

CONTRACT NO.

GUJARAT WATERSUPPLY & SEWERAGE BOARD
GANDHINAGAR
(A WHOLLY OWNED GOVERNMENT OF GUJARAT UNDERTAKING)



Bid Documents for “ Construction of RCC U/G sump, Providing Supplying, Lowering, Laying & Jointing 140 mm dia and 90 mm dia PVC Pipeline, Construction of Pump Room, Electricity for Dahisara Village, Tal. Bhuj under Rejuvenation Programme, YR 2025-26.”

Name of Project :- “ Construction of RCC U/G sump, Providing Supplying, Lowering, Laying & Jointing 140 mm dia and 90 mm dia PVC Pipeline, Construction of Pump Room, Electricity for Dahisara Village, Tal. Bhuj under Rejuvenation Programme, YR 2025-26.”

Estimated Cost :- Rs. 16,84,373.12

VOLUME – IIB

TECHNICAL SPECIFICATION - CIVIL

Executive Engineer
Public Health Works Division,
Gujarat Water Supply & Sewerage Board
Bhuj - Kachchh

**VOLUME - II B :
TECHNICAL SPECIFICATION – Civil works**

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SPECIFICATIONS

SECTION: 1 GENERAL AND MATERIAL

SECTION: 1

GENERAL AND MATERIAL

GENERAL

1.0 Employer's Drawings:

- 1.1. The drawings listed in the Tender document are the Employer's conceptual drawings and are to be got approved prior to start of the works with actual site conditions & level in consultation with EIC.

2.0 Drawing Sheet Format:

- 2.1. All drawings provided by the Contractor shall be on standard size sheets, prepared on computer with AutoCAD and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of Contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title.
- Executive Engineer, P.H. Works Division Bhuj
 - Project name: -

A blank space of 90 mm x 100 mm shall be provided for the Engineer's approval stamp and provision shall be made for details of revisions to be recorded.

- 2.2. All drawings submitted by the Tenderer/Contractor shall use the English language and SI units. All drawings shall be clearly and fully cross-referenced to the other drawings as relevant.

3.0 Tender / Contract Drawings:

- 3.1. Drawings submitted by the Tenderer shall show all the essential items of the Plant offered together with sufficient details to enable the general arrangement of the Plant to be determined.
- 3.2. The drawings and documents to be provided by the Tenderer / Contractor shall be as per the schedules of price but shall not be limited to those listed:

4.0 Submissions and Approval of Drawings:

- 4.1. The following shall be the procedure for submission and approval of drawings:
- 4.1.1. The Contractor shall submit 4 copies of the drawings to the Employer. All the drawings are to be signed by the Contractor or his authorized representatives
- 4.1.2. The Engineer's Representative will review the drawings and, if found fit for approval, the Employer will return 2 copies to the Contractor duly approved.
- 4.1.3. In case the drawings/documents are not fit for approval but worth for review, the Engineer's Representative will mark the comments on the drawings and return 2 copies to the Contractor. In such case, the Contractor shall resubmit the revised drawings within two weeks as per sub-clause 4.1.1 above and the same shall be repeated till the drawings are finally approved as per sub-clause 4.1.2 above.
- 4.1.4. If the submitted drawings/documents are not worth for review, the Contractor will be informed accordingly.
- 4.1.5. On receipt of the approved drawings as per sub-clause 4.1.2 above, the Contractor shall submit floppy and documents to the employer.
- 4.1.6. After tests on completion, the Contractor shall submit, within 15 days of the conclusion of the tests, floppies of the "As Built Drawings" to the Employer.

- 4.1.7 When the drawings are received by the Engineer's Representative after revision by the Contractor, he will only review the revision made and hence the Contractor shall carefully identify all the revised details / dimensions and also describe the revisions in the revision block.
- 4.1.8 No drawings, with corrections made after taking the prints, will be accepted.
- 4.1.9 Approval of drawings by the Engineer shall not relieve the Contractor of his responsibility in terms of the Contract.

5.0 Delivery, Unloading and Storing at Site:

- 5.1. The Contractor shall be responsible for checking all materials delivered to Site and shall keep the Engineer's Representative fully informed of the state of deliveries. The Contractor shall carry out, at his cost, all instructions of Engineer or his Representative for proper unloading, preservation, maintenance, storage and security of materials delivered to Site until he fulfills all his obligations under the Contract.
- 5.2. The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Engineer.
- 5.3. Multiple handling and movement of materials during storage and retrieval shall be avoided.

6.0 Spare Parts:

- 6.1. Spare Parts required after the taking over the Plant shall be filled up by the bidder in the price schedule.
- 6.2. Spares during pre-commissioning trials, commissioning tests/maintenance, guarantee etc. shall be provided by the Contractor. The necessary spares shall be brought by the Contractor prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All these spares have to be provided as required, by Contractor free of cost.
- 6.3. All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to Site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.
- 6.4. All cases, containers or other packages are liable to be opened for such examination as the Engineer's Representative may require and packing shall be designed to facilitate opening and thereafter re-packing. In the event of some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc., the Contractor shall inform the Employer before such withdrawal so that the Employer can take timely alternative steps.

7.0 Tools:

- 7.1. Tools shall be delivered to site just prior to Tests on Completion.
- 7.2. The specified tools shall not be used for the erection of the Plant being supplied and except that the Engineer may call upon the Contractor to demonstrate their use or effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools at site for erection, he shall provide his own.
The test equipment shall include special purpose items essential to the testing or re-calibration of related items of Facilities.

MATERIALS AND WORKMANSHIP:**1.0 Introduction:**

- 1.1 This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of employer's requirement or be subject to the approval of the Employer.

Particular attention shall be paid to a neat, orderly and well-arranged installation carried out in a methodical competent manner.

2.0 Reference Specifications and Standards:

- 2.1 Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Alaska, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard on the Tender opening date.
- 2.2 The Contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard.
- 2.3 All details, materials and utensils supplied and workmanship performed shall comply with the specified Standards. If Tenderer offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.
- 2.4 In the event of conflict between this Specification and the Codes for equipment, provisions of this Specification shall govern. Certain specifications issued by national or other widely recognized bodies are referred to in this Specification. In referring to the Standard Specifications the following abbreviations are used:

IS:	Indian Standard
ANSI:	American National Standards Institute
API:	American Petroleum Institute
ASME:	American Society of Mechanical Engineers
ASTM:	American Society of Testing and Materials
AWS:	American Welding Society
AWWA:	American Water Works Association
ISO:	International Organization for Standardization
DIN:	Deutsches Institute fur Normung
BS:	British Standard
IEC:	International Electro technical Commission
IEE:	Institution of Electrical Engineers
IEEE:	Institute of Electrical and Electronic Engineers
NEMA:	National Electrical Manufacturers Association
AGMA:	American Gear Manufacturer's Association

3.0 Materials – General:

- 3.1 All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

4.0 Workmanship – General:

- 4.1 Workmanship and general finish shall be of first-class quality and in accordance with best workshop practice.
- 4.2 All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items.
- 4.3 All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings. All materials incorporated in the Works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the Plant shall be supplied by the Contractor unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.

5.0 Welding:

- 5.1 Welding shall comply with the latest revision of the BS 5135 Code.
- 5.2 Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the Engineer does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each welding elements shall clearly be identified as to its welder marking the welder's Code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures, for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Engineer shall disqualify the welder whose Work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS EN 283-3.
- 5.3 Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.
- 5.4 Haphazard striking of the electrodes for establishing an arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag. The starting tag shall be of the same material or a material compatible with the base metal being welded. In case of any inadvertent strike on place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.
- 5.5 Generally, a stringer bead technique shall be used with a slight oscillation of necessary to avoid slag and to minimize the number of beads needed to fill exceed 3 times the wire

- diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia., welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.
- 5.6 The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive “such back”, etc. shall be cause for rejection of welds.
- 5.7 Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg lengths shall not exceed the specified size by more than 1.5 mm.
- 5.8 All attachments such as lugs, brackets and other non-pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.
- 5.9 All tack welds shall be made using qualified procedure and welders, the number of sizes of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouge. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.
- 5.10 All weld repairs shall be carried out using the approved welding procedures and welders. Re-welded areas shall be re-examined by the methods specified for the original welds and the Engineer’s Representative shall duly qualify repair procedures.
- 6.0 Pre-heating and Post-Heating Treatment:**
- 6.1 Pre-heating and post heating treatment shall conform to the relevant application Codes. Pre-heating not exceeding 121 deg. C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre-heating will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870-part 1 Table 6 to represent 30% of the long seams and each welder’s performance would be mandatory.
- 7.0 Electrodes:**
- 7.1 All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in Work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

8.0 Examination/NDT/Radiography

- 8.1 The various stages of examination and types shall be as stipulated in the respective fabrication Codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910; Ultrasonic tests where called for shall be carried out as per provisions of BS 3926; magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

9.0 Stainless Steel Welding:

- 9.1 All welding consumable such as electrodes, filler weirs, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the Engineer. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.
- 9.2 All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.
- 9.3 Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.
- 9.4 Non-destructive examination of the welds shall be carried out to ensure quality of weld.
- 9.5 The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

10.0 Castings:

- 10.1 Cast iron shall be of standard grey close-grained quality. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.
- 10.2 Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Engineer. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Non-destructive tests as directed by the Engineer will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

11.0 Forging:

- 11.1 All major stress-bearing forging shall be made to a Standard Specification. Forging shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect, which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5% of the finished thickness of the component, shall be reported to the Engineer giving the details like location, length, width and depth. For the magnetic particle inspection, the choice of wet or dry particles shall be at the Contractor's discretion.
- 11.2 All forging shall be demagnetized after test and shall be heat-treated for the relief of residual stresses.

12.0 Design Life:

- 12.1 The Works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The Contractor shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not requires the services of highly skilled personnel.
- 12.2 The Plant shall be designed to provide easy access to and replacement of component parts, which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years.
- 12.3 Design features shall include the protection of Plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause, which may have a detrimental effect upon the performance or life of the Works.
- 12.4 Plant located outside lockable areas/building shall have additional features to prevent un-authorized operation.

13.0 Name Plate:

- 13.1 Each item of the Plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as may be

required by the Engineer. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

- 13.2 Nameplates, rating plates and labels shall be of a non-flame propagating material, either non-hygroscopic or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non-corrosive screws; drive rivets or adhesives shall not be used.
- 13.3 Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background.
- 13.4 Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

14.0 Nuts, Bolts, Studs and Washers:

- 14.1 Nuts, bolts, studs and washers for incorporation in the Plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut.
- 14.2 Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.
- 14.3 Washers, locking devices and anti-vibration arrangements shall be provided where necessary Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.
- 14.4 Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers that are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.
- 14.5 The Contractor shall supply all holding down, alignment and leveling bolts complete with anchorages, nuts, washers and packing required to attach the Plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

15.0 Allowances for Wastage:

- 15.1 The Contractor shall supply reasonable excess quantities to cover wastage of those consumable, which will be normally subject to waste during erection, commissioning and setting to Work.

16.0 Painting – General:

- 16.1 The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant at the place of manufacture prior to packing.
- 16.2 Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.
- 16.3 All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.

17.0 Painting at Place of Manufacture:

- 17.1 Steel and cast-iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns' dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.

18.0 Painting at Site:

- 18.1 Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.
- 18.2 After erection, such items, which are not finish painted, shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paintwork. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.
- 18.3 The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness specified the Contractor should ensure that the coverage rate given by the paint manufacturer would enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm^2 . Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

19.0 Galvanizing:

19.1 Wherever galvanizing has been specified the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a) Fabricated steel :

Thickness less than 2 mm but not less than 1.2 mm - 340 gms/sq.m

Thickness 2 mm and above - 460 gms/sq.m

b) Fasteners

Up to nominal size M10 - 270 gms/sq.m

Over M10 - 300 gms/sq.m

19.2 Galvanizing shall be carried out after all drilling; punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any Site modification of galvanized parts should be covered well by zinc rich primer and aluminum paint.

20.0 Support for Pipe work & Valves:

20.1. All necessary supports, saddles, sling, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other facilities mounted in the pipe work shall be supported independent of the pipes to which they connect.

20.2 TOOLS :-

The contractor shall supply a minimum of 2 Nos. Revolving Chairs suitable for use at the platform and 2 Nos. Steel Cup Board for the work. The Contractor Shall Supply Standard Plastic Chair 6 Nos. and one wooden office table with one table paddle fan as per instruction of engineer incharge.

INSPECTION AND TESTING AT MANUFACTURER'S PREMISES

1.0 Inspection and Tests:

1.1 Valve:

1.1.1 During testing there shall be no visible evidence of structural damage to any of the valve component.

1.1.2 Motorized valves shall be tested with their actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

1.1.3 The following test shall be carried out for sluice valves:

- a) Seat leakage test at rated pressure
- b) Hydrostatic test at 1.5 times the rated pressure
- c) Valve operation

1.1.4 The following test shall be carried out for non-return valves:

- a) Seat leakage test at rated pressure
- b) Body hydrostatic test at 1.5 times rated pressure
- c) Operation

1.2 Pipe work:

1.2.1 Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationally approved standard. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure.

1.3. E.O.T. Crane:

1.3.1 The cranes shall be completely assembled in the Contractor's or subcontractor's Works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard. The Contractor shall provide the test weights.

1.4 Equipment for testing:

Equipment required for testing CC cubes and testing of steel bars are installed at main H/W site.

SPECIFICATIONS

SECTION:2 SURVEY & GEOTECHNICAL INVESTIGATION FOR DESIGN

1. **Specifications for Minimum Investigations required for Project:**

1. **Survey and Soil Exploration:**

To plan out and obtain pre-approval and subsequently carry out Topographic and level Survey, preparing cross sections, Longitudinal sections, Soil exploration to obtain foundation design data at various locations for all the components listed in preamble on previous page, complete all as per general pre-approved plan and as per detailed description and specifications and including submitting survey, soil exploration and analysis reports in six copies along with two soft copies and getting the same approved by the engineer in charge.

Work consists of providing all equipment, materials, labour etc. to carry out survey, to provide permanent markers of various points for later use, to create permanent bench mark of approved design and approved location on the site, to carry out soil exploration to obtain information for foundation design as well as collecting data to determine various design parameters, to collect all data, prepare interim and final reports for submission and approval of the Engineer in-charge, all as per detailed description, specifications and as directed by the Engineer in-charge. This may call for revised hydraulic design, in case location of headwork/ sub headwork/ village level sump etc. changes. However, minimum pipe size (as given in Schedules and drawings) shall be adhered to. In certain cases, due to revised location of tail end point sump, level may be higher or frictional losses may increase. This will demand pipe size of higher diameter and contractor shall carry out hydraulic design to suit specific section subject. In case level of such sump reduces or location reduces the length ultimately resulting into permission of lower size, size given in schedule & drawing shall be provided and on no account, it shall be reduced.

It must be clearly understood that the data furnished with the tender and suggested procedure for survey and soil exploration are purely for general guidance of the bidders for selecting the best design criteria. The contractor is expected to carry out additional work if it becomes necessary in the process of selecting appropriate criteria. In any case responsibility of assuring the guaranteed water supply will fully rests with him.

Work Description:

Work under this item involves survey, soil exploration and investigation as described below. Survey maps and all interim as well as final reports of soil investigation, other tests as well as the reporting of final tests shall be submitted in six paper copies as well as two soft copies and these will form part of a permanent record of the project for use during construction, operation, and maintenance stages as well as for future use. All below mentioned work shall be all inclusive and will be carried out as per detailed specifications and as directed by the Engineer in-charge.

Survey and soil investigation shall be completed within one & half month. In case after delay of 15 calendar days the department will get completed the work from departmental agency at the risk and cost of the contractor which shall be binding to the contractor.

2. Survey work shall consist of the following:

- A. To carry out Block level survey based on GTS benchmark, prepare longitudinal section along alignment of all types of pipeline and prepare contour survey of the allotted plot of land and the river bed of the width of 100m – 50m on either side - of the suggested center line of the alignment, and prepare contour maps to a scale of 1:500 or larger. Survey in the river may be carried out with help of sounding technique or long metallic rod inserted in water from the boat. All the levels/ distance may be measured with help of total station or DGPS.
- B. Selecting most appropriate location (on the basis of survey) to determine various geotechnical parameters for carrying out design of various components shall be responsibility of the contractors and it shall be carried out by laboratory approved by GOG acceptable to GWSSB.
- C. Above survey shall be carried out in stages as and when required, using the latest equipment like TOTAL STATION or DGPS with high accuracy. In case dumpy level/ auto level is used, then fly back as well as closing error must be performed without which survey will be considered as NOT completed. All levels will be based on GTS, and the work shall include transferring level from a reliable established GTS benchmark in the vicinity of the site of work and establishing a permanent bench mark on site at a suitable location as per approved design and location. Above survey will be carried out jointly with the representative of the owner, as per his convenience during day time.
- D. Detailed Longitudinal Section for each pipe shall be prepared and HGL marked on it for approval of GWSSB. After marking of such data only, execution of pipeline shall be permitted.
- E. Detailed contour plan of the headwork/ sub headwork etc. prepared with interval of 0.2 m so as to determine position of various units.

Soil exploration work for intake, RCC and framed structures, underground sumps, Pump Houses (positive/ negative suction) shall consist of the following:

- A. 150 mm bores or more diameters (Minimum one no per unit/ structure) will be made to collect information for the foundation design of the intake well, approach bridge supports, underground sump, Pump House, other structures. Minimum depth of bores from the existing level at the location of proposed sump 12 m depth, and pump house 6 m depth, or more as per requirement of structural design. Disturbed and undisturbed soil samples will be collected, and grain size analysis by dry sieving/Wet analysis, determination of liquid/plastic limit and other necessary tests like C value, N value, ϕ value and important parameters to carry out structural design and facilitate execution of structures shall be carried out. All levels including ground level of the bore point, levels of various strata and water levels etc. will be noted in reference to GTS.
- (A) Specification for drilling, investigation, furnishing details of bore logs, laboratory testing and reporting:**
- 1. The investigation bores shall be made by percussion method and not by rotary method. No bentonite slurry or drilling mud shall be used. The bores shall be cased when it is to be done in sandy and silty strata.

2. The quantity of boring mentioned in work description is approximate and likely to vary materially if investigating alternative location of Infiltration Well becomes necessary. Any change in the quantity of boring work shall not entitle the contractor for any claim or compensation. His rates shall be deemed to cover such an eventuality.
3. The disturbed samples shall be collected at every 1.5 Mt. Depth or at the points where the strata changes whichever is less.
4. The samples so collected shall be preserved in systematic manner in core boxes, when the bore is in progress. After the bore is completed, each of the samples shall be packed in two separate poly thin bags with contents of approx. 0.5 Kg and properly numbered giving other details so as to identify the position to which the samples represent. All other details such as the bores Sr. Nos., the depth from which the samples are taken etc. should be clearly given with the samples.
5. Out of the two sets of samples collected for every bore one set of samples with all requisite details shall be sent to the laboratory for testing and the second set of samples together with requisite details shall be supplied to the clients in their office for record. The casing pipes shall be removed after above compliance and with the approval of the Engineer in-charge. The recovered samples shall be tested in the laboratory for grain size analysis and Atterberg's limits to identify the samples in accordance with the provision in IS.1498, 1971. The testing of samples shall have to be done at the recognized laboratory approved by the engineer-in charge.
6. The drilling shall be terminated at approx. 2.0 Mts. below the impervious (e.g. clay) strata, when bores are being made primarily to find the level of impervious strata. And if the samples collected indicate the soil being predominantly clayey further drilling shall be discontinued. In sandy strata including sand with gravels and small size boulders, Bores shall be extended at least up to 15 Mts. below bed level or low water level whichever is lower, however if required by Client /Consultants, the bores may have to be carried further.
7. Where bores are required to be done in water channel in river/ nallah bed, necessary island/islands shall be prepared in sand or sand filled gunny bags. The cost of which shall be covered within the rates quoted.
8. The rates quoted shall be inclusive for drilling in all kinds of strata including boulders, soft or hard rock.
9. For every bore water level encountered shall be recorded together with variation in water level if during the period of boring.
10. All levels shall be with reference to the GTS Bench Mark. For this purpose, a pucca GTS Bench mark shall be established in the region of proposed survey and investigation area.
11. The readings are to be recorded and observations are to be submitted with the reports in the format as per prosoma 1 and 2 shown below. The Contractor shall prepare bore charts for each and every bore in the approved manner and Performa as required by Client.
12. The disturbed samples are to be analyzed as per relevant clause of I.S. 2720 Part I to IV.

