shall, where possible, be hermetically sealed. If this is not possible, they shall be of weatherproof construction with heavy cases. Transmitters and similar equipment shall be further enclosed in purpose made weatherproof, glass reinforced fire-retardant polyester resin cabinets.

Particular regard shall be paid to the case of access to all instruments. Serial number/calibration plates shall be visible when the instrument is in its cabinet.

Locally mounted indicating instruments shall be mounted in viewable positions.

Field mounted instruments shall be complete with all mounting brackets, pillars, fittings and fixings to complete the installation.

Field Transmitters

Smart transmitters when used shall be used in analog mode only. Smart transmitters when specified shall have accuracy of 0.1% of span, as a minimum.

Differential Pressure type flow transmitter if used for congealing, corrosive and highly viscous services shall have diaphragm seal element with capillary.

Transmitter shall be capable of delivering rated current into external load of atleast 600 ohms when powered with 24V DC nominal voltage.

Push Buttons and Switches

Push buttons for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Illuminated push buttons where used shall be of a design that allows easy replacement of the lamps from the front of the panel.

If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer–in–charge before manufacture.

Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Instrument Connections

Electrical cable entry shall be ½" NPT(F). Suitable cable gland shall be used.
End connections shall meet the following unless, otherwise specified.
Threaded end connection shall be NPT as per ANSI/ASME B.1.20.
Flanged end connection shall be as per ANSI/ASME B16.5.

3. Instruments

Instruments as per following details and specifications shall be provided by vendor as minimum. Quantities mentioned, if any, are indicative only and contractor shall provide all necessary instruments described inthis section or as required for proper operation of the plant as described else where in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations. Bidder choosing to supply instrument with communication port suitable for process/ diagnostic data transfer with PLC/HMI need not consider analog signal and alarm contacts inputs to PLC.

All instruments, gauges and control equipment shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents.

a) Pressure Gauges

All pumps, compressors and air blowers shall have pressure gauge at their discharge lines. Pressure gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

Pressure gauge dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS: 3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure gauge dial size shall be of minimum 150mm and of white with balck engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of SS 304, Boudron Element/Socket of SS 316, movement parts of SS, weather proof to IP 65, offering accuracy of ± 1% of FSD. Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of diaphragm type pressure gauge, diaphragm/lower chamber wetted parts shall be os SS 316, upper chamber of SS 304/SS 316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection.

Following accessories shall shall be supplied as a standard with all pressure gauges.

Isolation Valve : Required, Gate/Ball Valve, SS 316
Manifold Valve : Required, SS 316, 3 Way 2 Valve type
Qty. : As Per SOQ

b) HYDROSTATIC TYPE LEVEL TRANSMITTER:

A.	**General**		
1	Location		Across Mechanical Coarse Screen
2	Function		To measure & transmitt Level
3	Type		Hydrostatic Type
4	Service		Sewage / Waste Water
5	Max. Operating Temperature		Ambient, 70 °C Max.
6	Max. Operating Pressure		Atm./ Upto 1 Bar
7	Installation		Outdoor/Field
B.	**Transmitter /Sensor**		
1	Type		2 Wire type
2	Power Supply		24 V DC (2 wire)
3	Measurement Range, mtr		As per SOQ
4	No. of Measurement Channels		One
5	Accuracy		±0.5% of full scale
6	Out put signal	Analog	4-20 mA
7	Measuring Principle		Hydro-static Pressure Measurement
8	MOC - Body		SS-316L
9	Measuring Cell		Ceramic / as per mfr. Std.
10	Seal MOC		Viton / as per mfr. Std.
11	Protection Class		IP 68
12	Process Connection/Mounting		Mounting clamp,MOC SS 316L
13	Cable Length		As per SOQ
14	Terminal Box/Housing		Required (IP-65 as a min)
15	Guide Pipe/Mounting Assembly		Required
C.	**Options / Accessories**		
a.	Mounting Hardware		Required
b.	Tag Plate		Required, SS 304
c.	Cable Glands		Required
d.	Canopy		Required

c) Ultrasonic Type Level Transmitter

Ultrasonic transmitter shall be provided to measure liquid level of Wet well. The purpose is to monitor sump levels and for start/stop of pumps in auto mode through suitable logic to be decided during detailed engineering.The specifications shall be as under.

a.	**General**		
1	Location of Measurement		To measure liquid level of Wet Well
2	Service		sewage
3	Function		To measure and indicate Level/Transmit
4	Operating Temperature		0 to 50 ^{0}C
5	Operating Pressure		Atm.
6	Installation		Outdoor
b.	**Level Transmitter/Sensor**		
1	Measuring Principle		Ultrasonic Non-contact type level measurement, Time of Flight method
2	Type		Microprocessor based, User Programmable, 4-Wire type, Remote Transmitter
3	Measurement Range		As per SOQ
	- Blanking Distance	Maximum	0-3-0.4 meter maximum
	- Sensor Meas. Range Selection		Sensor range shall be actual measurement range + Unit Free Board + Blanking Distance. Sensor shall be mounted above the top of sump by at least the blanking distance i.e. entire unit depth shall be measurable.
4	Temperature Compensation		Built-in, Automatic
5	Output Signal	Analog	4 -20 mA DC HART
6	Accuracy		± 0.5 % of measuring range
7	Resolution		± 3mm or suitable as per mfr. Std.
8	**Protection**		
a	Electric Area Classification		Safe
b	Enclosure	Type and Protection Class	Weather Proof to IP 66/68 minimum for transmitter
		MOC	Aluminium/PBT or equivalent as per manufacturers' standards
		Paint	Chemical Resistant/Epoxy Coating
c	Sensor	MOC	PVDF or equivalent as per manufacturers' standards
		Protection Class	IP 68
9	Cable Length - Sensor	Remote Transmitter	10 Meter
10	Process Connection (Mounting)		1.5"/2" NPT threaded or 3" or 4" Flanged or as per manufacturers' standards
11	Programmer		Built-in or Hand held type

12	Instrument Power Supply		100 to 240V AC ± 10%, 50 Hz ± 5% or 24V DC as per manufacturers' standards
13	Cable/Conduit Entry		1/2" NPT or M20 or equivalent as per manufacturers' standards
14	Local Indicator/Display	Level in mm or m	LCD Display
15	Scale Graduation/ Measuring Units		Engineering Units
c.	**Options/Accessories**		
1	Tag Plate		Required, SS 304
2	Cable Glands	Protection	Required, IP 65/66 as minimum
		MOC	Ni plated Brass or Polyamide (IP 67/68 only)
3	Plugs for additional cable entries		Close up Plugs shall be provided for all unused cable entries, SS 316/Polyamide/Equivalent
4	Cabinet for Transmitter	To prevent from direct sun and rain	Required. Lockable with transparent protection cover

Level readings shall be continuously displayed locally as well as in remote at Panel mounted indicator and PLC/HMI. Low-Low & High-High level alarms shall be flashed at HMI and annunciatead at Panel mounted hooter. The raw sewage pumps shall operate in level based auto mode i.e. start at set high level and stop at set low level. The working and standby pump shall be selected by operator at HMI or shall be determined by operating hours of pump such that pump with minimum operating hours shall start first & so on and in case of pump trip, pump with maximum operating hours shall stop first and so on. Also in case of power failure, the same shall be sensed by PLC and in such an event, the pump shall operate on programmed timer basis for start cycle till such time that all pumps turn off and after that it shall resume operation on level basis. Operating hours of pump shall be logged in PLC.