13. The water samples of water pumped out during pump test shall be collected and analyzed covering requirements of I.S. 10500 to establish its portability and the results of the chemical and other tests submitted in the format shown in Performa 3.
14. A Technical report covering the observations and tests is to be submitted to the client with the contractor's recommendations for selecting the most suitable site for the Radial well which could give the desired yield. The site for location of the pumping test shall be finalized in consultation with the clients before the work of pumping test including necessary boring work for the same is taken up.

(B) Specification for preparing and submitting the full technical report:

1. The survey work shall be carried out with proper accuracy and permanent Bench Marks shall be established at points which are approved by the Engineer in-charge. Also, sufficient number of permanent identification marks shall be established on the bank to enable establishment of base lines and the survey map to be included in the report shall contain sufficient details with respect to these permanent marks to enable the contractor to relocate the soil investigation bores as well as pump well and piezometric bores positions.
2. Based on the soil investigation carried out, a contour map of the area investigated showing the soil strata shall be prepared and included in the technical report.
3. The soil investigation work shall be carried out as per specifications and information will be recorded in the format given in attached Performa 1 and 2.
4. The short chemical analysis of water samples shall be carried out as per I.S. 10500 and results reported in format given in attached Performa 3.
7. The Performa included in the tender are only for guidance and by no means are they to be considered as the only ones required for reporting the investigation. Additional information which is considered necessary shall be collected and recorded systematically in proper format to arrive at the relevant conclusions.
8. Using these parameters discharge shall be calculated for different water levels of the river, and the report shall make definite recommendations as regards to the number of radials, their levels, and their lengths required to obtain the desired yield.

PERFORMA 1														
Bore hole no.		Date of start		Date of comp.		GTS value		Revision no.						
Method	Casing	Bore dia in cm	Core recovery	Depth in m	Th. Of layer in m	Soil	Visual soil description	Penetration test N-Value				Undisturbed sample	Disturbed sample	Remarks

PERFORMA 2

Bore hole no.	Date of start	Date of comp.			Termination depth	Revision no.	
Depth of sample	Grain size analysis						
	% Gravel	% sand	Hydrometer		LL%	PL %	PI%
			% Silt	% Clay			

PERFORMA 3: CHEMICAL ANALYSIS OF WATER				
Date of collection		Source		
Date of arrival at lab		Location	Village:	
Lab ref. no.				
Sr. no.	Characteristics	Permissible value as per IS 10500		
		Desirable	Relaxation in absence of alternate source	Analytical value
1	Color			
2	Odor			
3	Turbidity			
4	Dissolved solids			
5	pH			
6	Total hardness as CaCO ₃			
7	Calcium			
8	Magnesium			
9	Chloride			
10	Sulphate			
11	Nitrate			
12	Fluoride			
13	Manganese			
Signature:				
Date:				

SPECIFICATIONS

SECTION:3 CONCRETE

SECTION -3: **CONCRETE**

1.0 Applicable Codes with latest revisions.

1.1 Materials

- 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 and 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.

2.0 Material Testing:

- 1) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- 2) IS:4032 Method chemical analysis of hydraulic cement.
- 3) IS:650 Specification for standard sand for testing of cement.
- 4) IS:2430 Methods for sampling of aggregates for concrete.
- 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.

2.1 Material Storage:

- 1) IS:4082 Recommendations on stacking and storing of construction Materials at site.

2.1.4 Concrete Mix Design:

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

2.1.5 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 specimens.
- 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 Methods of testing bond in reinforced concrete.

2.1.6 Equipment:

- 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 Requirements for concrete vibrators: Immersion type.
- 7) IS:2506 General Requirements for screed board concrete vibrators.
- 8) IS:2514 Specification for concrete vibrating tables.
- 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.

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- 13) IS:2722 Specification for portable swing weigh batchers for concrete (Single and double bucket type).
 - 14) IS:2750 Specification for steel scaffoldings.

2.1.7 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 structure for storage of liquids (Part 1 to 4)
- 4) IS:3935 Code of practice for composite construction.
- 5) IS:2204 Code of practice for construction of reinforced concrete shell roof
- 6) IS:2210 Criteria for the design of reinforced concrete shell structures and Folded Plates.
- 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 works.
- 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 resistant design and construction of building.
- 14) IS:4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
- 15) IS:2571 Code of practice for laying in situ cement concrete flooring.
- 16) IS:7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

2.1.8 Construction Safety:

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

2.2 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's approval obtained, prior to starting of concrete work. This shall however, not relieve the Contractor from any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due 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 their performance suitability based on previous data, experience or tests.

2.3 Materials:

2.3.1 Cement:

Unless otherwise called for by the Engineer in charge, cement shall be ordinary Portland cement conforming to IS: 269, IS: 8112 or IS: 12269. However, in any case, cement grade shall not be lower than 43 grades.

Where Portland Pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in a particular unit. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer in charge.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer in charge and until the results of such tests are found satisfactory, it shall not be used in any work.

2.3.2 Aggregates (General):

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS:383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer in charge.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete where directed. Plums shall not constitute more than 20% by volume of the concrete.

2.3.3 Water:

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

2.3.4 Reinforcement:

All reinforcement steel shall be TMT tor steel conforming to relevant I.S. for all RCC structure with CRS - Fe-500 conforming to IS-1786.

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

All Grade of reinforcement steel shall be as per Price bid & Data-sheet.

2.3.5 Admixtures:

Accelerating, retarding, 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 verified by trial mixes with the other materials used in the works. If two or more admixtures are 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.

Wastage:

Wastage allowance for cement and steel shall be considered in the item rate and no extra payment shall be paid to the Contractor on any account.

2.4 Samples and Tests:

All materials used for the works shall be tested before use.

Manufacturer'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. Engineer in charge may appoint separate third-party inspection for the material testing to ensure the quality of the 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 certificates 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.

2.5 Storing 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. Requirements 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

material shall be rejected. Cement bags 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 the 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.

2.6 Concrete:

2.6.1 General:

Concrete grade shall be as designated on drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150X150X150 mm cube at 28 days, expressed in N/mm^2 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. Concrete grade shall not be lower than M-25 for building and M-30 for water retaining structures (all units of STP including distribution chambers, sludge chambers, inlet/ outlet chambers adjacent to PST/ AT/ SST).

2.6.2 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 be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS:456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/m^3 of Concrete
M15	260
M20	315
M25	360
M30	380
M 35	400

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 be paid to the CONTRACTOR on this account. Even in the case where the quantity 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 responsibility to carry out the mix designs at his own cost. He shall furnish to the EMPLOYER at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the 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 at 7 days	Specified Characteristic Compressive Strength N/sq.mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

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

Structure/Member	<i>Slump in millimeters</i>	
	Maximum	Minimum
Reinforced foundation walls and	75	25
Plain footings, caissons and	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	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. These 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 when the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement 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:456, IS 3370.

2.6.3 Nominal Mix Concrete;

(a) Mix Design & Testing:

Mix design and preliminary tests are not necessary for Nominal Mix Concrete.

However, works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and Water Cement Ratio may be adopted as per Table 3 of IS:456. However, it will be the Contractor's sole 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.

2.7 Formwork:

Formwork shall be all inclusive and shall consist of shoring, bracings, sides of footings, 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 as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer in charge,

the drawings and calculations 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/ slurry or mortar from the concrete at all stages and appropriate to the methods 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 dynamic effects arising from construction and compacting activities, earthquake, wind and weather forces.

- (e) Capable of easy striking out without shock, disturbance or damage 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 cleaned 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 type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer in charge. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between 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, shavings, sawdust, wire pieces dust 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 properly 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 spilling, 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.

Forms 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 excavations shall be larger, as approved by the Engineer in charge, than 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 structures.

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 built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Engineer in charge. The Contractor shall temporarily and securely fix items to be casted (embedment / 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 requirements:

- (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; and
- (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°C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the Engineer in charge. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the 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.

2.8 Reinforcement Workmanship;

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 10° C. All bars shall be accurately cut and bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as 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 designs as will be durable, not lead to corrosion of the

reinforcement and not cause spilling of the concrete cover. Binding wire shall be 16-gauge soft annealed wires. Ends 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.

2.9 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+ 12 mm
(b)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
	1) Dimension in plan	- 12 mm+ 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

2.10 Preparation Prior to Concrete Placement:

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

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.

2.11 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 re handled or caused 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 1.0m.

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

While placing concrete the Contractor shall proceed 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 pipes, ducts, fixings 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 linings progressively as concrete is placed.
- (h) If placed directly onto 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 melding 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 time to settle as approved by the Engineer in charge. Concrete shall be protected against damage until final acceptance.

2.12 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.

2.13 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 ponded water or continuously saturated coverings of sacking, canvas 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 base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the EMPLOYER before use 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 well sealed and fastened.

2.14 Construction Joints and Keys:

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

Dowels for concrete work, not likely 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 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 thickness shall be placed and well rammed against the old work. **Thereafter work shall proceed in the normal way.**

2.15 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.

2.16 Finishes:

2.16.1 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 as specified. Defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

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 surfaces 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.

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.

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.

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 screened 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.

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, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

2.17 Repair and Replacement of Unsatisfactory Concrete:

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, 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 Contractor at no additional cost to the Employer.

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 repairs 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 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer in charge.

2.18 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, floating and toweling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the Engineer in charge's approval.

2.19 Hot Weather Requirements:

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

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40° 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.

Cold Weather Requirements.

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° 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 stripping period shall be closely monitored.

2.20 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 as defined elsewhere. All such structures shall be hydro-tested.

The Contractor shall make all arrangements 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, guiniting 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.

2.21 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 be satisfied if the external faces show no sign of 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, considering whether the structures are open or closed and the corresponding effect it has on evaporation losses. 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.

2.22 Optional Tests:

If the Employer 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 its 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 Engineer in charge. Alternately Engineer in charge also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

2.23 Grouting:

2.23.1 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:

Use	Grout Thickness	Mix Proportions	Water Cement Ratio (max)
1. Fluid mix	Under 25mm	One-part Portland Cement to one-part sand	0.44
b) General mix	25mm and over but less than 50mm	One-part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One-part Portland Cement to 3 parts of sand	0.53

2.23.2 Non-Shrink Grout:

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

Inspection:

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer in charge. Materials 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 materials;
- 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 dimensions;
 - l) Tolerances 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's 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 Employer for executing the remedial measures.

2.24 Water stops:

2.24.1 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/mm² minimum
- c) Ultimate elongation : 300 % minimum

d)	Tear resistance	:	4.9 N/mm ² minimum
e)	Stiffness in flexure	:	2.46 N/mm ² minimum
f)	Accelerated extraction		
g)	Tensile strength	:	10.50 N/mm ² minimum
h)	Ultimate elongation	:	250% minimum
i)	Effect of Alkali	:	7 days
j)	Weight increase	:	0.10% maximum
k)	Weight decrease	:	0.10% maximum
l)	Hardness change	:	± 5 points
m)	Effect of Alkali	:	28 days
n)	Weight increase	:	0.40% maximum
o)	Weight decrease	:	0.30% maximum
p)	Dimension change	:	±1%

PVC water stops shall be either of the bar type, serrated with center bulb and end 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. Alternatively, G.I. sheet of 18 gage (1.3mm) thick and 200mm wide can be used by the contractor as construction joints.

Alternatively, contractors can use G.I sheet 200mm wide and 18 gauge thick as constructions joints.

2.24.2 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 stop 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.

2.25 Preformed Fillers and Joint Sealing Compound:

2.25.1 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.

2.25.2 Workmanship:

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses 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 hot by brushing at the rate of 1.20 kg/m². When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it 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 1.20 kg/m².

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 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/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/QUANTITY/:			MAX. AGGREGATE SIZE /		
SLUMP:			START / COMPLETION TIME:		
SL.NO	ITEM				Remarks If Any
1	BEFORE CONCRETI NG	CENTRELINE S CHECKED		YES/NO	
2		FORMWORK 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) CHECKED	CIVIL	YES/NO	
	MECH.		YES/NO		
	ELEC.		YES/NO		
8	SOFFIT(S) & POUR TOP(T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL		S(B)		
			T(B)		
			S(A)		
			T(A)		
9	CONSTRUCTION JOINTS LOCATION & TYPE				
	EXPANSION JOINTS – LOCATION AND TYPE				
10	CEMENT CONSUMPTION IN KGS.				
10A	REINFORCEMENT CONSUMPTION DIAWISE IN KGS				
11	NUMBER OF CUBES AND IDENTIFICATION MARKS				
12	TEST CUBE RESULTS (7 DAYS / 28 DAYS)				
13	CONCRETE CONDITION ON FORM REMOVAL		V.GOOD/GOOD/FAIR /POOR		
Contractor's Representative			Engineer- in-charge's Representative		

NOTES:

1. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONTRACTOR & SITE OFFICE.
- a) UNDER REMARKS, INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURRENCES SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

SPECIFICATIONS

SECTION -4 BUILDING ITEMS

SECTION - 4: **BUILDING ITEMS.**

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.

IS:110 -	Ready mixed paint, brushing, gray filler, for Enamels for use over primers
IS:269 -	Specification for 33 grade ordinary Portland cement
IS:280 -	Specification for mild steel wire for general Engineering purposes
IS:287 -	Recommendations for maximum permissible Moisture content of timber used for different purposes
IS:383 -	Specif. for coarse & fine aggregates from natural sources for concrete
IS:412 -	Expanded metal steel sheets for general purposes
IS:419 -	Specification for putty for use on window frames
IS:428 -	Distemper, oil emulsion, color as required
IS:459 -	Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets
IS:702 -	Specification for industrial bitumen
IS:710 -	Specification for marine plywood
IS:712 -	Specification for building limes
IS:730 -	Specification for hook bolts for corrugated sheet Roofing
IS:733 -	Wrought aluminum and aluminum alloys, bars, Rods and sections for general engineering purposes
IS:777 -	Specification for glazed earthenware tiles
IS:1003 -	Specification for timber paneled and glazed shutters (Parts 1 & 2)
IS:1038 -	Specification for steel doors, windows and ventilators
IS:1077 -	Specification for common burnt clay building bricks
IS:1081 -	Code of practice for fixing and glazing of metal (steel & aluminum) doors, windows and ventilators.
IS:1124 -	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS:1237 -	Specification for cement concrete flooring tiles
IS:1322 -	Bitumen felts for water proofing and damp proofing
IS:1346 -	Code of practice for water proofing of roofs with bitumen felts
IS:1361 -	Specification for steel windows for industrial buildings
IS:1443 -	Code of practice for laying and finishing of cement concrete flooring tiles
IS:1477 -	Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS:1542 -	Specification for sand for plaster
IS:1580 -	Specification for bituminous compounds for water-proofing and caulking purposes
IS:1597 -	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry
IS:1661 -	Code of practice for application of cement and cement-lime plaster finishes
IS:1834 -	Specification for hot applied sealing compound for joint in concrete
IS:1838 -	Specification for preformed fillers for expansion joint in concrete Pavements and structures (none extruding and resilient type): Part 1 Bitumen impregnated fiber.
IS:1948 -	Specification for aluminum doors, windows and ventilators
IS:1949 -	Specification for aluminum windows for industrial buildings
IS:2074 -	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2114 -	Code of practice for laying in-situ terrazzo floor finish
IS:2116 -	Specification for sand for masonry mortars
IS:2185 -	Specification for concrete masonry units (Parts 1,2& 3)

IS:2202	-	Specification for wooden flush door shutters (Solid core type): Parts 1&2
IS:2212	-	Code of practice for brickwork
IS:2250	-	Code of practice for preparation and use of masonry mortars
IS:2338	-	Code of practice for finishing of wood and wood-based materials (Parts 1 & 2)
IS: 2395-		Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS:2402	-	Code of practice for external rendered finishes
IS:2571	-	Code of practice for laying in-situ cement concrete flooring
IS:2572	-	Code of practice for construction of hollow concrete block masonry
IS:2645	-	Specification of integral cement waterproofing compounds
IS:2690	-	Specification for burnt clay flat terracing tiles: Part 1 Machine made
IS:2691	-	Specification for burnt clay facing bricks
IS:2750	-	Specification for steel scaffoldings
IS:2835	-	Flat transparent sheet glass
IS:2932	-	Specification for enamel, synthetic, exterior type (a) undercoating,(b) finishing
IS:3007-		Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets
IS:3067	-	Code of practice of general design details and preparatory work for Damp-proofing and water- proofing of buildings
IS:3068-		Specification for broken brick (burnt clay) coarse aggregates for use in Lime concrete.
IS:3384	-	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3462	-	Specification for unbaked flexible PVC flooring
IS:3495	-	Method of test for burnt clay building bricks: Part 1 to 4
IS:3536	-	Specification for ready mixed paint, brushing, and wood primer, pink
IS:3696	-	Safety code of scaffolds and ladders (Parts 1 & 2)
IS:4020	-	Methods of test for wooden flush door: Type test
IS:4021	-	Specification for timber door, window and ventilator frames
IS:4351	-	Specification for steel door frames
IS:4443	-	Code of practice for use of resin type chemical resistant mortars
IS:4457	-	Specification for ceramic unglazed vitreous acid resisting tile
IS:4631	-	Code of practice for laying epoxy resin floor toppings
IS:4832	-	Specification for chemical resistant mortars (Part II)
IS:4860	-	Specification for acid resistant bricks
IS:4948	-	Specification for welded steel wire fabric for general use
IS:5318	-	Code of practice for laying of flexible PVC sheet and tile flooring
IS:5410	-	Cement paint, color as required
IS:5411	-	Specification for plastic emulsion paint (Parts 1 & 2)
IS:5437	-	Wired and figured glass
IS:5491	-	Code of practice for laying of in-situ granolithic concrete floor topping
IS:6042	-	Code of practice for construction of light weight concrete block masonry
IS:6248	-	Specification for metal rolling shutters and rolling grilles
IS:7193	-	Specification for glass fiber base coal tar pitch and bitumen felts
IS:7452	-	Specification for hot rolled steel sections for doors, windows and Ventilators
IS:8042	-	Specification for white Portland cement
IS:9197-		Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
IS:9862		Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting

IS:12200- Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams

Brickwork:**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 work.

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 190mm x 90 mm x 90 mm 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 mmx115mmx75mm with tolerance up to ± 3 mm in each dimension, one brick and half 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 colored, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be molded 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 3N/sq.mm unless otherwise specified in the Items of work prepared by the Contractor.

The average water absorption 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 burnt bricks are not acceptable for use in the works. Sample bricks shall be submitted to the GWSSB for approval and bricks supplied shall conform to approved samples. If demanded by GWSSB, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by GWSSB 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 1:5 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 work prepared by the Contractor. 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 GWSSB. If so directed by the GWSSB, 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 GWSSB. 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 shall be removed 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 GWSSB.

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 work prepared by the Contractor. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm 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. Brickwork 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 joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm 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 be done later. When plastering or pointing is not required to be done, the joints shall be uniform in 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.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the E.I.C.

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 GWSSB. 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 115mm x 75mm, the courses at the top of the plinth and sills as well as at 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 members.

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 on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50-micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either side of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 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 to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor 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 20mm 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 surfaces 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 Drawings prepared by the Contractor and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brickwork 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 prepared by the Contractor. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the Contractor. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

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

Materials:

Stones for the works shall be of the specified variety, which are hard, durable, fine grained and uniform in color (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 absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the GWSSB 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 7.2.1.

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 hammer dressed stones with squared quoins at corners. The bushings 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 hearting 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. Spalls 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-thirds into the wall and a set of two or more bond stones overlapping 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 raked back (and not saw toothed) at an angle not exceeding 45deg. 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 7.2.2.

Coursed Rubble Masonry (First Sort) for Superstructure:**Materials:**

The Material specification for the work shall be as per clause 7.3.1.

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 $\frac{1}{3}$ 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 by at least 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 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 beyond the surface of bed and side joints.