d) Float Type Level Switches

a.	**General**	
1	Type	Float Type
2	Operating Temperature	0 to 50 ^{0}C
3	Maximum Pressure	Atmospheric+Liquid Depth/Maximum 1 Bar
4	Specific Gravity	1.0 to 1.1
b.	**Float**	
1	MOC of Float	Polypropelene
2	Construction	Circular/Tubular/Bioconical
3	No. of Float	1
4	Protection	Minimum IP 68
5	Switch Type	Micro Switch, SPDT
6	Contact Rating	8A @ 230V AC (1 NO + 1 NC)
7	Cable	Inbuilt cable from float up to terminal box
8	Cable Material	Suitable for Fluid application
9	Cable Length	As per SOQ
10	Process Connection	Flanged 4" NB
11	Counter Weight (Ballast)	Required to ensure stable vertical

		position of the Float
	Support pipe for Clamping cable	
12	Adj. Stopper	As Applicable
13	Stopper/Ballast MOC	Rubber
c.	**Junction Box**	
1	Mounting	On Top of tank and sump, Flanged
2	Junction Box - MOC	Cast Aluminum
	Protection Class	IP 55
3	Connection Size	1/2" NPT/3/4" ET or to suit cable dia.
4	Electrical Area Classification	Safe
5	Process Connection	Through Flange
d.	**Accessories**	
1	Cable gland	Required
2	Mounting accessories	Required
e	**Locations / Service**	As per SOQ for Screen Upstream high level alarm of manual screen and Dry Run Protection of Pump (relay based logic to stop pump in any mode, auto or manual, of operation with necessary alarms at HMI and panel mounted hooter.alarms.

e) Receiving Indicators Mounted at ICP/LCP

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel located in the control room. Multiplying factors, shall be specified on manufacturers' nameplate, if applicable. Specifications, as applicable are as follows.

Process Indicator

Type	:	Microprocessor based, programmable
Input	:	4-20 mA
Display	:	4 ½ Digit, 7 Segment LED display
Display Units	:	% or Engineering Units, user programmable at site
Alarm Setpoint	:	Two nos. potential free relay contact rated at 5A @ 230V AC resistive load, adjustable over entire range
Transmitter Supply	:	Required, 24V DC @ 30mA
Retransmission Output	:	Required, 4-20 mA in 600 ohm load
Accuracy	:	± 0.25% of FSD
Terminals	:	suitable for up to 2.5 sq. mm. wires
Mounting	:	panel flush mounting
Power	:	110/230V AC, 50 Hz

Flow Indicator cum totaliser shall also have following in addition to above.

Totalising Counts/Hr	:	User Programmable at site
Totaliser Display	:	6/8 Digit Digital display with battery backup to retain totalized data in the event of power failure for a minimum period of 24 hours.

f) Electro-Magnetic Flow Measuring System (MAINS OPERATED)

Generally, the flow meter shall be as follows.

Flow metering System
Each flowmetering system shall consist of the primary transducer, earthing rings, the necessary signal converter and power supply unit and all cabling between the primary transducer and signal converter and power supply unit. Flowmeter in general shall be sized considering maximum design line velocity as specified in this tender specifications (2.5m/sec maximum for pumped flow).

Each of the signal converts/power supply units shall be supplied for remote mounting, unless otherwise specified.

The signal converts/power supply units shall be provided with a 4-20 mA output signal, linear with flow and suitable for retransmission to remote instrumentation.The above units shall operate from a 230 V AC/24V DC supply.

The contractor shall provide sufficient suitable cable to allow for the primary transducers to be situated up to **20** meters from their signal converters, unless a longer length is specified.
The Contractor shall provide full details of the cable; he proposes to use.

The general specifications for electromagnetic flow meter shall be as under.

Service		Sewage Application
Function		To measure and indicate Instantaneous Flow and Totalised Flow/Transmit (Flow)
Fluid Conductivity		> 5 µS/cm
Installation		Indoor or Outdoor, Below or Above Ground as per piping/site conditions
Operating Temperature		0 to 50 ^{0}C
Accuracy		**±** 0.5 % of Flow Rate/Measured Value or better
Flow Sensor/Tube/ Element		
Type of Sensor		Full Bore type
Flange Materials		CS/MS with anti-corrosive epoxy paint or better as per manufacturers' standards
Tube Material		SS 304 or SS 316
Liner Material		Hard Rubber
Body Material/Coil Housing		MS/CS or better with anti-corrosive epoxy paint
Electrode Material		SS 316L or Ha-C
Power Supply		From Transmitter
Grounding	Type/Material	Earthing Electrode/Set of earth rings SS 316
Protection Class		IP 68
Cable Entry (for separated/ remote version) and Glands		Shall be as per manufacturers' standards and suitable to maintain the specified protection class at site
Cable Length	Sensor to Transmitter	Minimum 20m, dual shielded cable
Painting, where applicable	CS/other	Chemical Resistant, Epoxy Painted
Transmitter		
Function		Transmit and Indicate
Type		Remote (Non-Integral) type, Microprocessor based, User Programmable, 2-Wire or 4-Wire type as

		per mfr. Std.
Flow/Velocity Measurement Range	Maximum Flow Velocity	Flowmeter shall be capable to measure flow with velocity up to maximum 5 meter/second
	Minimum Flow Velocity	up to 0.3 meter/second (shall measure flow without loss of accuracy up to 0.5 m/sec and below that, accuracy shall be as per manufacturers' standards)
Accuracy	Flow Velocity ≥ 0.5 m/s	± 0.5% of Flow Rate/Measured Value or better
	Flow Velocity < 0.5 m/s	as per manufacturers' standards for flow velocity up to 0.3 m/s
Analogue Output Signal	For Flow	Isolated, 4 -20 mA DC with HART/Modbus RS 485
Pulsed O/P		Required For Totalized flow
Instrument Power Supply		100 to 240V AC ± 10%, 50 Hz ± 5% or 24V DC as per manufacturers' standards
Cable/Conduit Entry		1/2" NPT.
Local Indicator / Display	Inst. and Total Flow	LCD Display (Instantaneous flow and 8/9 digit internal totalized flow)
Enclosure	Type and Protection Class	Weather Proof to IP 66 as minimum or better
	MOC	Cast Aluminum or equivalent as per manufacturers' standards suitable for withstanding harsh environment with chemical resistant/epoxy coating
	Type	Wall mounting/Pipe mounting
Vibration Conditions		Conformity with IEC 60068-2-6 or equivalent, shall be able to endure vibration, when in service, without any degradation in performance
Pipe Not Full (Partial Full) Detection/Empty Pipe Detection		Required
Cabinet for Transmitter	To prevent from direct sun and rain	Required. Lockable MSEP housing with front transparent door cover for viewing

Flow (Instantaneous and Totalised) readings shall be continuously displayed locally as well as at Panel mounted flow indicator cum totalizer and at PLC/HMI.

Flow meter shall be mounted as per manufacturer's recommendation and good engineering practices and each flow meter shall be provided with a bellows at suitable location to enable ease of removal/ insertion of flow meter for maintenance. For flow meter mounted below ground level, chamber shall be sized suitably to accommodate flowmeter and bellows in the same chamber.

4. PROGRAMMABLE LOGIC CONTROLLERS

Codes and Standards

PLC shall comply with International standards such as NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE.

Design and Construction Requirement

PLC hardware and software shall be from the same family and should be sourced from approved vendors only.

Programmable logic controller (PLC) shall be microprocessor based with 32 bit or suitable processor and be fully programmable and capable of performing control relay logic, including timing, counting, sequencing, and interlocking.

The PLC shall be high performance processors suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be some of the features of PLC.