No spalls or pinning 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 stones shall be as specified in clause 7.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

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 beds, 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 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 7.2.2. Requirements of execution of the work and curing shall be as stipulated in clause 7.3.2.

Concrete Block Masonry:

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 blocks shall conform to the requirements 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 lengths of 200, 250 or 300mm to correspond to the full-length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ± 5 mm and maximum variation in height or width of the units shall not be more than ± 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 specify. 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 values 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 GWSSB.

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 100mm. 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 blocks 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 7.2.1.

The thickness of both horizontal and vertical joints shall be 10mm. 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 a 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 10mm. 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 joint. 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 raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks 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, joint 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 openings, solid 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 doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be 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 and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 7.2 for the brick work. Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet. Double scaffolding as per clause 7.2.2 shall be adopted for execution of 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.

Damp - Proof Course:

Materials and Workmanship:

Where Specified, all the walls in a building shall be provided with damp-proof course cover at 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 manufacturer. 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.

Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawings to be prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the GWSSB. 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 GWSSB.

Wood Work for Doors, Windows, Ventilators & Partitions

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 sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform color 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 1) 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. Wired and figured glass shall be as per IS:5437.

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

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 detailed Drawings prepared by the Contractor and/or as directed by the GWSSB.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well-planned faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortise 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 shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work prepared by the Contractor. The workmanship shall generally conform to the 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 window 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 prepared by the Contractor. The stiles and rails shall be joined by mortise and tenon joints at right angles. All members of the shutter 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 shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. 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 (Parts 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 requirement of the thickness, core, face panels, viewing glazed panel, Venetian louver opening, teak wood lapping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS:710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS:4020, if so desired by the GWSSB.

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 GWSSB. The type of finish and the number of coats shall be as stipulated in the respective items of work prepared by the Contractor. Preparation of the wood surfaces and application of the finishes shall be in accordance with clause 7.32.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the Drawings prepared by the Contractor.

The framework 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 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 prepared by the Contractor.

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

Steel Doors, Windows and Ventilators:

Materials:

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

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

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 and fixtures shall be of the best quality from the approved manufacturers.

Workmanship:

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work prepared by the Contractor and of sizes as indicated in the Drawings prepared by the Contractor prepared by the Contractor. 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 $\pm 1.5\text{mm}$. The frames and shutters shall be free from warp 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 GWSSB 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 Drawings prepared by the Contractor for single or composite units.

For windows with fly proof mesh as per the item of work prepared by the Contractor, 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 rubber 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 walls shall be built up solid on either side or 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 skins of 1.25mm thick steel sheets, 1mm 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 prepared by the Contractor. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/distorting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the Drawings prepared by the Contractor.

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 10mm 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 prepared by the Contractor. All glass panels shall have properly squared corner and 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 beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings prepared by the Contractor.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanized with thickness of the zinc coating as stipulated all as described in the respective items of works prepared by the Contractor.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidized or anodized aluminum shall be as specified in the items of works prepared by the Contractor. The number, size and type of fittings and fixtures shall be as in the Drawings /items of works prepared by the Contractor.

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.

Aluminum Doors, Windows, Ventilators & Partitions:**Materials:**

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, 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 from approved manufacturers.

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 of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitered and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within $\pm 1.5\text{mm}$. 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 sizes, 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 GWSSB 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 transom 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 to be prepared by the Contractor. 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 to be prepared by the Contractor.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 7.9.2 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 prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminum sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

Steel Rolling Shutters:**Materials and Workmanship:**

Rolling shutters shall be of an approved manufacture, 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 m², gear operated type (mechanical) for clear areas up to 35 m² 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 prepared by the Contractor. 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 3.50m 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 prepared by the Contractor. Painting shall be carried out as per clause 7.33.

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 610gms/m².

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.

Rubble Sub-Base:**Materials:**

Stones used for rubble packing under floors on grade, foundations 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: 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 ± 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 GWSSB.

Workmanship:

Stones 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 breaking 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 stones shall be unfilled 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.

Base Concrete:

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the contractor.

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 tamped 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.

Terrazzo and Plain Cement Tiling Work:**Materials:**

Terrazzo tiles and cement tiles shall generally conform in all respects to standards 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 color 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 coloring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder 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 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

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

Workmanship

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

Tiling work shall be commenced only after the door and window frames 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 45mm below the level of finished floor. Before the tiling 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 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles

over the base concrete. The thickness of bedding mortar shall not be less than 10mm 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 m² 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 1.5mm 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 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the color 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 tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm 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 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with beveled edges to obtain a neat and true joint. After the work has set, hand polishing with carbonado stones 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, usage 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 tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localized deviation of $\pm 3\text{mm}$ in any 3m length is acceptable in a nominally flat floor.

In-Situ Terrazzo Work:

Materials:

The requirements of marble aggregates for terrazzo topping shall be as per clause 7.14.1.

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 centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been 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.

Workmanship:

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

In-situ terrazzo finish 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 10mm downgraded coarse aggregates. The combined thickness of under

layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm 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 m² for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. 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 items of works prepared by the Contractor. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall not be less than 1.5mm and width not less than 25mm 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 finish. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/m². Over this slurry, the under layer shall be spread and leveled with a screening 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 color 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 toweling. 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.

Shahabad / Tandur/ Kota Stone Slab work:

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 100mm shall be $\pm 5\text{mm}$. This shall be $\pm 2\text{mm}$ on dimensions less than 100mm. 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 the 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.

Workmanship:

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

Preparation of the concrete base, laying and curing shall be as per clause 7.14.2.

Dado / skirting work shall be as per clause 7.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, 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 7.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not be applied before polishing.

Carborundum Tile Finish:**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 6mm. The quantity of Carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The Carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

Workmanship:

Requirements as detailed for terrazzo/cement tile finish under clause 7.14.2 shall be applicable for Carborundum tile flooring.

Glazed / Vitrified Tile Finish:**Materials:**

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. 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 from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

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 12mm for flooring and 10mm 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.

Colored 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 droppings 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 m² of floor area shall be spread over the hardened mortar bed over such an area 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. 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 of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1mm 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 10mm. 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 3mm 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.

In-Situ Cement Concrete Floor Topping:**Materials:**

The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one-part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified.

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

Coarse aggregates shall have high hardness 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 12.5mm and below shall be as per IS:2571.

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

Workmanship:

The thickness of the floor topping shall be as specified in the items of work prepared by the Contractor. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 7.13. 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 GWSSB. 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 of 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/m² 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 at this stage. The surface shall be re- trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final 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 preferable 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 tolerances 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 discolorations to the floor finish which are difficult to repair satisfactorily.

In-Situ Granolithic Concrete Floor Topping:

Materials and Workmanship:

The Requirements of materials and workmanship shall be all as per clause 7.19 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 40mm.

Floor Hardener Topping:

Materials & Workmanship:

Floor Hardener topping shall be provided either as integrally finished over the structural slab/grade slab or lay 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 work prepared by the Contractor. For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. 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 tread 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. Trowelling to a smooth finish shall be carried out as per clause 7.19.2. 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.

PVC Sheet/Tile Flooring:

Materials:

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

Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer 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 work prepared by the Contractor.

Workmanship:

PVC Floor covering shall be provided over an under bed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed 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 20deg.C and 30deg.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, according 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 area 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 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 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 center 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 slide on the surface. Tiles shall be rolled with a light wooden roller of about 5kg 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 treads.

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.

Acid Resisting Brick/Tiling Work:

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.

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 is 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 furan 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 days respectively, if heat treatment is given with infrared lamp.

Epoxy Lining Work:

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: Hydrochloric acid up to 30% concentration Sodium hydroxide up to 50% concentration Liquid temperature up to 60deg.C Ultraviolet radiation 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 GWSSB.

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 to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces 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 surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or 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 to 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.

Water-Proofing:

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 Employers Representative.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick 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 GWSSB.

Modified Bituminous Membrane:

Modified Bituminous Membrane shall be "SUPER THERMOLAY" 4 mm thick weighing 4 Kg/sq.m, 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 Bitumen Company Limited. "PLYFLEX" of Bitumen Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

Waterproofing of Roofs with Lime Concrete:

Materials:

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

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

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 12kg of washing soap and 4kg 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 to be prepared by the Contractor. 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 will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it

shall be laid in layers not exceeding 100mm to 125mm. Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards center and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points. Lime concrete fillet for a minimum height of 150mm 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 lime 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 surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column 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 that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the GWSSB.

- a) By mixing about 3 Kg of Jaggery 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 jaggery 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 straw 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 12mm 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 angles to the direction of run-off gradient. Transverse joints in alternate 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 instructions. 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.

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 the 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 GWSSB, as the unrolling progresses.

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

Khurras and Rainwater down Pipes:

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam 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 layers 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 take pipes.

Testing:

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.

Cement Plastering Work:

Materials:

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 GWSSB. If so desired by the GWSSB sand shall be screened and washed to meet the Specifications. 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. Droppings of plaster shall not be re-used under any circumstances.

Workmanship:

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements 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 10mm/20mm 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 13mm thickness. 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 on jambs, lintel and sill faces etc. as shown in the drawing and as directed by the GWSSB.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. 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 6 mm thick. 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 20mm 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 14mm thick and the second coat shall be 6mm 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 dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm 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 GWSSB duly satisfying the 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 GWSSB.

Where specified in the Drawings to be prepared by the Contractor prepared by the Contractor, 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 to be prepared by the Contractor prepared by the Contractor.

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 from 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/windows 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 4mm when checked with a straight edge of 2m length placed against the surface.

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

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

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

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.

Cement Pointing:

Material:

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 GWSSB and if so directed it shall be washed/screened to meet specification requirements.

Workmanship:

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm 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 colored pointing has to be done, the coloring pigment of the color required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the GWSSB.

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 GWSSB.

Painting of Concrete, Masonry & Plastered Surfaces:**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.

Color 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 GWSSB.

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

Workmanship:

Contractor shall obtain the approval of the GWSSB 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 thorough 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. Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

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.

Color Wash:

Color 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 finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

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 manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/m². A minimum of 2 coats of the same color shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat 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.

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

application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

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 coat shall be as per manufacturer's instructions.

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 instructions. 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 takes about 2 to 3 hours. A minimum of 2 finishing coats of the same color 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.

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.

Painting & Polishing of Wood Work:**Materials:**

- 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 GWSSB for the brand of manufacture and the color/shade. All materials shall be brought to the site of works in sealed containers.

Workmanship:

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor. 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 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 work to be prepared by the Contractor. 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 smoothly 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 vary slightly in shade and this shall be got approved by the GWSSB. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor. 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 GWSSB. When two coats of varnish are specified, the first coat should be a hard-drying undercoat or 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 using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with 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 spirit 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.

Painting of Steel Work:

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 GWSSB for the brand of manufacture and the color/shade. All the materials shall be brought to the site in sealed containers.

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 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 coats 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 manufacturer. 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 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 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, 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 vary slightly in shade and this shall be got approved by the GWSSB.

Flashing:**Materials:**

Anodized Aluminum sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanized mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fiber base self finished felt Type-2 Grade 1 conforming to IS:7193.

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 100mm.

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 filletting as indicated in the Drawings to be prepared by the Contractor. 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 of bituminous paint at the rate of 0.10 liter/m² after the installation.

Thermal Insulation for Ceiling

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

Fixing:

"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/m².

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen. The boards shall be further secured with screws, washers and plugs. The joints of the boards shall be sealed with bitumen.

Fiber Glass Boards:

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centers with 6mm x 65mm long wood screws. 20-gauge G.I. lacing wire shall be tied to the pegs. 'Crown' 200 fiberglass boards 50mm thick shall be stuck to the pegs 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 20mm – 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 50mm overlap and secured to the timer pegs by screws. If 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 battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

Plaster of Paris Board for False Ceiling:

Materials:

Plaster of Paris Boards:

- The plaster of Paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by GWSSB.

- 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 3.35mm 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 oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 Kg per sq.cm.

· The plaster of Paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by GWSSB. 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 coir 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. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. 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 a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

· The size of boards shall generally be 600mm 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.

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 color, 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 GWSSB. 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 GWSSB.

Metal Framework:

The metal frame work may be made of sections 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.

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 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 GWSSB.
- The false ceiling grid work shall be carried out as per the approved drawings or as directed by GWSSB. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm 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 1.2m 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 35mm x 6mm size or bars of 10mm dia. Threaded at the lower end and anchored securely in the roof concrete or welded to inserts 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 be 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 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm 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 work, 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, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. 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 joint. 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 Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by GWSSB.

Finishing:

It is essential that 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 GWSSB. The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for 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 Paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the Troweling the scrim down to the board.

Fire Stopping:

In case of fire protective ceilings, 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 GWSSB (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).

False or Cavity Floor; Frame Work:

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools 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 prop head.

The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm 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 prop head 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 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the prop heads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved color and shade. Floor Panels:

The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unvinegared/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cu.m 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 kCal/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 panel size not more than 600mm under any circumstances. Exposed 2mm 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 underside. The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 – “Specification for unbaked flexible PVC flooring” and of approved color 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.

Imposed Loading:

The finished floor shall be capable of supporting uniformly distributed loads of 500 to 1000 Kg. per m² 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 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

Finish:

The finished floor shall be true to lines and levels and present a neat flush surface.

Vendor Drawing:

Vendor 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 GWSSB for his approval. Work shall be carried out on approved drawings only.

Fire Proof Doors:**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 conform 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 conform 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 (conforming to IS:304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two-hour fire rating and 46 for four-hour fire rating. The shutter with the required insulating material shall be mounted on angle iron frame or the special

made frame from zinc coated (16G 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.

SPECIFICATIONS

SECTION – 5 STRUCTURAL STEEL WORK

SECTION - 5: STRUCTURAL STEEL WORK

Applicable Codes and Specifications:

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

IS: 808	Dimensions for Hot Rolled Steel sections
IS: 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
IS: 800	Code of Practice for General Construction in Steel
IS: 801	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
IS: 806	Code of Practice for Use of Steel Tubes in General Building Construction
IS: 7205	Safety Code for Erection of Structural Steel Work
IS: 7215	Tolerances for Fabrication of Steel Structures
IS: 4000	High Strength Bolts in Steel Structure – Code of Practice
AISC	Specifications for Design, Fabrication and Erection of Buildings
IS: 1161	Steel Tubes for structural purposes
IS:10 IS:102	Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
IS:110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.
IS:117	Ready Mixed paint, Brushing, Finishing, and Exterior Semigloss for general purposes, to Indian Standard colors.
IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, color as required.
IS:341	Black Japan, Types A, B and C
IS:2339	Aluminum paint for general purposes, in Dual container
IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) Undercoating, (b) finishing
IS:2933	Specification for enamel, exterior, type 2, (a) Undercoating, (b) finishing.
IS:5905	Sprayed aluminum and zinc coatings on Iron and Steel.
IS:6005	Code of practice for phosphating of Iron and Steel.
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
IS:13183	Aluminum paint, Heat resistant.
SIS-05-5900	(Swedish Standard)
IS: 1239	Mild steel tubes, tubulars and other Wrought steel fittings
	Part 1 – Mild steel tubes
	Part 2 – Mild steel tubulars and other wrought steel pipe fittings
IS: 1363 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)

IS: 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
IS: 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
IS: 1977	Structural Steel (Ordinary Quality)
IS: 2062	Steel for General Structural Purposes
IS: 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
IS: 3502	Steel Chequered Plate
IS: 3757	High Strength Structural Bolts
IS: 5369	General Requirements for Plain Washers and Lock Washers
IS: 5372	Taper Washers for Channels
IS: 5374	Taper Washer for 1 Beams
IS: 6610	Heavy Washers for Steel Structures
IS: 8500	Structural Steel-micro alloyed (medium and high strength qualities)
IS: 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
IS: 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
IS: 822	Code of Procedure for Inspection of Welds
IS: 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
IS: 1200	Method of Measurement in Building Civil Works
IS: 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
IS: 2595	Code of Practice for Radiographic Testing
IS: 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS: 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
IS: 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

Steel Materials:

Steel materials shall comply with the referred to 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:

Fe310-0 (St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
Fe410-0 (St 42-0)	For structures not subjected to dynamic loading other than wind loads such as: Platform roofs, foot over bridges, building, factory sheds etc.
Fe510-0 (St 42-0)	Grade steel shall not be used
	<ul style="list-style-type: none"> a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) If plastic theory of design is used

Drawings prepared by the VENDOR/CONTRACTOR:

The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Engineer-In-Charge for approval.

No fabrication drawings will be accepted for Engineer In charge's approval unless checked and approved by the VENDOR/Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the VENDOR/CONTRACTOR only after Engineer In charge's approval of fabrication drawings. Approval by the Engineer-In-Charge of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon. The Engineer In charge's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

Fabrication:

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 machined/ground smooth true and square 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.

Connections:

Shop/field connections shall be as per approved fabrication drawings. 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 to be used under the nuts or the bolt heads whichever are 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 members 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 rainwater shall have drain holes provided.

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 prior approval of the Engineer-In-Charge in writing.

Rolling and Forming:

Plates, 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.

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.

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 1) and IS: 7318 (Part 1).

While fabricating 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 panned 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° 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 25

mm 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.

Tolerances:

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

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

End Milling:

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

Inspection:**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 and 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 invalidate 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 Employer may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or dispatched to site without inspection and approval by the ENGINEER INCHARGE unless such inspection is waived in writing by the ENGINEER-IN-CHARGE.

The Contractor shall provide all the testing and inspection services 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 tests on structural steel members shall be as set forth below.

Material Testing:

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

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 Penetrate 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.

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 Contractor's approved fabrication drawings.

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 obtain 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 Employer, 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.

Shop Matching:

For structures like bunkers, tanks, etc. Shop assembly is essential. For other steel work, such as columns 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.

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 contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost of the EMPLOYER. The information for such extra holes will be supplied by the EMPLOYER/ENGINEER-IN-CHARGE.

Marking of Members:

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved 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 holes. 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 in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

Errors:

Any error in shop 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 Specifications by the Contractor, at no cost to the Employer.

Painting of Steel Work:

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

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 color/shade. All the materials shall be brought to the site in sealed containers.

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 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 coats 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 manufacturer. 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 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 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, 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 vary slightly in shade and this shall be got approved by the Engineer-In-Charge.

Acceptance of Steel, its Handling & 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 300mm 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 prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well

before such excavation and/or grading commences to a safe distance to 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 suit able coating and also from damage.

Anchor Bolts & Foundations:

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures 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 locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost. Here beams bear in pockets or on walls; bearing plates shall be set and leveled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

Assembly & connections:

Field connections may be affected 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 field connections shall be supplied by the Contractor 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 from 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.

Erection:

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, 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 place 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 cables to pass through
- c) Splicing as shown in relevant drawings
- d) Smoothing 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. The Contractor shall furnish test certificates.

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-erecting required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Engineer-In-Charge.

Tolerances:

General:

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

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 ±5mm.		
Out of plumb ness (verticality) of column axis from true vertical axis, as measured at column top:		
(a)	For columns up to and including 15 meters	±1/1000 of column height in mm or ±15 mm whichever is less
(b)	For columns exceeding	±1/1000 of column height in mm or ±20 mm whichever is less
Deviation in straightness in longitudinal transverse planes of column at any height		±1/1000 of column height in mm or ±10 mm whichever is less
Point along the height		
Difference in erected position of adjacent Pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance		±10 mm
Width of building prior to connecting trusses/beams with respect to true distance		±10 mm
Deviation in any bearing or seating level with respect to true level		±5 mm
Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building		±10 mm
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		±1/1500 of height 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		1. ±20 mm for trusses

beams from	2. For beams: the true difference
Depth < 1800mm:	±6mm
Depth > 1800mm:	±10mm
Deviation in sag in chords and diagonals of truss between node points	1/1500 of length in mm or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc. horizontal plan	1/1000 of span in mm subject to a maximum of 10 mm
Crane Girders & Rails	
Shift in the center line of crane rail respect to center line of web of with crane girder	±5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	±1 mm
Difference in alignment of crane rail in plan measured between any two points 2 meters apart	±1 mm
Deviation in crane track with respect to true gauge	
For track gauges up to and Including 15 meters	±5 mm
For track gauges more than 15 meters	± [5 + 0.25 (S-15)] where S in meters are true gauge
Deviation in the crane rail level at any point from true level	±1/1200 of the gauge distance or ±10mm whichever is less
Difference in the crane rail actual levels between any two points 2 meters apart along the rail length	±2 mm
Difference in levels between crane track Rails at	
(a) Supports of crane girders	±15 mm
(b) Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plane and elevation surfaces for smooth transition	2 mm
Relative shift in the location of crane stops (end buffer along the crane tracks with track gauge S	1/1000 of track gauge subject to maximum of 20 mm S in

Painting:

After steel has been erected, all bare and abraded spots, 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.