The PLC shall have a modular/modular chassis design which allows for ease of future expansion. The processor module shall be easily removed from the I/O chassis for service or repair. The I/O chassis shall have slots for installing I/O cards, communications, or other special function modules. All I/O cards and modules shall be capable of being installed in any open slot in the chassis or DIN rail mounted. Module and channel level diagnostics should be standard feature.

The PLC shall have a suitable power supply and can be easily serviced or replaceable. The system shall be capable of being powered on 120V AC/230V AC/24V DC as per manufacturers' standards.

The PLC shall be rated to operate from 0 to 55 ± 5 ^{0}C, with a humidity rating of 10 to 95% ± 5% (non-condensing). All module circuit boards shall be encased and protected such that, when properly installed, they are not exposed to accidental contact by personnel or other objects.

The PLC shall be of high quality and reliability with replacement processors, power supplies, chassis, I/O and specialty modules that are readily available on an urgent or emergency basis. **All PLC/HMI products shall be fully supported and available for purchase for up to ten (10) years from the date of the original system purchase and shall be upgraded or maintained as requried till completion period of contract, at no extra cost and accorindgly any software or hardware getting obsolete shall be upgraded or replaced by contractor at no extra cost with prevailing latest version during this period. Further all softwater for PLC/HMI and HMI console (OS etc.) shall be with license for required update/re-installaiton as required in case of system crash or any such issue requiring re-installation.**

Basic Processor Functions

Real time control of output points for turning on and off digital devices such as motor starters and solenoids.
Read the status of real world digital inputs from limit switches, float switches, and other field devices.
Real time control of analog process control variables.
Read the status of real world analog set points and feedback values.
Perform timing, counting, sequencing, and interlocking functions for pump/equipment control.
Process local alarm handling functions

Math and Advanced Functions

Four function math in floating point or signed integer format Convert to/from BCD,
Data comparison and manipulation,
Scaling from integer data into engineering units such as flow, level and pressure,
Full PID Instructions for control of process control variables such as flow, level and pressure,
ASCII instruction set for interfacing to ASCII devices,
Compute instruction which executes mathematical expression and can be used for totalizing functions,
Trigonometric and Exponential math functions,
Real Time Calendar Clock for time stamping alarms and events.

Automatic restart of the system on resumption of power shall be provided.

The processor shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost. It shall also have the capability of EEPROM backup which automatically reloads the memory on a power cycle. The processor shall have the ability to automatically control the process on a power cycle, provided there are no major or unrecoverable processor faults.

Processor RAM memory shall be adequate and selected with at least 25-30% spare capacity for application program storage over the actual requirement, and also should be expandable for future expansions. Bidder shall demonstrate the spare capacity at the time of commissioning and after completion of entire logic development for the plant controls and monitoring as per the logic write-up to be furnished by Client/Consultant to the successful bidder after award of work.

Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up

All process parameters and electrical parameters as specified in the tender shall be monitored at HMI and necessary controls actions shall be initiated.

The PLC and SCADA System shall be provided either by PLC OEM or Authorized System integrator of PLC OEM only. In case of system integrator, required valid certificate from OEM shall be provided in this regards along with drawing/document submission.

Specific Requirements for PLC

(a)	Expandability in future	:	30% of installed capacity
(b)	Weather Protection	:	IP 20 for PLC hardware and shall be IP 52 of IS: 13947 when mounted in ICP
(c)	Power Supply	:	230V AC/24V DC
(d)	Interrogation Voltage	:	24V DC
(e)	CPU, communication module and power supply module	:	Required, high performance 32 bit or suitable CPU Module having modular configuration suitable for real time process application. CPU shall be of same family if provided at different locations.
(f)	Scan Time	:	0.7 Milliseconds or better for 1 K

			instructions
(g)	Key Switch for Processor	:	Shall be as per manufacturers' standards
(h)	Three way to configure channel	:	(1) Via BOOT P or DHCP (2) Manually by software
(i)	Mounting	:	Inside the main instrument/local instrument control panel
(j)	Inputs and Outputs	:	As required for process operation with an intention to maximise the automatic operation of equipment/plant and ease of operation and maintenance of the plant. Bidder shall submit the proposed I/O list along with their technical bid. However, the proposed I/O list shall not be limiting and bidder shall provide for I/O for the explained purpose.
(k)	System Loading	:	Maximum 60% under worst loading conditions
(l)	Power supply to Sensor/ Transmitters	:	Required
(m)	Type of Input	:	NO/NC – Contacts field selectable from programmer
(n)	Outputs	:	Relay outputs for driving MCC starter coils, driving motorized valves etc.
(o)	Spare I/O (Wired)	:	Minimum 2 nos. or 20% of each type of I/O, whichever is higher, at each panel/location, wired to terminal block
(p)	Interposing Relays	:	Shall be provided for all (Actual + Spare) the Digital Output (DO) including spare DO and for Digital Input where ever required
(q)	Interface (Hardware and Software) to HMI	:	Required (plug and play) ready to use type Remote data transmission facility (GSM/GPRS)
(r)	Printers for alarm, status, report generation	:	NA
(s)	HMI	:	10" color touch screen
(t)	Type of Protocol on communication port	:	The data communication shall be based on GSM/GPRS with required communication port and modem suitable for GPRS data communication on 4G network and SIM card at SPS site for Remote data transmission in future through (GSM/GPRS) to Central SCADA of Client.
(v)	Tests	:	Functional test (simulated) for complete system Test for monitoring function Factory acceptance test (to be witnessed by Client/Client's representative Simulation test for all logic/loops (to be witnessed by Client/Client's representative Vendor to submit all Test Certificates for Client/Consultant's review.

Input/Output Modules

(a) Standard DIN Rail/rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with preferably pre-fabricated cables and plug in card type connectors.

(b) Minimum 2 numbers or 20% of each type of I/O, whichever is higher, extra I/O's of installed capacity for each type shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules of the installed capacity.

(c) Discrete Input Cards: Solid-state input circuits rated for 10-30V DC operation. Cards must be available in 8 or 16 or 32 point configurations and shall source current to the field device. Each input point shall have a status LED which indicates the ON or CLOSED condition for that field sensor or switch. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring online while system is running.

(d) Discrete Output Cards: Solid-state output circuits rated for 24V DC operation. Cards must be available in 8 or 16 or 32 point configurations and shall be able to operate a control relay. Each output point shall have a status LED which indicates the ON condition of the output. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring. The control relay-contact shall be rated for 5A @ 240V AC or 5A @ 125V DC. The control relay shall have a LED indication to show the status of the control relay.

(e) Analogue Input Cards: Analog inputs shall capable of reading in 0 to 20 mA or 4 to 20 mA signal. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

(f). Analogue Output Cards: Analogue Outputs shall be capable of outputting 0 to 20 mA or 4 to 20 mA signals. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

Communications

(a) The remote data communication shall be based on GPRS with required communication port and modem suitable for GPRS data communication on 4G or higher network of selected service provider for remote data transmission to central SCADA of client for remote monitoring and control of WDS functioning from client control room. Ethenet switch shall be of industrial grade only.

(b) RS 232/RS 485/Etherenetor other such required port/s for the program upload/download, on-line editing, peer-to-peer messaging, data acquisition and man machine interface.

(c) One Modbus Converter port for connecting devices over network for data acquisition from Energy analyzers/soft starters/temperature scanners etc. Bidder to include connectivity of all energy analyzers of alogn with required cabling in the scope of work.

General specifications for HMI shall be as under.