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.

SPECIFICATIONS

SECTION -6 WATER SUPPLY AND SANITARY WORKS

SECTION - 6:

WATER SUPPLY AND SANITARY WORKS

Applicable Codes:

The following standards and codes are made a part of this Employer's Requirement. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

IS: 210	: Specification for grey iron castings
IS: 269	: Specification for ordinary and low heat Portland cement
IS: 383	: Specification for coarse and fine aggregates from natural sources for concrete
IS: 432	: Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS: 456	: Code of Practice for plain and reinforced concrete
IS: 458	: Concrete Pipes (with and without reinforcement).
IS: 516	: Methods of tests for strength of concrete
IS: 554	: Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 651	: Salt glazed stoneware pipes and fittings.
IS: 774	: Flushing Cisterns for water closets and urinals (valueless siphonic type)
IS: 775	: Cast iron brackets and supports for wash basins and sinks.
IS: 781	: Sand-cast brass screw-down bib taps and stop taps for water services.
IS: 783	: Code of practice for laying of concrete pipes.
IS: 1068	: Electroplated coatings of nickel and chromium of iron and steel.
IS: 1077	: Specification for common burnt clay building bricks
IS: 1786	: Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1239	: Mild steel tubes (Part I) and mild steel tubular and other wrought steel pipe fittings (Part II)
IS: 1536	: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1626	: Asbestos cement building pipes, gutters and fittings (spigot and socket types).
IS: 1703	: Copper Alloy float valves (horizontal plunger type) for water supply purposes.
IS: 1726	: Cast iron manhole covers and frames.
IS: 1729	: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 1742	: Code of practice for buildings drainage
IS: 2116	: Specification for sand for masonry mortars
IS: 2212	: Code of practice for brickwork
IS: 2250	: Code of practice for preparation and use of masonry mortars
IS: 2326	: Automatic flushing cisterns for urinals
IS: 2470	: Code of practice for design and construction of septic tanks (Parts I & II)
IS: 2556	: Vitreous sanitary appliances (Part I to Part XV)
IS: 2963	: Specification for copper alloy waste fittings for wash basins and sinks
IS: 3006	: Specification for chemically resistant glazed stoneware pipes and fittings
IS: 3311	: Waste plug and its accessories for sinks and wash basins
IS: 5455	: Specification for cast iron steps for manholes
IS: 4127	: Code of Practice for laying of glazed stoneware pipes
IS: 3495	: Methods of tests of burnt clay building bricks
IS: 4111	: Code of practice for ancillary structures in sewerage system manholes
IS: 5382	: Specification for rubber sealing rings for gas mains, water mains and sewers
IS: 5329	: Code of practice for sanitary pipe work above ground for buildings
IS: 5434	: Non-ferrous alloy bottle traps for marine use

Sanitary Installation:

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary and plumbing work shall be carried out by licensed plumbers.

All sanitary appliances including sanitary fittings, fixtures, and toilet requisites shall be of size, and design as approved by the Employer's Representative. All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used. Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

A) Indian Type Water Closet:

This shall be the long pan pattern with separate footrests made of white glazed earthenware; white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap 'P' or 'S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1-part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

B) European Type Water Closet:

Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Symphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one-piece construction with approved plastic/Bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an ant siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate shall be capable of holding not less than 10 liters of water between the normal water level and the highest possible water level of the water closet installed.

Urinals:

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS:2556 (Part VI). The urinals shall be of one-piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weep hole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

Wash Basins:

Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type		Size
	Flat Back	630 x 450 mm
	Flat Back	550 x 400 mm

- (a) Wash basins shall be of one-piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the underside of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the center of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 cm². shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.
- (b) All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

Sinks:

- (a) The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:
 450 x 300 x 150 mm
 600 x 450 x 200 mm
- (b) They shall be of one-piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm

at the bottom to suit the waste fittings. The waste hole shall be either rebated or beveled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS: 2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS: 1068.

Flushing Cisterns:

The flushing cisterns shall be automatic or manually operated high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low-level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS: 774. Automatic flushing cistern for urinals shall conform to IS: 2326.

Cast Iron Soil Waste and Vent Pipes and Fittings:

All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS: 1536. The diameter approved shall be internal diameter of pipe. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I. or M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required color to get the approved shade shall be given over the base primer coat.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions approved for the corresponding sizes of straight pipes.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Employer's Representative and left in working condition after completion. The smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline. Water test and air test shall be conducted as stipulated in IS: 5329.

Galvanized Mild Steel (G.I.) Pipe:

The pipes shall be galvanized mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS: 1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanized on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS: 554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as to make them slack, water tight joint. The screw- thread of pipes and fittings shall be protected from damage until they are fitted. The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter. Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanized iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be

buried. M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. 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 lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Employer's Representative.

G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

The work of excavation and backfilling shall be done true to line and gradient in accordance with General Employer's Requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0 cm sand and filled up to 15 cm above the pipes. A sand cushion of 15cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. When excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Employer's Representative and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped; the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor.

The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

Stoneware pipes and fittings:

All pipes with spigot and socket ends shall conform to IS: 651/3006 and shall be of grade 'A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting:

- (a) Internal diameter;
- (b) Grade;
- (c) Date of manufacture;
- (d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382.

Spigot and Socket Joint (Cement Joint):

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of the depth of socket. Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees. The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantity of cement required for each joint for certain common sizes of pipes are given below for guidance:

Nominal diameter of pipe (mm)	Cement (kg)
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

Spigot and Socket Joint (Bituminous Joint):

The general requirements for this type of joint shall be as specified in 5.12.1 the material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

Spigot and Socket Joint (Rubber Ring Joint):

The 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 rubber rings conforming to IS: 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. 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.

Cleaning of Pipes:

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc. If as a result of the removal of any obstruction the Employer's Representative

considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches. After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good. If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

Water for testing of pipeline shall be arranged by the Contractor.

Stop Cock and Bib Cock:

A bibcock (bib tap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. in finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discolored.

These fittings shall be of brass heavy class; chromium plated (C.P) and of approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical

with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

Soak Pit:

Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit up to 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level up to ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

Manholes:**Location:**

Manholes shall be constructed at places approved by the Employer's Representative.

Excavation:

Excavation, shoring, dewatering etc. for the pits of manholes, laying of pipes and fittings/specials shall be done in accordance with Employer's Requirements described elsewhere in the document.

Bed Concrete:

The bed concrete for manholes shall be done in accordance with Employer's Requirements described elsewhere in the document.

Bricks:

Bricks to be used for construction of manholes shall conform to the relevant Indian Standards. They shall be sound, hard, and homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper colored, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm. Unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS: 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance up to ± 3 mm in each direction shall be permitted. Only full-size brick shall be used for masonry work. Brick bats shall be used only with the permission of Employer's Representative to make up required wall length or for bonding. Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If required by the Employer's Representative, brick sample shall be tested as per IS: 3495 by Contractor. Bricks rejected by the Employer's Representative shall be removed from the Site within 24 hours.

Cement Mortar:

Mortar for brick masonry shall be prepared as per IS: 2250. Manholes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. 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 as approved by the Employer's Representative. If required by the Employer's Representative Sand shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

The Contractor shall arrange for tests on mortar samples if so required by Employer's Representative. Retendering of mortar shall not be permitted.

Brick Masonry:

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 of manholes shall be in the proportion specified in 5.15.5. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work 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 pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing 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. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. 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 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS: 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in 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. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

Cement Plaster:

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar

thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

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

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

Cement Concrete Channel:

The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

Pipe Entering or Leaving Manhole:

Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

Cast Iron Steps:

Cast iron steps shall be as per IS: 5455. The steps shall be of grey cast iron of grade 15 as per IS: 210. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and warping. The portion of the step which projects from the wall of the manhole shall have a raised chequered design to provide an adequate non-slip grip. C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as to chip off at temperature of 0-degree C.

Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the brick work at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type C.I. steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole.

Frame and Covers:

Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

- i. Year of manufacture,
- ii. Identification mark of the Employer: PROJECT DIRECTOR AND CHIEF ENGINEER.
- iii. Arrow showing direction of flow.

(a) Cast Iron Frame and Cover:

The cast iron frame and cover shall be of grey cast iron as per IS: 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in

Clause 5.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequered shall not be less than 4 mm. The locking device for the cover shall be provided as approved by the Employer's Representative. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Employer's Representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. Including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole, the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

(b) Fiber Reinforced Concrete Frame and Cover:

Fiber reinforced concrete frame and cover shall be capable of withstanding load of 35 tones. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fiber reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fiber shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly, for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fiber reinforced frame and cover shall be manufactured as approved.

(c) Reinforced Cement Concrete Frame and Cover:

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

Drop Manhole:

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop-in level may be accomplished by one of the following approved methods:

- (a) A cascade;
- (b) A ramp;
- (c) By drops in previous manholes.

RCC Manhole:

M25 grade of concrete used for construction of RCC manhole shall have minimum cement content of 360 kg/cum of concrete. Minimum cover to the reinforcement shall be 50 mm.

Vent Shafts:**(a) General:**

Vent shafts shall be erected at such places as approved by the Employer's Representative.

(b) Mild Steel Vent Shaft:

Mild steel vent shaft shall be of 150 mm diameter and 12.17 m height from ground level with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

(c) RCC Vent Shaft:

Reinforced cement concrete vent shaft shall be of M25 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

Miscellaneous:

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

SPECIFICATIONS

SECTION -7 EARTHWORK

SECTION -7:

EARTHWORK

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.

IS 3764 - 1992	Excavation work - Code of Safety.
IS 2720	Methods of test for soils:
(Part-1) - 1983	Part 1 Preparation of dry soil samples for various tests.
(Part-2) - 1986	Part 2 Determination of Water Content.
(Part-4) - 1985	Part 4 Grain size analysis.
(Part-5) - 1985	Part 5 Determination of liquid and plastic limit.
(Part-7)	Part 7 Determination of water content - dry density relation using light compaction.
(Part-9)	Part 9 Determination of dry density - moisture by constant weight of soil method.
(Part-14) – 1983	Part 14 Determination of density index (relative density) of cohesion less soils.
(Part-22) – 1978	Part 22 Determination of organic matter.
(Part-26) – 1987	Part 26 Determination of pH Value.
(Part-27) – 1987	Part 27 Determination of total soluble sulphates.
(Part-28) – 1974	Part 28 Determination of dry density of soils in place by the sand replacement method.
(Part-33) – 1971	Part 33 Determination of the density in place by the ring and water replacement method.
(Part-34) – 1972	Part 34 Determination of density of soil in place by rubber balloon method.
(Part-38) – 1976	Part 38 Compaction control test (Hilf Method).

General:

The Contractor 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 Employer's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines 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 excavation 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, bunds, riprap with regular slopes within the lead specified and leveling the same so as to provide natural drainage. Rock/soil & murrum excavated shall be stacked properly as approved by the Employer's Representative. 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 piled separately for later re-use.

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 material so removed shall be disposed off as approved by the Employer's Representative. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

Excavation:

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's Representative, 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 or such other lines and grades as may be agreed with the Employer's Representative. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care.

Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the drawings provided by the Contractor as agreed with the Employer's Representative. 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 to the required elevation at no cost to the Employer.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual 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 safely 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.

Rock:**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 and which in any individual mass has a volume not exceeding 1m^3 or 0.25m^3 where the net width of excavation is less than 2 m. Ordinary excavating machinery means a hydraulic back hoe with rated output of 50 kW or less.

Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer's Representative his inability to excavate it without resort to heavy percussion tools complete 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 Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

Excavation by the Use of Explosives

Unless otherwise stated herein, I.S. 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 Employer's Representative, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Employer's Representative at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and number 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 far possible from the area to be blasted. Employer's Representative'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.

- i) 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.
- ii) Before any blasting is carried out, Contractor shall intimate Employer's representative and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.
- iii) Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m 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.
- iv) The blasting of rock near any existing buildings, equipment 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 Employer's Representative; a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

v) The firing shall be supervised by a Supervisor and not more than 6 (six) 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.

vi) 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.

vii) Contractor shall preferably detonate the explosives electrically.

viii) The explosives 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.

ix) 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.

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

xi) 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 Employer's Representative, with concrete of strength not less than M10. Stopping in rock excavation shall be done by hand trimming.

xii) Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the State and / or Union Government as applicable at the place of excavation.

Stripping Loose Rock:

All loose boulders, 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 Employer's Representative, 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 complete the permanent works, but which, in the opinion of Employer's Representative, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

Classification of Strata:

The decision regarding, classification of strata shall rest with the Engineer in charge and his decision shall be final and binding to the contractor.

All the materials encountered in the excavation shall be classified as under: -

ORDINARY SOIL AND SOFT MURRUM:

These will include all materials of an earthy or sandy nature, which can be easily ploughed or small shingle, and gravel, which can be easily removed.

HARD MURRUM:

This shall include all kinds of disintegrated rock or shale or inundated clay which can be removed with a shovel without difficulty and which do not require blasting.

SOFT ROCK:

This shall include all materials which is rock or hard conglomerate, all decomposed and whether rock, highly fissured rock old masonry and also soft rock boulders bigger than 1/2 cubic meter and other varieties of rock. Which do not require blasting and which can be removed with the pie crowbars wedges and hammer.

HARD ROCK:

This shall include rocks, occurring in masses, which could best be removed by chiseling or by blasting.

Fill, Backfilling and Site Grading:**General:**

All fill material shall be subject to the Employer's Representative's approval. If any material is rejected by Employer's Representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Employer's Representative 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 Employer's Representative.

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 boulders 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 decide to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer's Representative. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Topsoil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Employer's Representative. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

Filling in pits and trenches around foundations of structures, walls, 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 Employer's Representative. Earth shall be ramming with approved mechanical compaction machines. Usually no

manual compaction shall be allowed unless the Employer's Representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's Representative.

Plinth Filling:

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Employer's Representative may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. The finished level of the filling shall be trimmed to the level/slope specified.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300mm. 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 Employer's Representative obtained prior to commencing filling.

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.

Sand Filling in Plinth and Other Places:

Where backfilling 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 structures on sand fill shall not be started until the Employer's Representative has inspected and approved the fill.

Filling in Trenches:

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated 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 center 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 center 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 materials such as earth, murrum, etc. The filling up to the level of the centerline of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centerline 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.

General Site Grading:

Site grading shall be carried out as indicated in the drawings and as approved by the Employer's Representative. Excavation shall be carried out as specified in the Employer'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 225 mm and 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, the Contractor shall remove the affected material and make good.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate 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 does not get 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. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

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 the specified density has been obtained. In other areas the soil should be backfilled and compacted suitably as specified by the Engineer.**

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 Employer's Representative. 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 bullies or as approved by the Employer's Representative. The length of the bully 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 the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring 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 Employer's Representative. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

Timber 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 Employer's Representative.

The withdrawal 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 Employer's Representative. In all other respects, the Employer's Requirements for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring 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.

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 so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction planning. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Employer's Representative, 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 the concrete. The Contractor shall, however, ensure that no damage to the structure results 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 Employer's Representative 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 Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Employer's Representative, to be large, a well point system- single stage or multistage, shall be adopted. The Contractor shall submit to the Employer's Representative, 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.

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 of 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 Employer's Representative.

SECTION 8 : ITEMWISE SPECIFICATIONS

SPECIAL NOTES TO BE CONSIDERED:

1. ALL PIPELINE HYDRAULIC DESIGN AND QAP WITH SURVEY DRAWING, LAYOUT DRAWING AND L-SECTION OF 30 METER CHAINAGE WITH RELEVANT HYDRAULIC DESIGN FOR PIPELINE AS PER WORKING SURVEY SHALL BE SUBMITTED IN SOFT COPY AS WELL AS IN HARD COPY TO THE DEPARTMENT IN 5 SETS.
2. ALL ELECTRO-MECHANICAL DESIGN AND PUMP CDR AND QAP AS PER WORKING SURVEY SHALL BE SUBMITTED IN SOFT COPY AS WELL AS IN HARD COPY TO THE DEPARTMENT IN 5 SETS.
3. ALL STRUCTURAL DESIGN WITH SBC REPORT FOR PROPOSED CIVIL STRUCTURES IN THE SCHEME WITH GAD AND STRUCTURAL DRAWINGS AS PER WORKING SURVEY SHALL BE SUBMITTED IN SOFT COPY AS WELL AS IN HARD COPY TO THE DEPARTMENT IN 5 SETS.
4. AS BUILT DRAWINGS FOR PIPELINE AND CIVIL STRUCTURES MUST BE PREPARED AS PER ACTUAL WORK COMPLETED ON SITE AND SHALL BE SUBMITTED TO THE DEPARTMENT IN 5 SETS.
5. DETAILED ESTIMATE WITH ABSTRACT AND MEASUREMENT SHEET WITH DETAILED DRAWINGS WITH STRUCTURE DESIGN FOR PROPOSED CIVIL STRUCTURES AND FOR PIPELINE WITH L-SECTION OF 30 METER CHAINAGE WITH RELEVANT HYDRAULIC DESIGN SHALL HAVE TO BE SUBMITTED IN SOFT COPY AS WELL AS IN HARD COPY AS PER INSTRUCTIONS GIVEN BY ENGINEER IN CHARGE IN 5 SETS TO THE DEPARTMENT.

SCHEDULE – “Construction of RCC HGLR, PSLJ 110 mm dia 6 Kg PVC Rising and Gravity main Pipeline, Construction of Pump Cabin, Electrification for Dhrang Village WSS of Bhuj Taluka.”

Technical Specification

GUJARAT WATER SUPPLY AND SEWERAGE BOARD

NAME OF WORK:- “Construction of RCC HGLR, PSLLJ 110 mm dia 6 Kg PVC Rising and Gravity main Pipeline, Construction of Pump Cabin, Electrification for Dhrang Village WSS of Bhuj Taluka.”

Technical Specification

ITEM NO.1

RCC GSR (description of item turnkey tender)

Preparing structural design of RCC under ground/partially under ground /above high ground level reservoir if required capacity as per relevant IS standards and constructing the same ,including excavation in all types of soil starta including rock including shoring strutting if required for loose soil/to protect from colapse casting 100 mm thick P.C.C leveling course in M-15 ,refiling the pit with proper soil and disposing of the surplus stuff at all lead including cement plaster in CM 1:2 with approved water proofing compound to all over inside container (i.e walls,base,top slab/dome bottam etc all)including at types of labour and material charages of lowering ,laying ,eracting /hosting and jointing of pipe assembly to inlet ,oulet overflow washout and bye pass arrangement as per hydraulic design .Providing and fixing accesseries ,CI manhole frame and cover water level indicator,adequater cowl type ventilators or lantern type ventilator with stainless steel jai.RCC chambers for valves providing and applying three coats of cement paint /snowcem to the out side face of structure.it a so includes sacisfactory water tightness test as per relevant I.S code and painting name of scheme and capacity on the tank as per oriection of engineer in charge.

List of Indian Standards for Design of GSR / SUMP:-

The structural design of GSR shall be in accordance with provisions relevant I.Ss.

(1) I.S. 3370 part I & II 2009 or latest revised

(1.1) I.S. 3370 part III & IV 1965 or latest revised

(2) I.S. 456 – 2000 or latest revised.

(3) I.S. 1893 – 2000 – 1984 or latest revised.

(4) I.S. 875, Part – 1 to 3, 1987 or latest revised.

General Specifications:-

(1) Water depth in container shall be adopted as per data of tender. Capacity shall be calculated excluding free board of the reservoir. If water depth is not specified, the suitable water depth / acceptable to field engineer in accordance with hydraulic

(2) Shape of container (in plan) specified by in data shall ve adopted in absence circular shape shall be adopted.