1	HMI shall be with 10" wide size TFT Colour LCD touch screen display with 800 x 400 dots resolution as a minimum.
2	HMI shall have LED backlight.
3	HMI shall have FRAM/ROM of 10 MB and SRAM of 128 KB as a minimum.
4	HMI shall have 1 number 485 Port and 1 number RS 232 port as a minimum. Ethernet port shall be available as an option.
5	HMI shall be with 1 no USB Port to permit insertion of pen drive for data backup and 1 number mini USB port (for programming/printing as required) as a minimum.
6	HMI shall have built-in RTC with Lithium primary battery.
7	HMI shall be suitable to operate for ambient temperature of 50 ^{0}C and 95% RH.
8	HMI shall be provided with built-in software for viewing HMI screen on LAN (with Ethernet port).
9	HMI shall be provided with 64 GB removable pen drive for recording historical data and streaming.

Specifications for GPRS Modem shall be as under.

1	Modem shall support SIM 900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G or latest network.
2	Modem shall have built-in RS 232 serial interface port/Ethernet/suitable port/SIM.
3	Modem shall have built-in Network Status LED.
4	Modem shall have built-in Sim card holder.
5	Modem shall have configurable Baud Rate.
6	Modem shall operate with input voltage of 24V DC.
7	Modem must have auto reset facility when network resume.

Contractor shall provide minimum of 3 sets of as-built control panel wiring drawings, PLC logic write-up, I/O schedule/assignment, ladder diagram and other relvant documents in hard copy format and 3 sets in soft copy form on CDs. Soft copy format shall be in editable form to enable incorporating any changes in future. 3 sets of application program as back-up shall also be provided in soft form on CDs. All application programs shall be without password protection and as per final approved scheme ready to install and use by client and same shall be demonstrated by Bidder prior to acceptance of system at site.

Bidder to note that the operation philosophy/logic specified any where in tender specifications is indicative only and same shall be submitted by successful bidder as per requirement and to ensure smooth and trouble free operation with minimum manual intervention during detailed engineering for review and approval and shall carry out all software development as per approved philosophy only.

5. Uninterruptible power Supply

UPS of suitable capacity as per following specifications for minimum 60 minutes back-up for PLC System shall be supplied for entire load of instrument control

panel including PLC and essential/ critical instrument supply for necessary shut-down in case of power failure.

(a) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non-linear load.

(b) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.

(c) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

(d) The UPS shall incorporate a DC under voltage trip circuit to Electro-mechanically trip the UPS output in order to protect the batteries.

(e) The noise level of the unit shall not exceed 50 dB(A) at 1 m from the UPS cabinet.

(f) The output of the inverter shall be a sine wave having less than 3% THD for linear loads and less than 5% for 50% non linear loads. It shall be suitable for load power factors 0.8 lag to 0.9 lead.

(g) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than ± 4% with a recovery of less than 4 ms. The load crest factor shall not be less than 3:1.

(h) Indicators shall be provided for the following.
i. UPS status
ii. PS alarm conditions

(i) The UPS shall provide volt free contact outputs for the following purpose.
i. Warning (viz. low battery voltage),

(j) The UPS shall have an overloaded capacity of 110-125 % for 30 seconds and shall be protected in the event of a short circuit of the output.

(k) The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.

(l) Terminals shall be shrouded to prevent accidental contact
The Uninterruptible Power Supply (UPS) System with SMF Lead Acid battery shall conform to the minimum following specifications.

i. Input

Input Voltage	: 230V ± 5%
Frequency	: 50 Hz ± 5%
Nominal DC Input (Battery)	: Bidder to design and submit calculations

ii Output

Output	: 230V AC, applicable KVA with 25% margin as per Load Calculation
Regulation Mode	: ± 1%
Load Power Factor	: 0.8 to Unity
Duty	: Continuous

	Ripple on DC	: < 2%
iii	**General**	
	Principle of Operation	: Solid State, PWM (Pulse with Modulation)
	Cable Entry	: Bottom
	Cooling Method	: Forced Air
	Type of Battery	: Sealed Maintenance Free
	Alarms	: Potential free contact for Power Healthy, Fault and Battery Low to be provided

6. Installation Materials

Vendor shall supply all erection hardware required for the installation of complete instrumentation forming part of this tender.

This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping/tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

A) Cables

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between panel room and the unit. Specifications for cables for analog signals, digital signals and instrument power cables shall be as follows.

Cables for Analogue Signals

Cables shall be of 660V/1100V grade, single or multi-pair cables, annealed, tinned, high conductivity 1.5 sq. mm stranded Copper conductor, PVC insulated two cores twisted into pair, laid up collectively, individual pair shielded and overall shielded with aluminium mylar tape, ATC drain wire running continuously in contact with aluminium side of the tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS: 1554 and IEC 189 Part II shall be used for analog signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. For multipair cable, Pair identification as per BS 5308 Part-II marking pair no. for each pair shall be provided at maximum 50mm between two consecutive numbers.

Cables for Digital Signals

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq. mm stranded, tinned Copper conductor, PVC insulated, overall shielded with aluminium mylar tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS: 1554 and IEC 189 Part II shall be used for digital signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible. Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Color coding for cables upto 5 cores shall be as per IS.

Cables for Instrument Power Supply

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq. mm, stranded, tinned copper conductor, PVC insulated, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS: 1554 and IEC:189 Part I and II shall be used for instrument power supply. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter.

Laying of Cables

Cables shall be laid on trays, in trenches, conduits, ducts as necessary. Instrument cables shall not be buried in ground as far as possible. Cable joints in instruments signal and power supply cables shall not be permitted. In case if some of the instrument cables are to be buried in the ground, it shall be as per standard/good engineering practice and shall be subject to Client's/Consultant's approval.

The contractor shall also supply necessary materials such as junction boxes, glands, lugs etc. required for termination of cables. Each cable shall be terminated to individual panel/terminals box. Cable glands shall be of Nickel Plated Brass and of Double Compression Weather proof type.

Cable schedule, cable and tray layout shall be approved prior to execution.

A distance of minimum 300mm shall be maintained between the cables carrying low voltage AC and DC signals and a distance of minimum 600mm shall be maintained between cables carrying HV and LV cables.

Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by contractor. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedule. Identification tags shall be securely fastened to the cables at both ends.

B) Cable Glands

Cable glands shall be nickel-plated brass and shall be of double compression type suitable for armored cables.

Flame proof gland wherever required shall be with Ex(d) certification.

C) Instrument Valves (Miniature Type) and Manifolds

Body rating shall be as per piping class or better. Valve body and Trim material shall be SS 316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

D) Pipe and Tube Fittings

Tube fitting shall be flareless compression type and of three piece construction of Swagelok/Parker Hannnifen make.

Ferrule shall be of SS in general.

Socket Weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 lbs. Weld neck fittings shall be used where socket weld is not allowed by piping class.

For air service instrument brass fittings suitable for use on copper tubes conforming to ASTM B 68/B 68 M shall be used. It shall be manufactured from Bar Stock or equi and shall be nickel plated.

E) Perforated Cable Trays

All branch cables/tubes, cables on various civil units/structures shall run on cable trays only.

Cable trays shall be made out of galvanized mild steel sheets of 2 mm thickness with required accessories. All material shall be hot dip galavanized as per IS: 2629. The width shall be so selected that 40-50% space is available for future use.

Suitable cable clamps shall be supplied for binding cables/tubes at every 500mm.

F) Junction Box

Junction box material shall be Cast Aluminium (LM-6) only and shall be weather proof to IP 65. Flame proof junction boxes shall be supplied with Ex(d) certification in addition.

The boxes shall have terminals suitable for a minimum of 4 mm^2 cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2 numbers, whichever is higher, spare entries of each size. Spare entries shall be provided with plugs

7. Inspection

- The PLC/SCADA based control panels shall be offered for inspection at manufacturers' works prior to dispatch as per approved QAPs and FAT. This inspection shall be jointly witnessed by the Client/PMC/TPI representatives.

- All electro-magnetic flow meters shall be provided with manufacturers' calibration certificates. Additionally the quantity of flow meters to be witnessed for wet calibration (3-Point Calibration, 3 Separate point) and as per approved Quality Assurance Plan (QAP) by Client/PMC/TPI representatives as applicable shall be as specified below.

Meter Size	**Wet Calibration to be witnessed for each size / Class and type of Flow Meter (in addition to vendor's Internal Test Certificates as per Note below)**
up to **≤** 500 mm dia.	Visual and wet calibration witnessing is not required. Vendor to submit internal test certificates only as per note below for review and approval and dispatch clearance prior to dispatch.
> 500 mm and up to **≤** 900 mm dia.	5% Quantity of entire lot or Minimum One Number whichever is higher per type or size or class of meter.
> 900 mm dia.	10% Quantity of entire lot or Minimum One Number whichever is higher per type or size or class of meter.

Note: (1) Manufacturer shall test all the meters internally and shall provide their internal test records along with material test certificates, dimensional check certificates etc. OR manufacturers' Certificate of Compliance as per approved QAP for review, record and dispatch clearance prior to dispatch of material.
(2) Further all electro-magnetic flow meters shall be provided with manufacturers' calibration certificates.

The flow calibration and testing should be as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - weighing method) and shall be calibrated for minimum 3-Point Calibration (3 Separate point). Performance Type Testing Certification (ISO 9104) strictly not acceptable. The manufacturer shall also have flow calibration and testing facility in India or abroad so that methodology and procedures can be verified and each meter shall be tested and wet calibrated before shipment by the manufacturer. The flow calibration and testing facility shall be duly accredited in accordance with ISO 17025 standards.

- For all Indian manufacturers', their flow calibration and testing facility shall be accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL). However if that is not the case, the flow meter(s) shall be subjected to wet calibration at any NABL accredited laboratory/FCRI, Palakkad, Kerala.

- For all manufacturers outside India, flow calibration and testing facility should be accredited by reputed International Authority such as RVA, NMi, PTB etc.
  Further for all imported flow meters, contractor shall arrange to inspect/witness for wet calibration by any reputed third party inspection agency (SGS/Bureau Veritas/TUV etc.) as per approved QAP/inspection plan at manufacturers' works. The test/performance certificates and relevant supporting documents shall be submitted to Client/TPI for review and approval prior to dispatch. Flow meters shall be dispatched only after obtaining dispatch clearance from Client/PMC/TPI. Additionally, if specifically instructed by the Client/PMC/TPI simultaneous inspection/witness for wet calibration shall be offered virtually to Client/Client representative.

- For rest all instruments Test/Calibration Certificates shall be reviewed and approved prior to dispatch clearance.

All equipment/instruments/materials shall be dispatched only after obtaining dispatch clearance from client.

Approved Vendor List for Instrumentation System

Sr. No.	Description	Vendors/Manufacturers
1	Ultrasonic/Hydrostatic Level Transmitter	SIEMENS, ENDRESS + HAUSER, EMERSON, KROHNE, ABB
2	Electromagnetic Flowmeters	SIEMENS, ENDRESS + HAUSER, EMERSON, KROHNE, ABB, AAROHI EMBEDDED SYSTEMS, SBEM, ADEPT FLUIDYNE, ADDMASS
3	Pressure Transmitter	SIEMENS, ENDRESS + HAUSER, EMERSON, KROHNE, ABB
4	Analyzers	HACH, EMERSON, ENDRESS + HAUSER, WTW/XYLEM
5	PLC, SCADA, HMI	SIEMENS, SCHNEIDER, ROCKWELL, GE,

		ABB, HONEYWELL
6	Panel Enclosure	RITTAL, SCHNEIDER, ELDON
7	Power Cables	R R KABLE, POLYCAB, HAVELLS, UDEY PYRO, ASSOCIATED CABLES, BROOKS CABLES
8	Instrument Signal Cable	R R KABLE, POLYCAB, HAVELLS, UDEY PYRO, ASSOCIATED CABLES, BROOKS CABLES
9	UPS System	EMERSON, APC, MERLIN GERIN, SOCOMEC
10	LED/LCD TV	SAMSUNG, SONY, PANASONIC
11	Panel Mounted Indicators	MASIBUS, LECTROTE, NISHKO, NIVAM, SELEC
12	Float Type Level Switch	LEVCON, NIVO/TOSHBRO, PUNE TECHTROL, SBEM, SAPCON
13	GSM/GPRS MODEM	MAESTRO, AXITECH, D LINK, NETGEAR, MOXA, ROBUSTELL
14	Cable Tray	M. M. ENGINERING, GLOBE, JACINTH, SILVERLINE POWER
15	Cable Glands	EX-PROTECTA, BRACO, SUDHIR, COMET, CONNECTWELL
16	Junction Box	EX-PROTECTA, CEAG, SUDHIR, BALIGA, FCG
17	Tube Fittings	EXCEL HYDROPNEUMATIC, MULTIMETAL, PLACKA, WESMEC, FLUID CONTROL
18	Instrument Valve and Manifold	APTEK, ANMOL (SUPERLOCK), EXCEL HYDROPNEUMATIC, GENERAL, SMART
19	Miniature Relay	OMRAN, PHOENIX, ROCKWELL, SCHNEIDER
20	Indication Pilot Lamps (LED Type)	TEKNIC, SCHNEIDER, SIEMENS
21	Push Button/Selector Switch (With NO/NC Element)	TEKNIC, SCHNEIDER, SIEMENS
22	DC Power Supplier (DIN Rail Mounted)	PHOENIX, OMRAN, APLAB, SCHNEIDER, ROCKWELL
23	Terminals	ELMEX, PHOENIX, WAGO, CONNECTWELL
24	Panel Wires	FINOLEX, HAVELLS, R R KABLE, L & T
25	Panel Illumination	PHILIPS, CROMPTON, GE
26	Float and Board Type Level Gauge	TOSHNIWAL, NIVO CONTROLS, PUNE TECHTROL, SAPCON
27	Panel Mounted Indicators	MASIBUS, SELEC, MULTISPAN, NIVAM, NISHKO, LECTROTE
28	Pressure Gauge	BAUMER, GIC, EXCEL, H GURU, MANOMETER (I) PVT. LTD; PRICOL

Note: The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list. Final selection will be done with the approval of Engineer-in-charge.

SPECIFICATIONS
FOR
OPERATION AND MAINTENANCE WORKS

SPECIFICATIONS FOR OPERATION & MAINTENANCE WORK

1.0 ADMINISTRATIVE PROVISIONS

The following additional clauses shall apply only during Two Years of Operation and Maintenance period for entire system of sewage pumping station.