(3) Size shall be fixed as per availability of space (land area) at site / acceptable engineer in charge.

(4) Effect of overlapping of pressure bulbs on soil due near by structure and proposed sump should be considered.

(5) Care shall be taken that no damage should occur to nearby existing structure. Compensation shall be paid for the same by agency.

(6) The minimum concrete grade for RCC shall be M-30.

(7) HYSD Fe 415 / 500 grade reinforcing bars confirming to I.S. 1786 / 139 shall be considered in design. CRS / TMT bars shall be provided. In saline atmosphere corrosion resistance stainless steel / HCR rebar shall be provided. Any other steel can be used with approval of C.E./ in situation of non availability in market without extra cost.

8) Minimum size (or thickness) of various components shall be provided as per tender criteria / specifications in absence as per I.S./ Std. practice of G.W.S.S.B. Minimum dimensions specified for various components in tender data / specifications shall be provided without fail.

(9) The safe bearing capacity (SBC) shall be referred from SBC test report. In absence of report it shall be referred from data sheet. If poor soil is found / water table is met with during excavation

SBC shall be scientifically ascertained and design shall be revise. No extra shall be paid for increase in quantity.

(10) DI pipes and special shall only be used if type is not specified in tender.

(11) The rate shall include cost of dewatering during excavation making all arrangement when water table meets within depth.

(12) The structure shall be designed properly to resist uplift due to ground water table specified in data or actual ground water table meets with during excavation. If GWT / Uplift is mentioned in tender and during excavation it dose not meet 7.5% rate shall be reduced.

(13) SS pipes railing shall be provided over sump periphery when sump height is ≥ 1.5 meter above ground level.

(14.a) RCC staircase/RCC Steps should be provided from GL to sump top slab based on the height of the GSR above/below the ground.

(14.b) RCC Staircase with SS railing to be provided inside reservoir container. BB Masonry stair cabin to be provided to cover the same with MS safety door having locking arrangement.

(15) Appearance of structure should be aesthetically good looking acceptable to authority.

(16) Any change in size, shape, depth below GL, height above GL, water depth, F.B., size of member etc can be permitted in exceptional case due to site condition or hydraulic design requirement by C.E. No extra shall be paid for change.

(17) Any change in data, dimensions, shape, water depth, reduction in size if permitted by competent authority and if it reduces quantity then payment shall be reduced prorated.

(18) When capacity of GSR / Sump is > 20 lakh litres two or suitable compartments acceptable to executive engineer shall be designed and provided.

(19) Agency shall engage qualified (at least graduate) consulting engineer for designing the structure and he / she shall visit the site for guidance of work.

(20) 75% part rate shall be payable for concrete, reinforcement and plastering items of container until satisfactory hydraulic testing for water tightness is performed as per tender condition. Till the work shall be treated as incomplete.

Above conditions / general specifications Sr. No. 1 to 20 are part and parcel of tender (contract) and prevail over other provisions in tender.

as above without water table(sub soil water below foundation)

for GSR (U/G sump)with cover slab to be constructed at site situated in seismic zone V,the above rates shall be increased by 2%

1.500 lac liter sump capacity of GSR /SUMP

Technical Specification

GENERAL

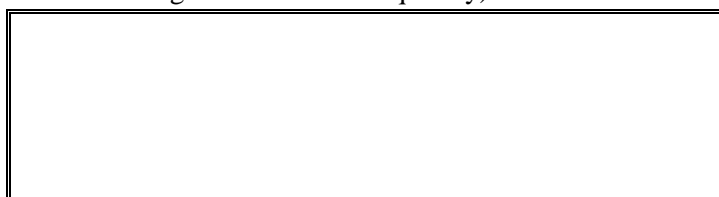
1. Employer's Drawings

1.1. The drawings listed in the Tender document are the Employer's drawings and are provided by the Employer as illustrative of the Specification.

1.2. All data and information furnished in the drawings by the Employer is given in good faith but the Employer does not accept the responsibility for the completeness and accuracy thereof. The same shall be verified by the Contractor promptly pointing out errors or discrepancies thereof to the Engineer.

2. Drawing Sheet Format

2.1. All drawings provided by the Contractor shall be on standard size sheets, prepared on computer with AutoCAD 14 and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of Contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title.



A blank space of 90 mm x 100 mm shall be provided for the Engineer's approval stamp and provision shall be made for details of revisions to be recorded.

2.2. All drawings submitted by the Tenderer/Contractor shall use the English language and preferably SI units. All drawings shall be clearly and fully cross-referenced to the other drawings as relevant.

3. Tender / Contract Drawings

3.1. Drawings submitted by the Tenderer shall show all the essential items of the Plant offered together with sufficient details to enable the general arrangement of the Plant to be determined.

3.2. The drawings and documents to be provided by the Tenderer / Contractor shall be as per the schedules of price but shall not be limited to those listed:

4. Submissions and Approval of Drawings

4.1. The following shall be the procedure for submission and approval of drawings:

4.1.1. The Contractor shall submit 4 copies of the drawings to the Employer. All the drawings are to be signed by the Contractor or his authorized representatives

4.1.2. The Engineer's Representative will review the drawings and, if found fit for approval, the Employer will return 2 copies to the Contractor duly approved.

4.1.3. In case the drawings/documents are not fit for approval but worth for review, the Engineer's Representative will mark the comments on the drawings and return 2 copies to the Contractor. In such case, the Contractor shall resubmit the revised drawings within two weeks and the same shall be repeated till the drawings are finally approved.

4.1.4. If the submitted drawings/documents are not worth for review, the Contractor will be informed accordingly.

4.1.5. On receipt of the approved drawings, the Contractor shall submit soft copies and documents to the employer.

4.1.6. After tests on completion, the Contractor shall submit, within 15 days of the conclusion of the tests, floppies of the "As Built Drawings" to the Employer.

4.2. When the drawings are received by the Engineer's Representative after revision by the Contractor, he will only review the revision made and hence the Contractor shall carefully identify all the revised details / dimensions and also describe the revisions in the revision block.

4.3. No drawings, with corrections made after taking the prints, will be accepted.

4.4. Approval of drawings by the Engineer shall not relieve the Contractor of his responsibility in terms of the Contract.

5. Delivery, Unloading and Storing at Site

5.1. The Contractor shall be responsible for checking all materials delivered to Site and shall keep the Engineer's Representative fully informed of the state of deliveries. The Contractor shall carry out, at his cost, all instructions of Engineer or his Representative for proper unloading, preservation, maintenance, storage, and security of materials delivered to Site until he fulfills all his obligations under the Contract.

5.2. The Contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the Engineer.

5.3. Multiple handling and movement of materials during storage and retrieval shall be avoided.

6. Spare Parts:

6.1. Spare Parts required after the taking over the Plant shall be filled up by the bidder in the price schedule.

6.2. Spares during pre-commissioning trials, commissioning tests/maintenance, guarantee etc. shall be provided by the Contractor. The necessary spares shall be brought by the Contractor prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All these spares have to be provided as required, by Contractor free of cost.

6.3. All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labeled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to Site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.

6.4. All cases, containers or other packages are liable to be opened for such examination as the Engineer's

Representative may require and packing shall be designed to facilitate opening and thereafter re-packing. In the event of the some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc., the Contractor shall inform the Employer before such withdrawal so that the Employer can take timely alternative steps.

7. Tools:

7.1. Tools shall be delivered to site just prior to Tests on Completion.

7.2. The specified tools shall not be used for the erection of the Plant being supplied and except that the Engineer may call upon the Contractor to demonstrate their use or effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools at site for erection, he shall provide his own.

The test equipment shall include special purpose items essential to the testing or re-calibration of related items of Facilities.

CRITERIA FOR PREPARATION OF DESIGNS OF RCC HGLR & PUMP HOUSE BY PRIVATE AGENCY

The payment for preparation of design shall be borned by the contractor will not be reimbursed by GWSSB.

Approved Vendor List for Proof Checking/ Preparation of Structural Design of RCC HGLR by G.W.S.S.B.

LIST OF QUALIFIED STRUCTURAL CONSULTANTS

1.0

1	To, The Consultant Sthapati Designers & consultant Pvt Ltd "Ohm"Chamber" Station Road Navsari-396445 Ph No. (02637) 250330,280330	5	To, The Consultant Stup Consultant Pvt Ltd. 2 nd Floor, Shoopers Plaza-2 Opp. Telephone Bhavan C.G. Road, Navrangpura Ahmedabad-380009 Ph No. (079) 26468495,26468496
2	To, The Consultant Ashirwad Engineering Consultant 2 nd Floor, Induchacha House, above Prakash Group Opp. Chhani Jakat naka Baroda-390002 Ph No. (0265) 2761977,2781753	6	To, The Consultant Deesh Civil Engineering Design 17,Sarohi-III, Naroda Nikol-Road, Nikol, Ahmedabad. Ph No. (079) 22893839, (M) 9426067039
3	To, The Consultant Saurachna Strucon Pvt Ltd 330,Akshar Arcade Opp: Memnagar Fire Station, Vijay Cross Road,Navrangpura Ahmedabad-380014 Ph No. (079) 26562119,26562120	7	To, The Consultant Shri Manish V.Doshi, 507, Hem Arcade, Dr. Yagnik road, Opp. Swami Vivekanand Statue, Rajkot-360001 Ph No. (0281) 2466303
4	To, The Consultant Dr. H.J.Shah B-9,Sai Krupa Society Vibhag-2, Besides Sai Temple,Water tank Road, Harni Road, Baroda-390006 Ph No.(0265) 2483407	8	To, The Consultant Mars Planning & Engineering Service Pvt Ltd., 601, Sun Mount Building, Opp. Iscon Mega Mall, S.G. Highway, Ahmedabad-15 Ph No.(079) 40026333

GENERAL:

1.1.0 Capacity of the container of the tank shall be the volume of the water it can store between the designed full supply level (F.S.L) and lowest supply level (L.S.L) i.e. the level of the lip of the outlet pipe. Due allowance shall be made for 20 mm. thick plastering the tank from inside, while calculating the capacity of the tank.

1.2.0 Freeboard is the vertical distance between F.S.L. and Soffit of covering slab or dome or beam supporting the cover. In any case the free board shall not be less than 300 mm from bottom of beam.

1.3.0 Height of the staging or height of the tower shall be the vertical difference between L.S.L. of the tank and the average ground level at the site of tank.

1.4.0 Dead storage shall be the storage capacity of water below L.S.L. depth of dead storage shall be the vertical distance between the top outlet level and wash out level. The washout pipe level shall be at the lowest portion of the container.

1.4.1 Minimum depth of water for dead storage shall be 100 mm even for flat bottom slab and not more than 300 mm for inlet i.e. bottom dome slab type tank.

1.5.0 Water depth in the tank shall be the vertical distance between L.S.L. and F.S.L. of tank.

1.6.0 The agency has to carry out the safe bearing capacity test from Government approved laboratory.

1.7 As per IS:11682-1985 Page-25 typical reinforcement details "The" Ties or "Links" jointing to vertical bars of shaft is highly needed.

1.8 The Min. concrete grade for RCC shall be M: 30. Proportion of concrete ingredients shall be as per Mix design using weigh batching.

1.9 TMT (Fe 415) or higher grade reinforcing bars confirming to IS 1786-1139/1139-1986 TMT bars shall be used as per detailed specification.

1.10 Maximum spacing between horizontal bracings shall be 5 m (storey height).

1.11 Water level indicator shall be provided and fixed float type /electronic (as specified).

1.12 The rate shall include providing and fixing pipes, specials, and valves required for inlet, outlet, wash out, over flow and bye pass arrangement. The scope of work includes constructing supporting RCC pillars, erecting, laying, fixing and joining pipes and specials etc up to 5m length from face of staging (outer most columns).

1.13 CI pipes & specials shall only be used.

1.14 The rate shall include cost of dewatering during execution making all arrangement and any dewatering technique.

1.15 The structure shall be designed properly for uplift due to Groundwater table specified in data or GWT met with during execution. No extra shall be paid.

1.16 Effective curing shall be carried out as per specifications.

1.17 Agency shall engage qualified (at least graduate) consulting engineer for designing the structure and he/she shall visit the site for guidance of work at least 3 times.

1.18 TMT Fe 415 grade reinforcing bars confirming to I.S. 1786 -1985 1139-1986 shall be considered in design. TMT bars shall be provided. Any other steel can be used with approval of C.E. / in situation of non availability in market without extra cost.

General Specifications FOR RCC H.G.L.R.:-

(1) Water depth in container shall be adopted as per data of tender. If water depth is not specified the suitable water depth / acceptable to field engineer in accordance with hydraulic requirement shall be adopted for capacity.

(2) Shape of container (in plan) specified by in data shall be adopted in absence circular shape shall be adopted.

(3) Size shall be fixed as per availability of space (land area) at site / acceptable engineer in charge.

(4) Effect of overlapping of pressure bulbs on soil due nearby structure and proposed HGLR should be considered.

(5) Care shall be taken that no damage should occur to nearby existing structure. Compensation shall be paid for the same by agency.

(6) The minimum concrete grade for RCC shall be M-300.

(7) HYSD Fe 415/500 grade reinforcing bars confirming to IS 1786/1139 shall be considered in design. Any other steel can be used with approval of C.E./in situation of non availability in market without extra cost.

(8) Minimum size (or thickness) of various components shall be provided as per tender criteria / specifications in absence as per I.S./ Std. practice of G.W.S.S.B. Minimum dimensions specified for various components in tender data

/ specifications shall be provided without fail.

(9) The safe bearing capacity shall be referred from the SBC test. The SBS test shall be carried out by the contractor from government approved laboratory and to submit the report. No any extra shall be paid for this purpose.

(10) CI pipes and special shall only be used if type is not specified in tender.

(11) The rate shall include cost of dewatering during excavation making all arrangement when water table meets within depth.

(12) The structure shall be designed properly to resist uplift due to ground water table specified in data or actual ground water table meets with during excavation. No extra shall be paid.

(14) Appearance of structure should be aesthetically good looking acceptable to authority.

(15) Any charge in size, shape, depth below GL, height above GL, water depth, F.B., size of member etc can be permitted in exceptional case due to site condition or hydraulic design requirement by C.E. No extra shall be paid for change.

(16) Any charge in data, dimensions, shape, water depth, reduction in size if permitted by competent authority and if it reduces quantity then payment shall be reduced prorate.

(17) When capacity of GSR is > 20 lakh liters two or suitable compartments acceptable to executive engineer shall be designed and provided.

(18) Agency shall engage qualified (at least graduate) consulting engineer for designing the structure and he / she shall visit the site for guidance of work.

List of Indian Standards for Design of GSR:-

The structural design of GSR shall be in accordance with provisions relevant I.Ss.

List of I.S.Code :-

(1) I.S. 3370 part I to IV 1965 or latest revised

(2) IS 456-2000 or latest revised

(3) IS 11682- 1985 or latest revised

(4) IS 1893-2002 part I to V or latest revised

(5) IS 13920 -1993, or latest revised

(6) IS 875part I to III, 1987 or latest revised

(7) IS 11089- 1987 or latest revised

(8) IS 1080- 1985 or latest revised

(9) IS 2911- 1988 or latest revised

(19) The design of RCC HGLR shall be in accordance with IS-1893-(Part-I) " Criteria for Earthquake Resistant Design of Structures" Part-I General provisions and Buildings and IS - 1893-(Part-II (2002) " Liquid Retaining Tanks (Elevated and Ground supported " and IS 875 Part-III, IS 13920, IS 4326.

(20) As per IS : 11682 - 1985 page 25 Typical reinforcement details " The " Ties or "Links" jointing to vertical bars of shaft is highly needed.

2.0 GENERAL REQUIREMENTS:

2.1.0 Cement concrete shall be in accordance with IS 456-2000 fine and coarse aggregates shall be confirming to IS 383-1963 or its latest revision. The selection of the type of fine and coarse aggregate to be actually used shall be as directed by the Engineer-in-charge.

2.2.0 For parts of the tank in contact with stored water and closing vapors above FSL shall be in concrete grade M300 or in richer grade.

2.3.0 Inlet, Outlet, Overflow, and Washout pipe:

2.3.1 Inlet Pipe: As per Data Sheet

2.3.2 Outlet Pipe: As per Data Sheet

2.3.3 Overflow pipe: As per Data Sheet

2.3.4 Washout Pipes: As per Data Sheet

Outlet cum washout arrangement shall be provided with sluice valves at GL. Detailed drawing showing all the pipes, duck foot bends, chamber, sluice valves and other necessary connection shall be furnished in the plan. Plain concrete block in M-150 for duck foot bands shall be of minimum depth of 600 mm. The width of the block shall have an offset minimum of 150 mm.

2.4.0 Water Level Indicator:

A water level indicator shall be provided for the tank reading depth of water in meters with least count of 10 cm. The system shall consist of uncorrodible material and shall be simple and easy to maintain. The water level indicator shall be provided and fixed as approved and directed by the Engineer-in-charge.

2.4.1 Access to roof for an entry to the inside of the tanks shall be provided. At roof level of the tank the access to roof manhole from the ladder or stair shall be properly provided with parapet or railing. At ground level or at walkway level the access forgoing up shall be provided with a door and locking arrangement. Railing at roof level and at gallery level shall be provided.

2.4.2 At least two manholes with frame and cover of CI medium type shall be provided with ladder for entering into the container for maintenance purpose. The size of manhole frame shall be of 0.6 x 0.6 meter 54 kg for each manhole frame.

2.5.0 Lightning Arrestor:

Lightning arrestors shall be provided on the roof of the tank as per IS 2309-1969. Position and height of lightning arrestors shall be such that the whole structure shall be enclosed within dome having its apex at top and of the arrestors and generated by a line inclines at 60° to the vertical. The arrestors shall be suitably earthed. Copper strip shall be covered with GI pipe 25-mm dia up to 4-meter height from GL.

2.6.0 The roof of the tank shall be ventilated by providing cowls or ventilators with mosquito proof net for ventilators. They shall be fixed with proper framing. Ventilation area shall not be less than of (A) 0.04% of the free water surface when cowl type ventilators are provided. (B) Cross sectional area of the inlet pipe. (C) Cross sectional area of the outlet pipe.

2.7.1 All tanks shall be checked for seismic forces confirming to IS 1893-1975 or its latest revision and wind forces also.

2.7.2 Water tank in vicinity of mines, galleries and blasting sites or in areas which may be subjected to blasting sites or in areas which may be subjected to blast or shock, shall be designed for the dynamic forces developed due to blast equipment.

2.7.3 Members of towers, which are primarily subjected to dynamic stresses, shall be checked for ductility of the members at the joint.

2.7.4 Staircase and all columns shall be tied together just above foundation level by structural members such as a braced or a tie ring beam.

2.8 Following shall be the minimum thickness of various members of the tank container.

Roof slab	100 mm
Bottom slab	200 mm
Container Dome	100 mm
Vertical wall including shaft wall	150 mm

2.9.0 Error up to 2 % in weights, forces, moments etc. in the design calculations may be neglected.

3.0 LOADS:

3.1.0 For all RCC and PCC component unit weight shall be taken as 25000 N/m^3 , 24000 N/m^3 respectively, allowance of plaster up to 20 mm. Inside surface of container shall be taken in to consideration of in normal circumstances.

3.2.0 Water load shall be taken as 10000 N/m^3 .

3.3.0 Live load and snow load shall be taken as per IS: 875-1964 or its latest revision.

3.3.1 No live load may be assumed while designing the staging (or tower) and foundation for seismic loads.

3.3.2 Live load on gallery all round the elevated tank shall be considered as 1500 N/m^2 .

3.4.0 Wind load as per Fig. i.e. basis maximum wind pressure or Indian including winds of short duration as per IS 875/1964 shall be considered.

3.5.0 Seismic forces on the tower shall be as per IS 1893-1975 or its latest revision. Wind and seismic forces shall not be assumed to act simultaneously.

INCREASES IN PERMISSIBLE STRESSES:

Where stresses due to wind or earth quack temperature & shrinkage effects are combined with those due to dead, live

and impact loads the stresses specified in table 13, 16 & 17 of 456-1978 may be increased up to a limit of 33.50%.