1.1 DEFINITIONS

1.1.1 In this Agreement, the following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires:

1. **"Contract"** shall mean the agreement between the Client and the Contractor along with all documents incorporated therein by reference and all documents incorporated by these Conditions of Contract.
2. **"Contractor's Equipment"** shall mean all equipment, instruments, tools, machinery and other appliances and things of whatsoever nature required for the fulfillment of the Contract or of the Contractor's Obligations, but not including those items which are intended to form, or which form part of the Facility.
3. **"Contractor's Obligations"** shall mean the obligation to execute the Project in its entirety and shall, without limitation, include the Contractor's Operation and Maintenance.
4. **"Taking Over Certificate"** shall mean the certificate to be issued when the whole of the Works or any sections or parts of the Permanent works have been substantially completed and satisfactorily passed the tests on completion in accordance with the provisions of the Contract.
5. **"Date of Taking Over"** shall mean the date of issue of the "Taking-Over Certificate" under the construction phase.
6. **"Defects Liability Period"** shall mean the Defects Liability Period of 2 (Two) years for all works commencing on and from Date of Taking Over during which the Contractor shall undertake the responsibilities, and have the liability for the facility (including Civil Works, mechanical and electrical installations including all allied works at sewage pumping station(s).
7. **"Facility"** shall mean the entire system to be designed and constructed in accordance with the provisions hereof, including the buildings, structures, ramps, pits, pipes, fencing, lighting, testing and analysis equipment, tools, mechanical, electrical as well as safety equipment, Sewage pumping machinery, supplies, instruments and inventory incorporated therein, as well as all open areas within the site, and including any additions, modifications, alterations, replacement and repairs as may be made thereto from time to time.
8. **"Authority"** shall mean any municipal corporation, authority or body exercising executive, legislative, judicial, regulatory or administrative functions, including, without limitation, any Government/Semi Government authority, agency, department, board, commission or instrumentality of Indian or any political subdivision thereof, court, tribunal, arbitrator or self-regulatory organisation.
9. **"Law"** shall mean and include all the provisions of all Indian statutes, regulations, ordinances, codes, official or other standards, administrative or other rules, zoning and other plans and restrictions, building and other permits, judgements awards and decrees of, or agreements with any Governmental, semi-Governmental or quasi-Governmental Authority, Municipal Corporations etc. as currently in effect or as may be in effect from time to time and /or as may be amended or supplemented from time to time.

10. **"Maintenance Standard"** shall mean the requirements for maintaining, repairing, and renewing the Facility :
    a) As set forth in the O & M Manual;
    b) Required pursuant to applicable Laws;
    c) As may be necessary for keeping the facility in a satisfactory condition such that the Facility will continuously, comply with the Operation Standards; and
    d) As may be necessary to ensure that the Facility shall continuously be in an optimum condition and state in relation with the lifetime of the Facility.
11. **"O & M Manual"** shall mean the final Manual for the Operation and Maintenance of the Facility to be prepared by the Contractor in accordance with the Bid Documents.
12. **"Operation and Maintenance Obligations"** shall mean the obligation of the Contractor pursuant to the Agreement to operate and maintain the Facility on and from the Date of Taking Over until the date of completion of this Agreement.
13. **"Operation and Maintenance Period"** shall mean the period starting on the Date of Taking Over and continuing for the term of the Agreement.
14. **"Operation and Maintenance Price"** shall mean the amount payable by the Client to the Contractor, for the fulfillment of the Contractor's Operation and Maintenance Obligations.
15. **"Operation Standard"** shall mean :
    a) The Performance Guarantees;
    b) All applicable Laws;
    c) All of the requirements, policies and procedures set forth in the O & M Manual
    d) All other operational requirements set forth in this Agreement.
16. **"Performance Guarantees"** shall mean the List of Guarantees offered/provided by the Contractor in its Bidder Submission pursuant of the Bid Documents.
17. "Site" **shall mean that specific area specified in the Bid Documents and shall include any other places as may be specifically designated by the Client from time to time as forming part of the Site.**

1.2 OBJECT OF CONTRACT

1.2.1 **RISKS AND OBLIGATION OF THE CONTRACTOR**

1.2.1.1 For the duration of COMPREHENSIVE O & M period, Contractor shall render and make available to the Client the following services.

a) During testing and commissioning work, required sewage and power will be the scope of Contractor.
b) Drawl of sewage from the inlet chamber of sewage pumping station and passing through screens and collected into wet well and from the wet well to sewage pumping and then transfer of sewage up to proposed point of location to join the sewage into large size sewer through rising main.
c) Control and Operation of Sewage Pumping Station with supply of all necessary spares, tools, consumables, lubricants etc.
d) Routine Maintenance of all Buildings, mechanical and electrical installations and equipment and areas; at the site of sewage pumping station.
e) Management of the sewage pumping station in administrative and financial operations connected to Sewage pumping management.
f) Training of O & M staff of the Client.

1.2.1.2 The Contractor shall take full responsibility for the care of the Facility and materials and Sewage pumping from the date of issue of the Taking-Over Certificate for the whole of the Works, until the date of completion of the Operation and Maintenance period, when the responsibility for the care shall pass to the Client.

1.2.1.3 If any loss or damage happens to the Facility, or any part thereof, or materials or Sewage pumping for incorporation therein, during the period for which the Contractor is responsible for the care thereof, from any cause whatsoever, other than the risks defined in Sub-Clause 1.2, the Contractor shall, at his own cost, rectify such loss or damage so that the Facility conform in every respect with the provisions of the Contract to the satisfaction of the Client. The Contractor shall also be liable for any loss or damage to the Works occasioned by him in the course of any operations carried out by him for the purpose of complying with his obligation.

1.2.1.4 In the case of a combination of risks causing loss or damage any such determination shall take into account the proportional responsibility of the Contractor and the Client.

1.2.2 **RISKS AND OBLIGATION OF THE CLIENT**

1.2.2.1 For the duration of COMPREHENSIVE O & M Contract, Client will supply power only.

1.2.2.2 Provide free access to the site and the Sewage pumping and all its components free of charge.

1.2.2.3 Make payments to the Contractor according to the terms of this Contract as specified herein after.

1.2.2.4 If the Client shall carry out work on the Site with his own workmen he shall, in respect of such work.

a) Have full regard to the safety of all entitled to be upon the Site, and

b) Keep the Site in an orderly state appropriate to the avoidance of danger to such persons.

1.2.2.5 If the Client shall employ other contractors in the Site, he shall require them to have the same regard for and avoidance of danger.

1.3 COMMENCEMENT AND DURATION OF COMPREHENSIVE O & M CONTRACT.

1.3.1 The O&M Period shall commence upon issuing of Taking-Over Certificate under the construction phase of the project and shall continue for a period of **Two (2) year, including defect liability period** as mentioned in the Conditions of Contract.

In event of any electrical and mechanical fault, the contractor has to attend the same immediately.

1.4 LIABILITY

1.4.1 The Contractor will not under any circumstances be liable for costs or loss of profit that the Client may incur as a result of the unavailability of the Sewage pumping on account of force major.

1.5 INSURANCE

1.5.1 The Contractor shall, without limiting his or the Client's obligations and responsibilities, insure.

a) The Works, together with materials and Sewage pumping for incorporation therein, to the full replacement cost (term "cost" in this context shall include profit).

b) The Contractor's Equipment and other things brought onto the Site by the Contractor, for a sum sufficient to provide for their replacement at the Site.

1.5.2 The insurance detailed above shall be in the joint names of the Contractor and the Client at the Contractor's cost and shall cover the Client and the Contractor against all loss or damage from whatsoever cause arising, other than as provided from the start of the operation and maintenance until the date of completion of operation and maintenance in respect of the Facility or any Section or part thereof as the case may be.

1.5.3 Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with their responsibilities.

1.5.4 The Contractor shall, except if and so far as the Contract provides otherwise, indemnify the Client against all losses and claims in respect of :

a) Death of or injury to any person, or,

b) Loss of or damage to any property (other than the Works),

Which may arise out of in consequent of the Operation and Maintenance of the Facility and the remedying of any defects therein, and against all claims proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto, subject to the exceptions defined above.

1.5.5 The "exceptions" referred to are:

a) The permanent use or occupation of land by the Works, or any part thereof.

b) The right of the Client to execute the Works, or any part thereof, on, over, under, in or through any land,

c) Damage to property which is the unavoidable result of the execution and completion of the Works, or the remedying of any defects therein, in accordance with the contract, and

d) Death of or injury to persons or loss of or damage to property resulting from any act or neglect if the Client, his agents, servants, or other contractors, not being employed by the Contractor or in respect of any claims, proceedings, damages, costs, charges and expenses in respect thereof or in relation thereof or, where the injury or damage was contributed to by the Contractor, his servants or agents, such part of the said injury or damage as may be just and equitable having regard to the extent of the responsibility of the Client, his servants or agents or other contractors for the injury or damage.

1.5.6 The Client shall indemnify the Contractor against all claims, proceedings, damages; costs, charges, and expenses in respect of the matters referred to in the exceptions defined above.

1.5.7 The Contractor shall, without limiting his or the Client's obligations and responsibilities as above, issue in the joint names of the Contractor and the Client, against liabilities for death of or injury to any person or loss of or damage to any property (other than the Facility) arising out of the Operation and Maintenance of the project other than the exceptions defined.

1.5.8 The insurance policy shall include a cross liability clause such that the insurance shall apply to the Contractor and to the Client as separate insurers.

1.5.9 The Client shall not liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or any Subcontractor, other than death or injury resulting from any act or default of the Client, his agents or servants. The Contractor shall indemnify and keep indemnified the Client against all such damages and compensation, other than those for which the Client is liable as aforesaid, and against all claims, proceedings, damages, costs, charges, and expenses whatsoever in respect thereof or in relation thereto.

1.5.10 The Contractor shall insure against such liability and shall continue such insurance during the whole of the time that any persons are employed by him on the Facility. Provided that, in respect of any persons employed by any Subcontractor, the Contractor's obligations to insure as aforesaid under this Sub-Clause shall be satisfied if the Subcontractor shall have insured against the liability in respect of such persons in such manner that the Client is indemnified under the policy, but the Contractor shall require such Subcontractor to produce to the Client, when required, such policy of insurance and receipt for the payment of the current premium.

1.5.11 In the event that the Contractor or the Client fails to comply with conditions imposed by the insurance policies effected pursuant to the Contract, each will indemnify the other against all losses and claims arising from such failure according to the Contract Conditions.

1.6 STAFF

1.6.1 All Contractor's staff employed at the Sewage pumping at any time during the period covered by the present Contract will be provided by him. The Client is not liable for staff in any way and cannot be held responsible in the event of litigation of any sort between the Contractor and members of Sewage pumping staff or their representatives.

1.6.2 All decisions related to staff numbers and qualifications should be approved by the Client.

1.6.3.1 The Contractor undertakes to comply with applicable legislation and the code of labour law on matters of health, hygiene and safety, and shall assume responsibility for works required in the event of any change in applicable regulations.

1.6.3.2 The Contractor shall provide the following staff for the operation & maintenance :

(1) Pump Operator : 1 No. per shift (XII Pass with Minimum 2 years of experience)

(2) Helper cum Operator : 1 No. per shift (X Pass with Minimum 2 years of Experience)

(3) Security/Mali/Sweeper : 1 No. for General Shift (Minimum 8th Standard Pass)

During COMPREHENSIVE O and M period of 24 hours a day and 7 days a week, minimum one person must be present on sewage pumping station. Person must be ITI Fitter / Electrician / Wireman trade passed for operation work of electro-mechanical equipment of sewage pumping station and this person must be for work of security also during night shift.

1.7 PENALTY

Failing the execution of the operation, maintenance, servicing and comprehensive repairing work as per the tender document, the penalty will be applicable as per the mention in the tender. If the penalty occurs three times in the month, then the contract shall be liable to terminate, security deposit shall be forfeited and party shall be black listed in the RMC.

1.7.1 Due to negligence, forgetfulness and irresponsibility of contractor's staff, if pump sets and machinery remains in non-usable condition/idle for more than two days, then in such a case penalty as mentioned below shall be recoverable from contractor's O and M bill. If such incidents occur three or more times in one month, then RMC can terminate the O and M Service and Comprehensive repairing work contract.

Idleness up to 7 days : Rs. 300/- per day per pump
Idleness for 8 days and above : Rs. 700/- per day per pump

Maximum ceiling of penalty shall be Rs. 10,000/- per month subject to 20 % of monthly O and M charges, whichever is higher.

1.7.2 Spare pumps shall also be kept ready for operation. If spare pump is not ready for operation for work more than five days RMC will deduct Rs. 500/-per day per pump as penalty from their bill.

1.7.4 If fault occurs in transformer, H.T. breaker or any electrical machineries that should be rectified or faulty parts should be replaced within 48 hours. Otherwise penalty of Rs. 5000/- Per day will be deducted from the contractor's bill.

1.7.5 (A) If the Contractor does not recruit/deploy the 'Personnel' identified as per the schedule or remain absent then penalty/Liquidated Damages will be deducted as follows.

For Pump Attendant : Rs. 500/- per person per day.
For Helper : Rs. 400/- per person per day.

(B) Force majeure means an event beyond the control of the contractor and not involving the contractor's fault or negligence and not force able. Such events may include but are not restricted to, acts of the contractor either in

its sovereign or contractual capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions and freight embargoes.

1.8 TERMINATION

1.8.1 Termination by the Client

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.8.2.1 Termination by the Contractor

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.9 FORCE MAJEURE

The relevant clause of the General Conditions of Contract shall be applicable in this case.

1.10 CONTRACT INTERPRETATION AND DIPUTES SETTLEMENT

1.10.1 The relevant clause for Amicable Settlement of Disputes of the General Conditions of Contract (Part I) shall apply.

1.11 ASSIGNMENT

1.11.1 The Contractor will not be entitled to sub-contract any part of his obligation to any third party without prior approval of the Client.

1.12 COMPLETION OF THE CONTRACT

1.12.1 On the date of Contract Completion or if the Contract is terminated, all the installations, works and equipment placed under the Contractor's responsibility shall be handed over to the Client, at no cost, in good working order, except for normal wear and tear. The Client may perform any inspections, tests or expert appraisals he shall consider necessary with a view to checking that the property is in good working order.

1.12.2 At the end of O&M period, the Contractor shall be entitled to receive an Operation and Maintenance Completion Certificate within twenty-one (21) days, of the completion of the Contract.

1.12.3 The delivery of such Completion Certificate will relieve the Contractor from his responsibility as regard to the Operation and Maintenance and confirm that the Contractor has fulfilled all of his obligations under the contract.

2.0 TECHNICAL PROVISIONS

2.1 NOT USED

2.2 MAINTENANCE

2.2.1 The Contractor shall be responsible for routine as well as corrective (preventive) maintenance of hydraulic, mechanical, electrical equipment as well as miscellaneous equipment and instruments as described in Conditions of Contract for O & M.

2.2.2 The Contractor shall be responsible for carrying out regular servicing and lubrication of machines, complying with maintenance instructions as defined in the Operation and Maintenance manual, and ensuring that electromechanical equipment and motors operate correctly at all times.

2.2.3 The Contractor shall ensure that measurement systems operate correctly at all times.

2.2.4 The Contractor is responsible for the maintenance of the landscaped areas inside the client's Sewage pumping fences.

2.2.5 The Contractor shall be responsible for maintenance of civil structures including inlet and screen chambers as well as wet and dry well, sewage pumping machineries as well as mechanical and electrical installations/equipment.