4.0 DESIGN:

4.1.0 General:

4.1.1 Shape of the structure shall be circular or as directed by Engineer-in-charge and shall be selected depending upon site condition from the standard shape

4.1.2 General description and salient feature as mentioned below of the design shall be not approved by the Engineer-in-charge and shall be mentioned in the design before detail design calculations starts.

4.2 Sketch showing dimensional section, elevation with plan shall be given.

4.3.1 The safety against overturning of structure shall be computed quite accurately.

4.3.2 Design shall be based on the worst possible combination of various loads, moments, shears and resultant stress in the tank for the following two cases.

(i) Tank Full 'A' (ii) Tank Empty

Tank full means depth of water inside the container up to full height of the container without consideration of free board Or safe bearing capacity of soil based on actual soil investigation report of the laboratory.

Position of sub soil water level. Chemical analysis if sub soil water and soil where possibility of brakish/saline water is ascertained.

Location of site on index plan.

4.3.3 Design shall be based on accepted basis and methods of design as well as the provision of IS 3370-1965, IS 456-1978, IS 1343-1960, IS 2210-1962, IS 2204-1962 etc. and their latest revision. However methods based on experimental investigation as mentioned in para 18.2 % "C" in IS 456-1978 shall not be entertained.

4.4.0 The parts of the structure neither in contact with the liquid on any face more enclosing the space above the liquid as in the case of stages of a tower shall be designed on working stress method on accordance with the requirement of IS 456-1978. Staging may be designed on limit method as per IS 456-1978.

4.5.0 Design of members other than these excluded by above (i.e. roof, walls, floor etc. of the container) shall be based on consolidation of adequate resistance of cracking as well as adequate strength calculation of stresses shall be para s per 3.2.2 of IS 3370 (part-II) 1965 or its latest revision.

4.5.1 PERMISSIBLE STRESS IN CONCRETE FOR RESISTANCE TO CRACKING:

For calculations relating to the resistance of members to cracking the permissible stresses in tension (direct and due to bending) and shear shall confirm the values specified in Table-I of IS 3370 (part-II 1965)

The permissible tensile stresses due to bending apply to the fact of the member in contact with the liquid. In members less than 225 mm thick and in contact with the liquid on one side, this permissible stress in bending apply to the face remote from liquid.

4.5.2 FOR STRENGTH CALCULATION:

In strength calculation, the permissible concrete stresses shall be in accordance with para-44 of IS 456-1978. Where the calculated shear stress in concrete alone exceeds the permissible value reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear.

4.5.3 Permissible compressive stress (Directly only) insheels (i.e. Top Dome, Wall and shall be reduced by 43% for 10 cm thick walls. For thickness more than 30 cm, the compressive stress shall be reduced by 50% and for inter media thickness 10 cm. to 30 cm. linear interpolation shall be done.

4.6 PERMISSIBLE STRESSES IN STEEL:

4.6.1 For resistance to cracking the steel and the concrete are assumed to act together. For checking the tensile stresses in un cracked concrete for avoidance of cracks, the tensile stress in the steel shall be the product of the modular ratio and the corresponding allowable tensile stress in concrete as per IS 3370(part-II) 1965 or its latest revision. Modular ratio "M" for different concrete mix shall be taken as under:

Grade of Concrete	Modular Ratio "M"
M-150	19
M-200	13
M-250	11
M - 300	9.33

4.6.2 For strength calculation (concrete assumed to be cracked), the permissible stresses in reinforcement shall be as per Table -2 of IS 3370(part-II) 1965 or its latest revision. For steel, the stresses shall be as per IS 1966 or its latest revision.

4.7.1 The analysis of staging of the tank shall be done by using any established method such as portal method etc. The staging shall be analyzed from combination of dead, dead live loads and wind seismic loads. The effect of continuity of beams of the junction shall be properly accounted and column reaction worked out, for different condition of loading, axial force, shear force, bending moments.

4.8.1 Modules of elasticity of concrete MEC shall be taken as 5700/FC where equal to characteristic cube strength of concrete in N/m^2 as per IS 456-1976.

4.8.2 Columns shall be checked for tensile stress for both the conditions as mentioned in para 4.3.2 in combination with axial tension and bending due to wind or seismic loads, and shall be checked for bond for maximum tensile stress arrived.

4.8.3 Columns may be assumed to fix at the top of footing.

4.8.4 Water Tower in seismic zone (V) of IS 1393-1975 twin diagonal (crossed) backing of steel in vertical plane in addition to the horizontal bracing may be provided.

4.9 COLUMNS:

4.9.2 Reinforcement shall be provided on both faces of the load-bearing shaft. Minimum vertical reinforcement in the shaft shall be of 0.4% of the gross concrete area required. Minimum horizontal reinforcement shall be 0.3% of the gross concrete area. Required in case, for tower in high seismic zone (V) minimum horizontal reinforced shall be 0.4% of the gross concrete area; for before bars of medium tensile or high tensile steel the above steel requirements may be reduced by 20 %.

4.9.3 Shaft shall be checked for combined axial load and bending to the wind or seismic loads and shall satisfy the provision of IS 456-1978 in tank full and tank empty condition.

4.9.4 Horizontal construction joints in shaft shall be as minimum as possible. On account of minor in accordance in construction shaft the allowable direct compressive stress shall be reduced by multiplying with 0.8% factor. On account of buckling reduction factor, if any, shall be multiplied to the value 0.85. For the calculation of direct compressive stress the contribution of steel shall be neglected.

4.9.5 Age factor for increasing strength shall not be considered.

4.9.6 Shaft shall be checked for tensile stress for worst condition in combination with axial tension on bending due to wind or seismic load.

5.0 FOUNDATION:

5.1 The permissible increase in bearing pressure for different types of foundation shall be as per table -I of IS 1893-1965 or its latest revision. When seismic forces are considered and for wind forces it shall be as per IS 1904-1966 or its latest revision.

5.2 For the purpose of the design of foundation the loading data shall be given the magnitude of vertical load, lateral load and moments at top of footing (Foundation) level. The data shall be made available, for both the cases as per para 4.3.2.

5.4.1 The foundation area, door, individual column footings, combined footings, angular rafts and solid rafts shall be worked out on the basis of lower most value of the safe bearing capacity or allowable bearing pressure values as derived from IS 1904-1978, IS 9403-1971, IS 8009-1976 or their latest revision.

5.4.2 In case of purely cohesive and CI pipe of soil particulars attention should be given to IS 1903-1978 clause 6 & 7. Settlement shall be calculated as per IS 8009 (part I) 1976 for foundation.

5.4.3 In case of purely cohesion less soil, foundation shall be design for safe bearing capacity and shall be checked for permissible total as well as differential settlement values as given in relevant IS.

5.4.4 If the foundation consists of individual columns footing, minimum clear distance between centers of column shall be equal to twice the width of footing and clear distance between the edges of footing shall be not less than width of footings.

5.4.5 In case of soil beneath the footings are not of the same characteristics the footing shall be designed for the soil having lowest SBC or ANP as the case may be. In such conditions the permissible limits of total as well as differential settlement shall be limited to 75% of the permissible limit given in IS.

5.4.6 For special type of foundations like well foundation under beam pipe foundation etc., decision of Superintending

Engineer, Public health Design Circle shall be final and binding to the designer.

5.4.7 Classification of soil and all characteristics of soil relevance to BSBC and APB shall be as per the soil in irrigation reports of Government stipulation. Government approved investigators.

5.5 For the design of foundation angular or solid raft type, the "PLACE THEORY" shall be adopted.

5.6 In normal circumstances minimum 100-mm thick plain cement concrete with 100 mm projection around in Grade M 100 with coarse aggregate as metal shall be provided as leveling course. Where injurious soil progressive water is expected the leveling course shall be grade not weaker than M 15 and if necessary sulfate resisting or the special cement shall be used. The ground level within the foundation area of the structure shall be consolidated properly with a suitable slope to drain out rainwater outside the foundation

6.0 DETAILING:

6.1 MINIMUM REINFORCEMENT FOR WATER RETAINING MEMBER:

6.1.1 The minimum reinforcement in walls, floors, roofs, in each of two directions at right angle shall have an area of 0.3% of the concrete section in that direction for sections up to 100.00 mm thick. For section for thickness greater than 100 mm and less than 450 mm thick, minimum reinforcement each of two directions shall be nearly deducted from at 0.3% for 100 mm thick sections or greater two layers of reinforcing steel shall be place one near each face of the section to make up to minimum reinforcement specified in this clause.

6.1.1 The minimum reinforcement specified in this 6.1 above may be decrease by 20 % in case of high yield strength bars confirming to IS 1786-1976 or IS 139-1966.

6.2.1 Minimum clear cover to reinforcement under normal conditions shall be as per para 25.4 of IS 456-1978.

6.2.2 For liquid faces of parts of members either in contact with the liquid or enclosing the space above the liquid shall be as per para 7.2 IS 3370 (part-I 1965).

6.2.3 In case of Raft Foundation, the cover to reinforcement shall be as per 4.6.2 of IS 295 (part-I) 1973.

6.2.4 In case of "shaft" the cover to reinforcement shall be as under; Vertical 25 mm, Horizontal 15 mm

6.3 For members of structure in contact with water, effective cover shall not be more than 60 mm. Even bars subjected to bending stress, or bars subjected to tension due pure tension in the member the effective cover shall not more than 75 mm.

6.4.1 Spacing of reinforcement shall be as per para 25.3 IS 456-1978.

6.4.2 Spacing of lateral ties for column shall satisfying provision of para 25.3.2 'C' of IS 456-1978.

6.4.3 The additional suggested criteria for reinforcing steel which accounts for existing moments, tension etc. i.e. other than temperature or binding steel shall comprise of minimum 8 mm for deformed or 10 mm mild steel bars.

6.4.4 The spacing between two para in main reinforcement shall distribution steel, stirrups, links etc. shall not exceed 30 cm.

6.5 For members of the container, the maximum diameter of reinforcement in tension shall not exceed as given below depending upon the geometrical percentage of reinforcement. (Ratio of tensile steel to gross is concrete.)

Up to 1.0%	16 mm dia
Up to 1.5%	22 mm dia
Up to 2.0%	25 mm dia

Note:

1.0 In case of dispute regarding interpretation any above clause, the decision of the Superintending Engineer, Public Health Circle, Concerned will be binding to the Designer.

2.0 In case of any clauses not included in the above criteria the decision of the Superintending Engineer, Public Health Design Circle will be final and binding to the Designer.

INSTRUCTION FOR PREPARATION OF DESIGN OF RCC ESR/HGLRS

(ONLY FOR SELF DESIGN BY CONTRACTOR)

1.0 The design of RCC ESR supplied by the contractor in his own design shall be in accordance with the design criteria prepared by the Public Health Design Circle, Gandhinagar. The design and drawing supplied by contractor should be accepted after the approval by the competent authority from the Department.

2.0 The contractor should mention the name, qualification, experience etc. of the design engineer who will be the

necessary design scrutiny work etc. The design Engineer should attend the office of the Department if required at any stage prior to the acceptance of design or drawing construction with reference books etc. It will be the duty of designer to submit the design drawings and compliance of remarks by the Department.

3.0 PAYMENT AS PER PAYMENT SCHEDULE

4.0 COMMON CONDITIONS:

4.1 All petty items occurring if the work shall be carried out in workman like manner as per specification published by G.W.S. & S. Board and as per general specification current in the Division and as per instruction of the Engineer-in-charge from time to time.

4.2 Extra charge of claims in respect of extra work shall not be allowed unless such works are ordered in written by the Engineer-in-charge and are claimed for in specified manner before the work is taken in Hand.

4.3 The contractor shall engage on in experience and qualified supervisor as his authorized agent for the work. He shall be responsible to take from time to time such orders as may be given by the Engineer-in-charge to carry them.

4.4 As order book shall be maintained on the work site and the contractor shall sign the orders given by the Engineer-in-charge and he shall carry out them promptly. The order books shall be surrendered to the Department on completion of Work.

4.5 The contractor shall have to clear the site of work before it commences and after the work is completed for which separate claim shall not be entertained.

4.6 In addition in the required stores the contractor shall provide at his own cost the suitable temporary office shed with a covered area of about 20 sq mt. with necessary furniture for the use of Government staff while in works. The shed and furniture on completion of the work shall be removed by the contractor at his own cost.

4.7 The contractor shall provide at his own cost all labour charges setting out the as may be required for lining and setting out the as may be required for lining and setting up the works satisfactory and adequate facilities site scaffolding etc. for facility of checking his work or taking measurements etc.

4.8 Department shall give reasonable facilities to the contractor to enable him to obtain controlled materials at controlled rates as may be fixed from time to time. The contractor shall however not be entitled to claim any compensation extra time limit to account of non-supply at controlled rates. The materials obtained shall be only used for the work in question. Any materials remaining surplus shall be neither disposed nor removed by the contractor without obtaining written permission of Department to that effect. Government shall have the right to take delivery of the surplus materials at the original purchase price of the receipt contractor shall be sue of such materials to the satisfaction of Engineer-in-charge and submit in monthly statement thereof.

4.9.1 The contractor at his own cost expense shall provide necessary housing accommodation and the sanitary.

4.9.2 Arrangement for his staff and labour and shall pay direct of the authorities concerned all rates. Taxes royalties and other charges.

The contractor shall also comply with the requirement of the Health Department as regards anti malarial measures etc.

4.10 Water require for the execution of work and for the water tightness test of the reservoir shall be supplied by the contractor at his own cost in manner satisfactory to the Engineer-in-charge of work.

4.11 The contractor shall not be entitled to claim compensation from the Government. For works suffered on account of delay where such delay is caused either by (i) Difficulties relating to the supply of Railway Wagons, (ii) Force majeure, (iii) Acts of the God, (iv) Any other reasonable caused beyond the control of the Department. In case of delay Govt. shall however grant such extension of time limit for the completion as may appear reasonable to the Engineer-in-charge and his decision shall be final.

4.12 The contractor shall be responsible to pay complete compensation to his staff and to his labours according to the labour compensation rules, on account of accidents and less of life or less of the life due to accident.

5.0 DECLARATION:

The contractor shall made declaration as under:-

"I have made myself thoroughly conversant conditions as regards the availabilities or otherwise of all construction materials skilled and unskilled labour on which. I have quoted my rates for this work. The specifications, drawing and design of this work have been careful studies and are understood by me before the submission of this tender.

DETAILED SPECIFICATION

Detailed specification given here shall be treated as extension or partial modifications to the specifications of

respective items given in the volume of specification published by Gujarat Water Supply and Sewerage Board.

1.0 EXCAVATION FOR FOUNDATION:

1.0 When the rates are to be quoted for a work based on "contractors own design" the word excavation for foundation shall mean excavation for foundation in all types strata such as soil soft murrum as well as hard rock up to the designed depth at which foundation is to rest. No extra payment will be given for any change in strata at the same place. The rate shall also include dewatering and shoring strengthens if and where found necessary.

1.1 Excavation shall be carried out as per approved drawing. The excavation made deeper or wider than that required as per drawing shall not paid, but such deeper excavation if carried out shall have to be filled up using C.C. 1:4:8 by the contractor without extra cost. If the type of strata require wider excavation at top (GL) Then contractor shall excavate the trench accordingly but no extra payment for such wider excavation shall be made.

1.2 The rate shall include providing cured warnings lights during night time providing barricading consisting of metal ropes and bamboo for which no extra payment will be made.

1.3 The contractor shall make his own arrangements to obtain prior permission directly from relevant authorities for staking of excavated stuff near work side. If he fails to obtain such permission, then he will have to make his own arrangement with out claiming extra cost to transport and stack the excavated stuff at a suitable place approved by the Engineer-in-charge of work.

1.4 The excavated stuff shall be stacked at least 3.0 meter away from the edge of excavated trench, If enough space is not available at work site then the excavated stuff shall be stacked at suitable place situated away from site. Similarly the surplus stuff shall have to be disposed off at a suitable place for which contractor shall have to obtain permission directly from relevant authorities. No extra payment for transportation of excavated stuff or surplus stuff shall be made.

1.5 No excavated stuff shall be disposed off or used for any purpose other than refilling without prior permission of Engineer-in-charge of work.

1.6 Details shown in the data sheet regarding water table are approximate. The contractor should make his own arrangements for taking trial pots at his own cost more quoting his rates for as certain type of strata water table, quantity of seepage water etc.

1.7 Work at nighttime shall be carried out only with written permission of Engineer-in-charge.

1.8 Bottom of the excavated foundation trench shall be sprinkles with water (If water table is not above foundation level) and wall rammed to obtain a reasonably firm and level bedding.

1.9 The rates shall include continuous dewatering of seepage water or rainwater from, trenches to keep the trench dry particularly during casting of base concrete. Concrete for footing and columns of shaft etc. till concrete fully cures etc.

1.10 Whenever collapsible types of strata are encountered pucca shoring and strutting shall be invariably claim shall be entertained.

2.0 C.C.M. 100 BASE CONCRETE FOR LEVELLING COARSE:

2.1 For all practical purpose and in absence of proportioning of concrete on base of preliminarily tests, C.C. 1:3:6 may be provided as a leveling course i.e. one part of cement three parts of sand and six parts of black trap kapachi. Specification for various ingredients of concrete such as sand, cement, kapachi, water shall be as these given in specification for C.C.M. 15.

2.2 While laying base-concrete for leveling course the concrete shall not be dumped from above but shall be carried out to the bottom and gently placed from a height not exceeding 1.5 meter. If concrete is transported by chutes, then the same shall be remixed at bottom of chutes to overcome any segregation that might have occurred.

3.0 C.C.M. 150:

3.1 As far as possible the preparation of various ingredients of concrete shall be determined on the bases of preliminary tests as per ISS using the actual materials to be used on site. However in absence of such preliminary tests the volumetric proportion of 1:2:4 may be adopted i.e. one part of cement, two parts of sand and four parts of kapachi, water just sufficient to attain desired workability may be added. However the aim while proportioning should be to fix the proportion of aggregation and water cement ratio shall be always sufficiently low enough to get desired strength.

3.2 Materials:

3.2.1 Coarse aggregate shall consist of tough angular black trap kapachi. The kapachi shall be obtained from approved source only. Normally at least two stock piles of different size of 12 to 20 mm and 25 mm to 40 mm shall be maintained. It will however, be preferably to maintain third stock pile of 6 mm to 12 mm also for better control on mix of concrete.

3.2.2 The maximum size of coarse aggregate to be used shall be as large as possible within the limits of requirements, based on size of member and spacing of reinforcement. But aggregate exceeding 40 mm shall not be used in concrete for ESR and HGLRs.

3.2.3 Depending up on the size of member, spacing of reinforcement and degree of workability desired, the coarse aggregates from different stockpiles may be mixed in a suitable proportion to get a uniform mix that does not segregate.

3.2.4 The coarse aggregate shall not contain dust, clay or other such harmful material. If directed by the Engineer the same shall be washed with water and dried before being used.

3.3.0 Fine Aggregates:

Fine aggregates shall consist of coarse, angular river sand free dirt and other harmful organic materials. If directed the same shall be screened and washed before being used. Sand brought from approved source shall only be used.

3.4.0 Cement:

Contractor shall provide a temporary store with double lock arrangement for storage of this cement on work site without extra cost. Cement shall be stored in such a way that it is not affected by moisture.

3.5.0 Water:

Water to be used in concrete work shall be potable, free from injurious elements such as chloride or sulphate etc. and shall be obtained from approved source only. Contractor shall make his own arrangements to obtain and store sufficient quantity of water at all times.

3.6.0 Reinforcement Steel:

The reinforcing bars to be provided with TMT Steel & shall confirm to its relevant IS specifications. The steel shall be supplied by the contractor at his own cost. The contractor shall cart the materials on site at his own cost. The steel bars should be cleaned should be free from rust. The binding material shall be provided by the contractor at his cost. The dimension of spacing and binding bars will be as per design. The reinforcement shall have to be got approved by the Executive Engineer or his Deputy Executive Engineer before starting concreting. Necessary certificate for testing of the reinforcement bar shall have to be provided by the contractor at his own cost. All main reinforcement shall be necessarily be tied to the cross reinforcement to prevent any displacement during laying of concrete.