Performance Standards

The Contractor will operate and maintain in a state of continuous operational readiness all Sewage pumping and systems to meet the incoming flow. It shall remain the Contractor's responsibility to ensure that sewage pumping systems are at all times able to operate to the maximum capacity of the installed duty Sewage pumping.

All Sewage pumping installation shall be operated within their designed limits. The Contractor shall operate the Sewage pumping strictly within these operating ranges and shall manage the operation of the sewage pumping to achieve optimum performance as far as possible.

2.3 CONSUMABLES AND UTILITIES SERVICES - SPARE PARTS - STORES

2.3.1 CONSUMABLES AND UTILITIES SERVICES

2.3.1.1 Unless stipulated otherwise elsewhere in the document, for the duration of the COMPREHENSIVE O and M period, the Contractor will be responsible for the supply and control of lubricants, spare parts, tools and consumable materials excluding electrical power, necessary for the continuous operation of the works.

2.3.1.2 The Contractor will manage the consumables and utilities services to ensure their most economic consumption and to minimize wastage.

2.3.1.3 Power required for COMPREHENSIVE O & M for 2 (Two) years will be supplied free of cost by the client from Power Supply Company. Only Diesel for the power generator set (DG Set) shall be provided by Client/RMC. Any other serviceable parts and lubricants oil, grease etc. for the DG Set shall be supply by contractor at his own cost. For the usage of diesel proper record shall be maintained by contractor. If any other energy required for COMPREHENSIVE O and M will have to be borne by contractor.

2.4 SPARE PARTS AND STORES

2.4.1 The stores' inventory, the issuing and recording of spare parts will be the responsibility of the Contractor.

2.4.2 The Contractor is also responsible for providing required spare parts, tools and any other material required during year of operation and maintenance period by **free of cost**, and also bare the cost of storing and safeguarding also.

2.4.3 The Contractor will make all necessary arrangements to ensure the continuous supply of spare parts and material for the works as would ensure uninterrupted operation and shall be supplied free of cost.

2.4.4 Spare parts shall be supplied by the Contractor and the same will be used during 2 (Two) year operation and maintenance period free of cost. Any spare parts not used during the O&M period shall be handed over to the Client at no cost.

2.4.5 The quality of spare parts, lubricants etc. required for COMPREHENSIVE O and M activities will be checked frequently by the Engineer-in-charge or his representative and the quality / brand of each will be approved. The material without approval shall not be allowed to be used and such material shall be immediately removed from the site in presence of the Client with a letter, addressed to the Engineer-in-charge as a confirmation.

2.5 MISCELLANEOUS EQUIPMENT

2.5.1 **OFFICE**

All the furniture and administrative office equipment etc. required shall be furnished by the Contractor. Costs of operating Administrative office and supplies shall be borne by the Contractor.

The Contractor shall take out subscriptions for standard telephone lines. Running cost for the telephone will be borne by the Contractor.

2.5.2 **SEWAGE PUMPING STATION COMPLEX**

Cost of operation, maintenance and housekeeping of sewage pumping station complex including domestic water supply and drainage, roads, gardens, electrical installations etc. will be borne by the contractor.

2.6 INSPECTION

2.6.1 **GENERAL PROVISIONS**

2.6.1.1 The Client shall check the operation of the Sewage pumping or designate an organisation of his choice to carry out inspections regularly. The Client or the organisation appointed by him shall check that the Contractor is performing the tasks for which he is responsible with due diligence. The Contractor shall at his cost provide all the assistance the Client requires to complete these inspections.

2.6.1.2 Before any inspection, the Employer shall give prior written notice of one day to the Contractor, indicating the name(s) of the person(s) empowered to carry out such inspection in the name of the Client.

2.6.2 **MEASUREMENT AND ANALYSIS**

The Client has the right to perform any analysis or inspection he deems necessary. Before any inspection, the Client shall give a prior written notice of one day to the Contractor and shall cover the costs of such action.

2.7 SEWAGE PUMPING STATION COMPLEX VISITS

2.7.1 At the end of each month, or at the initiative of the Client, a visit shall be organised so that both parties can check the condition of the installations at the Sewage pumping complexes.

2.7.2 A report shall be drawn up to record the opinions of both parties. The Client reserves the right to call in equipment manufacturers or specialised technicians for these visits.

2.7.3 These visits shall provide an opportunity for examining maintenance programs and operating procedures and improvements requiring additional investments.

2.8 DOCUMENTS TO BE PROVIDED BY THE CONTRACTOR

2.8.1 **OPERATION LOG BOOK**

2.8.1.1 The Contractor shall keep a permanent record of Sewage pumping station operation (logbook). This log book shall be kept at the site and shall be presented on request to agents approved by the Client.

2.8.1.2 On a daily basis, the following information shall be recorded in the log book.

a) Reading from the different meters, indicators and recorders (including but not limited to consumption of energy, volume of sewage lifted, operating times of the different electro-mechanical & instrumentation equipment's), voltage etc. as required.

b) Report of visits by persons other than those of the Client and the Contractor to the Facility.

2.8.1.3 The Contractor shall also indicate any significant modifications to the set-up characteristics of the installation, shut-downs, anomalies or incidents that have occurred with respect to operation.

2.8.2 **MONTHLY REPORT**

2.8.2.1 The monthly report shall include but not be limited to following.

a) Daily Volume of sewage actually received, pumped or conveyed to the off-take point (flow measurement per house and per day, sewage pumping total quality of sewage per day / month / year etc.).

b) All the problem areas in the facility.

c) The status and progress of the training programs.

d) Electricity consumed totally.

e) List of the parts replaced and quality of other different consumable items consumed during the month.

f) List of major defects / break down during the month

g) Details of rectification works during the month.

2.8.3 **ANNUAL REPORT OF OPERATION**

2.8.3.1 The Contractor shall provide the Client by March 31 of the current year (n) with an annual report for the preceding year (n-1). This report shall include following.

a) All technical statistics related to sewage pumping operation as supplied by the operation;

b) A statement of works carried out during the preceding year n-1 in connection with the Contractor's maintenance obligation.

3.0 FINANCIAL PROVISIONS

3.1 FINANCIAL PROVISIONS

3.1.1 **METHOD OF PAYMENT**

3.1.1.1 The Client will pay the Contractor for the O and M Price on a quarterly basis subjected to satisfactory performance of the entire system. The payment for comprehensive operation and maintenance shall be in **as per Price Schedule of tender document.**

3.1.2 **INVOICING**

3.1.2.1 The Contractor shall prepare and submit to the Client an invoice each month with all documents (Copy of Attendance register, Subscription copy of P.F, ESI, work report etc.) supporting its claim. The invoice shall be submitted between the first and fifth day of the month.

3.1.3 **FLUCTUATION FACTORS**

3.1.3.1 Deleted

3.2 LIQUIDATED DAMAGES

3.2.1 The system shall be capable to deliver the designed capacity of sewage pumping. However in the initial stage the sewage flow may not get developed fully, due to less population coverage. However, the bidder shall keep all the installations and system in working condition throughout the COMPREHENSIVE O and M period.

3.2.2 **For non-compliance of employment of key staff**

3.2.2.1 If the successful bidder does not recruit/depute or in absence of the key staff identified as per schedule, then liquidated damages will be deducted at **1½ times** of the rate quoted (per day).

3.3 TAXES, LICENSES, PERMITS AND FEES

3.3.1 No extra payment shall be made to the contractor against any taxes, licenses, permits and fees whichever is in force or may be imposed in future by Central/State Governments which affects this contract.

3.4 TRAINING

3.4.1 Before end of the contract, suitable training shall be given to the client's staff.