3.7.0 HANDLING:

3.7.1 The bars shall be carefully handled in technical manners.

4.0 FORM WORK:

Form work shall consist of steel plates or smooth timber planks to be joined by nuts, bolts, nails or pegs so as to have a reasonably water tight joints. Sufficient number of vertical and horizontal supports shall be providing when completed. Formwork shall be sufficiently sturdy & strong to absorb all stresses and movements. Before concrete is placed in position the formwork and steel shall be got checked through Engineer-in-charge of work. Advance intimation shall be given to the Engineer-in-charge for this purpose. The ultimate responsibility for safety and of lives of workmen and that of forms etc. from beginning of work till its completions shall always rest with the contractor proper ladders and plant forms for easy access shall be provided by the contractor without extra cost.

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, shavings, sawdust, wire pieces dust 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 properly 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 insitu shall not impair the desired appearance or durability of the structure by causing swelling, 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.

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

- (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; and
- (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°C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the Engineer In charge. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the 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.

5.0 MIXING, TRANSPORTATION AND LAYING:

5.1 For important works like ESR and HGLRs mixing of concrete shall be invariably done in approved machine mixer only. The mix obtained from the mixer shall be a uniform mass consisting of all aggregates coated with cement paste.

5.2 Fresh concrete shall be transported horizontally in ghamellas or wheelbarrows. Vertical transportation shall be done either by manual labour or using mechanical vertical lifts. When chutes are used for transportation, care should be exercised to avoid segregation and concrete may be remixed at bottom of chutes to get uniform mix. Before any concrete is placed in position all loose materials such as dirt, chips of stones, wood, steel etc. should be removed. Inner side of forms should be coated with thin layer of oil to get a good finished surface.

Concrete should not be dumped from above in which case aggregate will segregates, but placed gently from a height not exceeding 1.5 meter. Compaction of concrete shall be done by vibrators till cream appears at top. Over vibration shall be avoided to avoid segregation.

6.0 CURING:

After concrete is set in position it shall be kept continuously wet with water for 7 days either by using gunny bags (column and walls) by ponding (slab) or as directed by spraying of water.

Unless otherwise specified the rate shall include finishing the exposed surface to get good finished surface.

The forms shall be kept in position for period given below:-

1)	Vertical sides of walls, beams, columns	2	Days
2)	Slabs (props left under.)	7	"
3)	Bottom of beam (props left under)	7	"
4)	Removal of prop to slab spanning up to 4.5 sperious over 4.5 m.	7	"
5)	Removal of props to fearus spanning up to 6.0 m.	14	"
6)	Spanning over 6.0 m.	21	"

C.C. M-300:

Specification for various ingredients of concrete such as sand, cement, kapachi, water shall be as per given in specification for C.C.M. 15. The proportion of mix for Cement Concrete M-300 shall be of as per Mix Design. Since M300 mix is normally used in water retaining parts of container where the aim is not to get dense, strong and watertight concrete, special care shall be exercised in controlling proportion of aggregate, water cement ratio, compaction, and curing.

7.0 PROVIDING AND PLACING IN POSITION STEEL REINFORCEMENT:

7.1 Reinforcement bars to be used in RCC work shall have to be supplied by the contractor. The rates include providing, cutting, bending, binding, hooking and placing in position including cost of binding wire. The bars shall be fusion bonded and epoxy coated.

7.2 Depending upon the type of reinforcement steel proposed in design (i.e. M.S. or deformed etc.) the steel shall confirm to relevant ISS codes in practice. Contractor shall produce necessary test certificate in absence of which the steel bars shall be get tested by the Department at the contractor's cost.

7.3 Steel bars shall be cut, bent up, hooked bound with wires and then placed in position as per approved drawing. The steel shall be got checked through Engineer-in-charge. Before any concrete is placed in formwork advance intimation shall be given to the Engineer-in-charge for this purpose. The steel shall be cleared of any dust or rust that might have been deposited on bars.

7.4 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 SPECIAL OFFICER & CHIEF ENGINEER prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement, and not cause scaling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends 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 SPECIAL OFFICER & CHIEF Engineer's approval.

8.0 M.S. LEDDER FROM GL. TO TOP OF CONTAINER:

The materials shall be best quality & approved by the Executive Engineer or his Deputy Executive Engineer. The M.S. flat 10mm x 60mm size shall be kept 50 cms part and 20mm dia steps shall be welded or riveted to the iron at 30 cms interval or as directed by the Engineer-in-Charge.

The ladder shall be anchored properly & adequate stays of 10mm x 50mm flat iron fixed at 3 meter centre shall be provided. The ladder shall be fixed in 1:2:4 C.C. at the bottom as directed.

The stays of 10mm x 50mm flat iron shall be fixed at 3.00 mtr centre to centre. The whole work shall be carried out in a best work manlike & to entire satisfaction of the Executive Engineer two coats of anticorrosive paint shall be applied to the ladder after thoroughly cleaning the steel work.

9.0 WOODEN WATER LEVEL INDICATOR:

9.1 A wooden water level indicator of approved size and type shall be provided and fixed by the contractor. It shall consist of wooden plank of 250 mm x 40 mm.

9.2 The divisions on water level indicators shall show distance of 10 cm. clearly. A copper or PVC float of 500-mm dia and 50 mm height shall be provided along with steel wires pulleys etc. The entire arrangement shall be first got approved by the Engineer-in-charge of work. Letter and marking shall be painted with approved enamel paint.

10.0 COPPER LIGHTENING CONDUCTOR:

Copper lighting conductor with size of strip 20 mm x 3 mm with clamps and screw and copper plate of 600 mm x 600 mm x 6 mm and copper red as per specification no. 120 of PWD Hand book Vol I (ISS - 2309) shall be provided and fixed by the contractor. It shall consist of copper arrestor at top, copper conductor from top up to GL and copper Earthing plate shall be 1 m. deep below GL and filled with salt and charcoal to transmit the current to earth, minimum dimension of these part shall confirmed to relevant ISS. Heights of the arrestor shall be such as to enclose the entire structure with imaginary cone generated by a inclined at 60° degrees with vertical at top.

11.0 Providing and fixing CI flanged pipes and special such as duck foot bends, crippling flanges bell mouthpiece etc. for inlet outlet overflow and wash out.

11.1 Diameter and length of above pipes shall be as given in Appendix - A. DI flanged pipes shall be vertically cast double flanges and shall be confirm to relevant ISS. They shall be first get approved by the Engineer-in-charge of work.

11.2 Item shall include providing all specials such as crippling flanges, and duck feet bends etc. as may be required on site.

11.3 The Item shall also include cost of all jointing materials such as nuts, bolts, rubber packing, white zinc or pig lead or lead wool if required.

11.4 Pipes shall be fixed perfectly vertical and straight.

11.5 Before fixing in position pipes shall be coated with two coats of anticorrosive paint.

11.6 The pipes and specials shall be tested hydraulically. Leakage if found shall be repaired without extra cost.

12.0 PROVIDING AND FIXING CI SLUICE VALVE:

12.1 Diameter of CI sluice valve shall be as shown in Appendix - A. CI sluice valve shall be of class - I confirming to IS - 780-1980.

12.2 The rate includes providing and fixing CI sluice valves with tailpieces including jointing materials such as nuts, bolts, rubber packing zinc etc.

12.3 The rate includes giving hydraulic test to the satisfaction of Engineer-in-charge of work.

12.4 Sluice valve shall be supplied with necessary spindle or wheel for operating the same.

13.0 PROVIDING AND FIXING C I M H FRAME AND COVER:

Two number of C I M H frame and cover shall be provide and fixed in top slab of container. The dimensions and weight shall be as shown in Appendix - A. The C I M H frame and cover shall be first got approved by the Engineer-in-charge. Two coats of anticorrosive paints shall be applied before fixing them in position.

14.0 C I COWL TYPE VENTILATORS:

The C I Cowl type ventilator should be of 100 mm dia shape with flanged and roughing screen shall be as per Appendix - A. The rate includes providing and fixing C I Cowl type ventilator as per Appendix - A including cost of all jointing materials such as nuts, bolts, white zinc rubber packing etc. Two coats of anticorrosive paints shall be applied to the surface before they are fixed in position. They shall be first for approved by the Engineer-in-charge.

15.0 PROVIDING AND FIXING M.S. LADDER INSIDE CONTAINER:

Contractor shall have to fabricate and fixed M.S. ladder. The ladder to be fixed shall be fabricated from M.S. flat of 10 mm x 65 mm or M.S. angle having equivalent modular of selection 20 mm dia. Bars shall be fixed at 30 mm c/c. to act as steps. The ladder shall be 45 cm. wide if length of ladder is more than 8.0 m. Three coats of approved anticorrosive paint shall be applied to the ladder. The design of M.S. ladder shall be got approved by the Engineer-in-charge before it is fabricated and fixed in position. Rate includes providing and fabricating, painting and fixing in position of M.S. ladder as above.

16.0 CONSTRUCTION OF VALVE CHAMBER:

The chamber shall be such height so as to have the C.I.M.H. cover fixed flush with G.L. or a little above the G.L. as directed. The depth of chamber will be so depending upon the invert of pipe and G.L. at site. The M.H. frame and cover shall be fixed on the chamber if required and as directed by the Engineer-in-Charge.

Masonry walls of the chamber shall be of 25 cms. Thick & burnt bricks in cement mortar 1:6 shall be used. The floor shall be of cement concrete 1:3:6 with trap metal 25mm to 40 mm size & 150 mm thick.

The interior walls of the chamber shall be plastered with C.M. 1:6 12mm thick in case of brick masonry and 20mm thick in case of masonry chambers and properly cured.

Exposed faces of the masonry are to be pointed with cement pointing 1:3 for the covered portions. The joints shall be struck in cement mortar along with the progress of the masonry work. The off-set for the concrete foundation shall be 150 ms. On all sides beyond the walls of chamber.

Whenever, a tail pieces or a special enters or leaves the mason chamber, brick on edge must be so laid around the upper half of the pipes so as to form as such to prevent the weight of the masonry chamber over it.

On the top of the masonry walls, 10cms thick R.C.C. (1:2:4) slab with reinforcement as directed by the Executive Engineer or his representative shall be provided.

Cement concrete for slab shall be of proportion of 1:2:4 with black trap metal 12mm to 20mm size on part of cement 2 parts of sand 4 parts of aggregate by volume necessary from work and centering shall have to be provided by the contractor at his cost.

The R.C.C.work shall have to be cured for 14 days. The R.C.C. slab shall have full bearing on all the surrounding walls.

Under the special circumstance precast RCC slab. If required, in pieces shall be provided. If directed by the Executive Engineer or his representative any extra cost.

This item includes each completed chambers with materials, labour, curing, finishing etc. complete in all respect.

17.0 PAINTING LETTER:

The words for indication for capacity & programme name of ESR shall be painted on the container. The letters shall be 45 cm high and the black ground of suitable color shall be provided. Approved enameled paint shall only be used for painting letters and background. Entire work shall be carried out as per instruction of Engineer-in-charge.

18.0 PROVIDING AND FIXING GI PIPE RAILING AROUND TOP SLAB:

Railing shall consist of 3 raw of 25 mm dia GI pipes fixed in M.S. angles of 60 mm x 60 mm x 6 mm 0.9 m. height

fixed at 2 m c/c. The materials shall be got approved by Engineer-in-charge before fabrication. Three coats of approved anticorrosive paint shall be applied to M.S. angle before they are fixed in position.

19.0

20.0 WEATHER COAT PAINT:

The paint shall be of best quality and approved make. The work shall be carried out as per manufacturer's specification. The paint shall be of required shade approved by Engineer-in-charge. The paint shall be got approved before use.

The painting works shall be carried out as per technical manner. The surface shall be prepared by removing all mortar dropping and foreign matter and thoroughly cleaned with wire or fiber brush or and suitable means and washing the surface. All loose pieces shall be scrapped out and hole shall be stopped with mortar. After cleaning the surface the watering hole surface and applied snowcem paint in three coats. Necessary curing, scaffolding, materials, labours are including in this item.

21.0 WATERPROOF CEMENT PLASTER:

The cement mortar shall consist of two parts of fine river sand free from any dust and other organic matter and one part of approved quality of cement. The mortar shall be properly mixed on watertight platform. The mortar shall be used within half an hour after mixing. The water proofing materials weighting 1.5 kg of powder in one bag of cement shall be added.

The plaster shall be applied in uniform thickness of 20 mm and shall be properly smoothened with wooden & finished with cement finishing of required. The curing shall be done at least for week by sprinkling the water over the wall. The wall shall be tested for waterproofness. The rate includes the cost of waterproofing materials. The test for waterproof ness shall be carried out by the contractor at his own cost by filling the contractor with water and it shall be checked out that there is no percolation of water from the wall. Payment shall be made per sq. m. of plaster done.

22.0 BRICK PITCHING/CC FLOORING:

Brick Pitching:

The brick shall be of proper quality, standard size, uniform in color, well-burnt and free from cracks. The work of brick pitching shall be carried out in C.M. 1:6. It shall be laid as per the drawing and directed by the Engineer-in-charge. The bricks shall properly soak before being using in work. No brickbats shall be use except the bricks. The joint shall be racked out 20mm depth. Every day at the end of the day's work the cement pointing in C.M. 1:2 shall be carried out by line as directed by the Engineer-in-charge. The excavation required for brick pitching shall have to be carried out by the contractor as directed including necessary temping consolidation etc. complete.

After completion & testing of work the contractor shall have provide & fix the Marble 'Takti' of required size with necessary writings, as directed by the Engineer-in-charge.

CC Flooring:

The concrete shall be consists of one part of approved quality cement with two parts of clean and angular sand without parts of coarse aggregates of 12mm to 20mm size.

Portable water shall be added as per required quantity and shall be mixed in best work manlike manner.

Necessary form work shall be done by the contractor. Lining work shall be carried out as per instruction of Engineer-in-Charge.

The entire work shall be cured atleast for 14 days the total thickness of the flooring shall be kept 50mm.

The rate include all materials labour for mixing finishing, lining curing form work etc.complete

23.0 RCC work of shaft, container and staircase should be of well finished condition if the same is not satisfactory than contractor since have to finish the surface with 12 mm thick plaster C.M. without any extra cost.

24.0 The contractor shall have to make arrangement for testing of steel bars brought on site and concrete cubes, for different mix at different stage like foundation, shaft, column, and cube should be cast on site and send Govt. approved laboratory for compressive strength at 28 days. Results must be produced in office before taking payment of work done. Testing charge must bear by contractor.

25.0

1) Conditions: The paint is supplied in two packs, fine zinc dust mixed with epoxy resin as base and liquid hardener. They are to be mixed in following ratio.

	By Volume	By Weight
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Base	1.5	4.0
Harde Hardener	1.0	1.0

2) Mixed Paint Properties

i)	Viscosity	20+3% seconds by flow
		Cup No.4 @ 30 °C
ii)	Specific Gravity	1.70+3%
iii)	Post life of mixture	6-8 hrs.
iv)	Zinc dust content on DFT basis	92+/-3%
v)	Finish	Smooth and Matt.
vi)	Drying time	
	Surface dry	5 minutes
	Hard Dry	Less than 1 hr.
vii)	Over coating after	Minimum 24 hrs.
		Maximum No limit
viii)	Flash point	Above 23 o C
ix)	D.F.T.	20-25 microns depending on blasting profile
x)	Compatibility	Compatible with all systems of paints like Bituminous, conventional, chlorubber vinyl and epoxy paints.
xi)	Toxicity	Non toxic

5) Application: By Brush/Spray (Air and Airless)

6) Thinner: Epoxy thinner shall be used if required.

7) Coverage: 10 Sq. m./liter at 25 microns.

8) High build black paint.

1)	Dry time	Surface dry not more than 4 hours Hard dry not more than 18 hours Film thickness per coat 75 micron.
2)	Consistency	Thixotropic liquid
3)	Covering Capacity	5 Sq.m./liter
4)	Color	Black/Brown/Black in alternative layer

9) Characteristics:

The coating shall be non-phenolic, non-toxic. It shall afford a highly durable protective air tight coating to prevent corrosion or rusting of iron and steel against air moisture/water and shall be of sufficient elasticity to prevent racing, blistering or peeling. It shall retain its consistency at the ordinary atmospheric temperatures when packed in suitable containers. After application of drying, the coating shall not show any surface cracks due to drying, weathering action

or expansion and contraction. Its resistance to water must be perfect. It shall also be resistant to weak acid and alkalis, natural salts and to dry heat up to 150 centigrade. It should have good brush ability.

The primer as well as paint shall have to be applied as per the manufacturer's specification. The paints shall be tested in the laboratory by the owner at the cost of the contractor if found necessary. The manufacturer shall accompany each lot of primer and paint supplied. The entire procedure of applying the coating as specified shall be rigidly inspected right from cleaning stage to application of final coat.

10) Stacking of bars:

On receipt the pipes shall be stacked on wooden/concrete sleeper to ensure that they do not come in contact with earth. The contractor shall take necessary precaution for safety of bars so that no damage occurs during stacking.

26.0 Mode of measurement and payments: **Payment will be as per payment schedule.**

MATERIALS AND WORKMANSHIP

1. Introduction

1.1. This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of employer's requirement or be subject to the approval of the Employer. Particular attention shall be paid to a neat, orderly and well-arranged installation carried out in a methodical competent manner.

2. Reference Specifications and Standards

2.1. Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Akasaka, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard at the Tender opening date.

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

2.3. All details, materials and equipment supplied and workmanship performed shall comply with the specified Standards. If tenderer offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.

2.4. In the event of conflict between this Specification and the Codes for equipment, provisions of this Specification shall govern. Certain specifications issued by national or other widely recognized bodies are referred to in this Specification. In referring to the Standard Specifications the following abbreviations are used:

IS	:	Indian Standard
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society of Testing and Materials
AWS	:	American Welding Society
AWWA	:	American Water Works Association
ISO	:	International Organization for Standardization
DIN	:	Deutsches Institute fur Normung
BS	:	British Standard
IEC	:	International Electrotechnical Commission
IEE	:	Institution of Electrical Engineers
IEEE	:	Institute of Electrical and Electronic Engineers
NEMA	:	National Electrical Manufacturers Association
AGMA	:	American Gear Manufacturer's Association

3. Materials - General

3.1. All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

4. Workmanship – General

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

4.2. All similar items of the Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items.

4.3. All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings. All materials incorporated in the Works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the Plant shall be supplied by the Contractor unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.

5. Welding

5.1. Welding shall comply with the latest revision of the BS 5135 Code.

5.2. Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the Engineer does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each weldments shall clearly be identified as to its welder marking the welder's Code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Engineer shall disqualify the welder whose Work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS EN 283-3.

5.3. Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.

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

5.5. Generally, a stringer bead technique shall be used with a slight oscillation of necessary to avoid slag and to minimize the number of beads needed to fill exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia., welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.

5.6. The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive "such back", etc. shall be cause for rejection of welds.

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

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

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

gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.

5.10. All weld repairs shall be carried out using the approved welding procedures and welders. Re-welded areas shall be re-examined by the methods specified for the original welds and the Engineer's Representative shall duly qualify repair procedures.

6. Pre-heating and Post-heating Treatment

6.1. Pre-heating and post heating treatment shall conform to the relevant application Codes. Pre-heating not exceeding 121 deg. C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre-heating will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870 part 1 Table 6 to represent 30% of the long seams and each welder's performance would be mandatory.

7. Electrodes

7.1. All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in Work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

8. Examination/NDT/Radiography

8.1. The various stages of examination and types shall be as stipulated in the respective fabrication Codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910; Ultrasonic tests where called for shall be carried out as per provisions of BS 3926; magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

9. Stainless Steel Welding

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

9.2. All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.

9.3. Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.

9.4. Non-destructive examination of the welds shall be carried out to ensure quality of weld.

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

10. Castings

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

10.2. Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Engineer. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Non-destructive tests as directed by the Engineer will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

11. Forging

11.1. All major stress-bearing forging shall be made to a Standard Specification. Forging shall be subjected to

magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect, which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5% of the finished thickness of the component, shall be reported to the Engineer giving the details like location, length, width and depth. For the magnetic particle inspection the choice of wet or dry particles shall be at the Contractor's discretion.

11.2. All forging shall be demagnetized after test and shall be heat-treated for the relief of residual stresses.

12. Design Life

12.1. The Works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The Contractor shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not require the services of highly skilled personnel.

12.2. The Plant shall be designed to provide easy access to and replacement of component parts, which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years.

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

12.4. Plant located outside lockable areas/building shall have additional features to prevent un-authorized operation.

13. Name Plate

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

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

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

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

14. Nuts, Bolts, Studs and Washers

14.1. Nuts, bolts, studs and washers for incorporation in the Plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut

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

14.3. Washers, locking devices and anti-vibration arrangements shall be provided where necessary. Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.

14.4. Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and

washers that are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

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

15. Allowances for Wastage

15.1. The Contractor shall supply reasonable excess quantities to cover wastage of those consumable, which will be normally subject to waste during erection, commissioning and setting to Work.

16. Painting – General

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

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

16.3. All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.

17. Painting at Place of Manufacture

17.1. Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition the parts are to be provided with adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.

18. Painting at Site

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

18.2. After erection, such items, which are not finish painted, shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paintwork. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.

18.3. The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness specified the Contractor should ensure that the coverage rate given by the paint manufacturer would enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm². Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

19. Galvanizing

19.1. Wherever galvanizing has been specified the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a) Fabricated steel

Thickness less than 2 mm but not less than 1.2 mm 340 gms/sq.m

Thickness 2 mm and above 460 gms/sq.m

b) Fasteners

Up to nominal size M10 270 gms/sq.m

Over M10 300 gms/sq.m

19.2 Galvanizing shall be carried out after all drilling; punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any Site modification of galvanized parts should be covered well by zinc rich primer and aluminum paint.

20. Support for Pipe work & Valves

All necessary supports, saddles, sling, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other facilities mounted in the pipe work shall be supported independent of the pipes to which they connect.

INSPECTION AND TESTING AT MANUFACTURER'S PREMISES

1. Inspection and Tests

1.1. Valve

1.1.1. During testing there shall be no visible evidence of structural damage to any of the valve component.

1.1.2. Motorized valves shall be tested with their actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

1.1.3. The following test shall be carried out for butterfly valves:

- a) Seat leakage test at rated pressure
- b) Body hydrostatic test at 1.5 times the rated pressure
- c) Disc strength test at body test pressure
- d) Valve operation with and without actuator
- e) Crack opening test under tension

1.1.4. The following test shall be carried out for sluice valves:

- a) Seat leakage test at rated pressure
- b) hydrostatic test at 1.5 times the rated pressure
- c) Valve operation

1.1.5. The following test shall be carried out for non-return valves:

- a) Seat leakage test at rated pressure
- b) Body hydrostatic test at 1.5 times rated pressure
- c) Operation

1.2. Pipe work

1.2.1. Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationally approved standard. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure.

1.3. E.O.T. Crane

1.3.1. The cranes shall be completely assembled in the Contractor's or subcontractor's Works and shall be subjected to the tests as specified in IS 807/IS 3177 or relevant internationally approved standard. The Contractor shall provide the test weights.

CONCRETE

Applicable Codes

Materials

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 and 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. Material Testing
- 1) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- 2) IS: 4032 Method chemical analysis of hydraulic cement.
- 3) IS: 650 Specification for standard sand for testing of cement.
- 4) IS: 2430 Methods for sampling of aggregates for concrete.
- 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.

Material Storage

- 1) IS: 4082 Recommendations on stacking and storing of construction materials at site.

Concrete Mix Design

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

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 specimens.
- 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 Methods of testing bond in reinforced concrete.

Equipments

- 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 Requirements for concrete vibrators: Immersion type.
- 7) IS: 2506 General Requirements for screed board concrete vibrators.
- 8) IS: 2514 Specification for concrete vibrating tables.
- 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 weighs batchers for concrete (single and double bucket type).
- 14) IS: 2750 Specification for steel scaffoldings.

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 liquids (Parts 1 to 4)
- 4) IS: 3935 Code of practice for composite construction.
- 5) IS: 2204 Code of practice for construction of reinforced concrete shell roof.
- 6) IS: 2210 Criteria for the design of reinforced concrete shell structures and folded plates.
- 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 works.
- 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 resistant design and construction of building.
- 14) IS: 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
- 15) IS: 2571 Code of practice for laying inset cement concrete flooring.
- 16) IS: 7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

Construction Safety

- 1) IS: 3696 Safety code for scaffolds and ladders. (Parts 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.

General

The ENGINEER INCHARGE 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 INCHARGE's 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.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due 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 INCHARGE and after establishing their performance suitability based on previous data, experience or tests.

Materials

Cement:

Unless otherwise called for by the ENGINEER INCHARGE, cement shall be ordinary Portland cement conforming to

IS: 269, IS: 8112 or IS: 12269.

Where Portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the ENGINEER INCHARGE.

Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by the ENGINEER INCHARGE and until the results of such tests are found satisfactory, it shall not be used in any work.

Aggregates (General):

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER INCHARGE.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long-term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete.

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.

Reinforcement

All reinforcement steel shall be HYSD steel grade – Fe415 conforming to relevant I.S. 1786 for water retaining structure

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

Admixtures

Accelerating, retarding, 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 INCHARGE. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are 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 embedments.

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 works, 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.

Samples and Tests

All materials used for the works shall be tested before use.

Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by the ENGINEER INCHARGE samples shall also be got tested by the Contractor in a Government approved laboratory or approved by the ENGINEER INCHARGE at no extra cost to Employer. ENGINEER INCHARGE may appoint separate third party inspection for the material testing to ensure the quality of the 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 INCHARGE.

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

The Contractor shall furnish manufacturer's test certificates 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.

Storing 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. Requirements 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 material shall be rejected. Cement bags 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 the ENGINEER INCHARGE. 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.

Concrete**General**

Concrete grade shall be as designated on drawings. In concrete grade M15, M20 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.

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 be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in watertight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS: 456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu. m of Concrete
M 15	240
M 20	250
M 25	300
M 30	320

The minimum cement content stipulated above should 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 quantity 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 responsibility to carry out the mix designs at his own cost. He shall furnish to the

ENGINEER INCHARGE at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the 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 at 7 days	Specified Compressive Strength N/sq.mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the ENGINEER INCHARGE is given below:

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

(b) Batching & Mixing of Concrete:

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These 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 INCHARGE shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing; the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in Government approved laboratory or in field with prior consent of the ENGINEER INCHARGE. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456, IS 3370.

Nominal Mix Concrete

(a) Mix Design & Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests 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 sole 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.

Formwork

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, 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 as its construction shall be the responsibility of the Contractor. However, if so desired by the ENGINEER INCHARGE, the drawings and calculations for the design of the formwork shall be submitted to the ENGINEER INCHARGE 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 methods of placing and compacting.**
- (b) Made of suitable materials.**
- (c) Capable of providing concrete of the correct shape and surface finishes within the specified tolerance limits.**
- (d) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.**
- (e) Capable of easy striking out without shock, disturbance or damage 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 cleaned 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 type of finish specified. Sliding forms and slip form may be used with the approval of the ENGINEER INCHARGE. Timber for formwork shall be well seasoned, free from 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, shavings, sawdust, wire pieces dust 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 INCHARGE. 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 properly 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 insitu shall not impair the desired appearance or durability of the structure by causing spalling, 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.

Forms for substructure may be omitted when, in the opinion of the ENGINEER INCHARGE, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the ENGINEER INCHARGE, than 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 structures.

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 built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the ENGINEER INCHARGE. The Contractor shall temporarily and securely fix items to be cast (embedment/ 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 requirements:

- (h) Development of adequate concrete strength;
- (i) Permissible deflection at time of striking form work;
- (j) Curing procedure employed - its efficiency and effectiveness;
- (k) Subsequent surface treatment to be done;
- (l) Prevention of thermal cracking at re-entrant angles;
- (m) Ambient temperatures; and
- (n) 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°C) forms may be struck after expiry of the time period given in IS: 456 unless approved otherwise by the ENGINEER INCHARGE. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the ENGINEER INCHARGE. 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.

Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 10° C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER INCHARGE.

Re-bending or straightening incorrectly bent bars shall not be done without the approval of the ENGINEER INCHARGE.

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 INCHARGE prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement, and not cause spalling of the concrete cover.

Binding wire shall be 16-gauge soft annealed wire. Ends 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 INCHARGE's approval.

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 + 12 mm
(b)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
1)	Dimension in plan	- 12 mm + 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

Preparation Prior to Concrete Placement

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the ENGINEER INCHARGE. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

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 caused 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 1.0m.

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

While placing concrete the Contractor shall proceed 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 pipes, ducts, fixings 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 linings progressively as concrete is placed.**
- (h) **If placed directly onto 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 melding 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 INCHARGE. 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 time to settle as approved by the ENGINEER INCHARGE. Concrete shall be protected against damage until final acceptance.

Mass Concrete Works

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

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 INCHARGE, shall be cured by use of continuous sprays or ponded 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 INCHARGE, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the ENGINEER INCHARGE before use 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 well sealed and fastened.

Construction Joints and Keys

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

Dowels for concrete work, not likely 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 INCHARGE.

Before resuming concreting on a surface, which has 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.

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 INCHARGE. 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.

Finishes

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, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

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 surfaces 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.

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.

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 discolouration, blemishes, airholes 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.

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 INCHARGE shall be supplied and used as recommended by the manufacturer.

Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be inspected by the ENGINEER INCHARGE 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 Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the ENGINEER INCHARGE.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER INCHARGE as to the method of repairs 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 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the ENGINEER INCHARGE.

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, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the ENGINEER INCHARGE's approval.

Hot Weather Requirements

Concreting during hot weather shall be carried out as per IS: 7861 (Part I). Adequate provisions shall be made to lower concrete temperatures, which shall not exceed 40°C at the time of placement of fresh concrete.

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

Cold Weather Requirements

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 stripping period shall be closely monitored.

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 arrangements 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 INCHARGE. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the ENGINEER INCHARGE at no extra cost to the EMPLOYER.

Testing Concrete Structures for Leakage

Hydrostatic test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the ENGINEER INCHARGE, 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 be satisfied if the external faces show no sign of 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 INCHARGE 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 losses. 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.

Optional Tests

If the ENGINEER INCHARGE 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 INCHARGE, 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 its removal or if the works cubes do not give the stipulated strengths, the ENGINEER INCHARGE 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 INCHARGE also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer. Alternately ENGINEER INCHARGE also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

Grouting

Standard Grout

Grout shall be provided as specified on the drawings.

The proportion of Standard Grout shall be such as to produce a flowable 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 INCHARGE. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C (max)	Ratio
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.44	
Use	Grout Thickness	Mix Proportions	W/C (max)	Ratio
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53	
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53	

Non-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 INCHARGE. Materials rejected by ENGINEER INCHARGE 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 materials;
- 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 dimensions;
- l) tolerances 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 INCHARGE's 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 INCHARGE may review and decide whether remedial measures are feasible so as to render the work acceptable. The ENGINEER INCHARGE 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 Employer for executing the remedial measures.

Water stops

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 | : | 10.50 N/mm ² minimum |
| ii) | Ultimate elongation | : | 250% minimum |
| (f) | Effect of Alkali | : | 7 days |
| i) | Weight increase | : | 0.10% maximum |
| ii) | Weight decrease | : | 0.10% maximum |
| iii) | Hardness change | : | ± 5 points |
| (g) | Effect of Alkali | : | 28 days |
| i) | Weight increase | : | 0.40% maximum |
| ii) | Weight decrease | : | 0.30% maximum |
| iii) | Dimension change | : | ±1% |

PVC water stops shall be either of the bar type, serrated with centre bulb and end 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 INCHARGE before procurement for incorporation in the works. Alternatively G.I. sheet of 18 gage (1.3mm) thick and 200mm wide can be used by the contractor as construction joints.

Alternatively contractors can use G.I sheet 200mm wide and 18 gauge thick as constructions joints.

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 waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop 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.

Preformed Fillers and Joint Sealing Compound

Materials: Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres 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.

Workmanship

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses 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 hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it 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 1.20 kg/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 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/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.

15 SAMPLING AND STRENGTH OF DESIGNED CONCRETE MIX

15.1 General

Samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

15.1.1 In order to get a relatively quicker idea of the quality of concrete, optional tests on beams for modulus of rupture at 72 ± 2 h or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength test.

For this purpose the values should be arrived at based on actual testing. In all cases, the 28 days compressive strength specified in Table 2 shall alone be the criterion for acceptance or rejection of the concrete.

15.2 Frequency of Sampling

15.2.1 Sampling Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested that is, the sampling should be spread over the entire period of concreting and cover all mixing units.

15.2.2 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

Quantity of Concrete in the Work, m ³	Number of Samples
1-5	1
6-15	2
16 – 30	3
31- 50	4
51 and above	4 plus one

additional sample for each additional 50 m' or part thereof

NOTE---

At least one sample shall be taken from each shift. Where concrete is produced at continuous production unit, such as ready-mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.

15.3 Test Specimen

Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.

15.4 Test Results of Sample

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ± 15 percent of the average. If more, the test results of the sample are invalid

16 ACCEPTANCE CRITERIA

16.1 Compressive Strength

The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

- The mean strength determined from any group of four consecutive test results compiles with the appropriate limits in col 2 of Table 11.
- Any individual test result complies with the appropriate limits in col 3 of Table 11.

16.2 Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

- The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm².
- The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm².

16.3 Quantity of Concrete Represented by Strength Test Results

The quantity of concrete represented by a group of four consecutive test-results shall include the batches from which the first and last samples were taken together with all intervening batches. For the individual test result requirements given in col 2 of Table 11 or in item (b) of 16.2, only the particular batch from which the sample was taken shall be at risk. Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m³. 16.4 If the concrete is deemed not to comply pursuant to 16.3, the structural adequacy of the parts affected shall be investigated (see 17) and any consequential action as needed shall be taken.

Item No.2 :- Providing and supplying in standard length ISI mark rigid unplasticised PVC Pipes suitable for potable water with elastomeric sealing ring fit joint including cost of rings, as per IS specification No:-4985/1988 including all local and central taxes, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to department stores or site of work and including cost of jointing materials etc. complete.

110 mm dia 6 Kg/cm² PVC Pipe

UNPLASTICIZED PVC PIPES :

The agency shall provide and procure the PVC pipes from latest approved venders of G.W.S.S.& B. The list of approve vender is given separately.

Attached Annexure-1

STANDARDS:

The UPVC Pipes to be manufactured, supplied and delivered under the scope of this contract shall be manufactured in accordance and confirming to IS:4985-2000 or its latest revision or amendments or other authoritative standard that ensure at least a substantially equal quality to the IS:4985-2000 or its latest revision or amendments

Elastomeric sealing ring shall be as per specification of IS – 5382-1985, and ISO: 4633-1996 or it shall be EPDM rubber ring.

The dimensions, material compositions, tests etc. shall be as per IS:4985-2000 or with its latest revision or amendments.

The minimum wall thickness weight shall be as per Appendix I of the tender.

The colour of pipes shall be as per IS 4985-2000

Bureau of Indian Specifications (BIS) / Indian Standard (IS) shall mean the Latest version issued by BIS.

The material from which the pipes are made shall consist substantially of un plasticized polyvinyl chloride conforming to IS: 10151, to which may be added only those additives that are absolutely needed to facilitate the manufacture of the polymer, and the production of sound, durable pipes of good surface, finish, mechanical strength and opacity.

The bulk density of the UPVC compound shall be 0.50 to 0.53 and the density of UPVC pipe shall be 1.40 to 1.46 g / cm³.

The additional of the manufactures own rework material shall comply to clause 4.2 of IS: 4985.

PVC resin of suspension grade K-66/K-67 shall be used for extrusion of UPVC pipe.

In line with BIS 4985-2000 the tolerance on outside diameter of the pipe shall be as under:

Nominal outside Diameter	Min. outside diameter in mm		Outside diameter at any point in mm	
	Minimum	Maximum	Minimum	Maximum
90	90	90.3	88.9	91.1
110	110	110.4	108.6	111.4
140	140	140.5	138.3	141.7

160	160	160.50	158.0	162.0
180	180	180.6	177.8	182.2
200	200	200.6	197.6	202.4
225	225	225.7	222.3	227.7
250	250	250.8	247.0	253.0
280	280	280.9	276.6	283.4
315	315	316.0	311.2	318.8

“The pipes shall be transported to the store by flat floored trucks in pre packed wooden crate. The height of crate should not be exceeding more than 2 meters. The both ends of packaging unit (crate) shall be covered with plastic sheet to ensure adequate protection during transport. At the time of packing and stacking of pipes, the sockets shall be alternated within the pipe of pipes and shall project sufficiently for the pipes to be correctly supported along their whole length. The pipes shall rest uniformly on the vehicle bed over their whole length during transport to avoid sagging or deformation.

The packing material like wooden crate, plastic sheet etc. shall be the property of tenderer and he is permitted to reuse the packing material for transporting next batch of pipes”.

The pressure rating of pipes shall be in accordance with IS 4985 with a maximum continuous M working pressure at 27⁰ C. of 6 & 10 kg/cm². This working pressure shall be down graded for ambient underground soil temperature of 45⁰ C. as per the figure given in IS 4985 for design purposes.

The pipes when subjected to internal hydrostatic pressure in accordance with IS: 12235-1986 (part – 8) shall not burst during the prescribed test duration. The temperature, duration and test and induced internal stress shall conform to the parameters given below:

Sr. No.	Test	Temp. (°C)	Min. duration (h)	Induced Stress (Mpa)	Requirements
1	Type test	60	1000	10	No failure
2	Acceptance Test	27	1	36	No failure

The integral socket of the pipe shall be tested for internal hydrostatic pressure in accordance with ISO: 3603 and ISO 1167.

The UPVC pipe shall not contain vinyl chloride monomer (VCM) exceeding 1 ppm when determined by means of gas phase chromatography using the “headspace” method according to IS: 10151.

The wall of the socket and the wall of the plain pipe shall not transmit more than 0.2% of visible light falling on them when tested in accordance with IS:12235 (part -3).

The pipes shall be supplied in straight length of 6 mtrs with tolerance of +20mm and -0mm. The effective length of socket pipe shall be considered as shown in figure 2 of IS 4985.

All plastic and non plastic material for components of the UPVC piping system e.g. Elastomeric sealing ring, lubricants, when in permanent or in temporary contact with water which is intended for human consumption, shall not adversely affect the quality of the drinking water.

Concentrations of chemicals, biological agents or other substance leached from pipe materials in contact with drinking water and the values of the relevant physical parameters, shall not exceed the maximum values recommended by IS: 10500.

The pipe material shall be in accordance with IS 4985, clause 6.3.

The quality control system and sampling model shall be as under:

TEMPerature variations:

All the pipes to be manufactured, supplied and delivered shall be subjected to weather conditions like sun, dust, rain, wind as available in State of Gujarat. They shall be also subjected to carry and convey drinking water under variable temperature conditions ranging from 4 C⁰ to 45 C⁰.

MARKING :

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

- Certification mark on each pipe.
- Manufacturers brand name and/or trademark.
- Purchasers mark as “GWSSB” be inscribed.
- The outside diameter and pressure rating.

Batch number or lot number.

Inspector’s mark on each pipe

- Any other important matter that the manufacturer or purchaser deems fit to be inscribed.

Elastomeric sealing ring

These sealing ring shall be Sturine Butadin in red color as specified in IS. The lubricant applied for jointing of elastomeric rubber ring shall be of good quality and comply the following specifications: **MUST HAVE PASTE LIKE CONSISTENCY AND BE READY FOR USE, PREFERABLY SOAP JELLY. HAS TO ADHERE WET AND DRY SURFACES OF UPVC PIPES AND RUBBER RING. MUST BE NON-TOXIC. MUST BE WATER-SOLUBLE.**

MUST NON-AFFECTING PHYSIO-CHEMICAL AND ORGANOLEPTIC PROPERTIES OF DRINKING WATER CARRIED ION THE PIPE.

MUST NOT HAVE AN OBJECTIONABLE ODOUR.

MUST NOT HARMFUL TO THE SKIN.

Elastomeric sealing ring shall be in accordance with one of the types (Type - 1 to Type – 6) as per ISS 5382. These sealing rings shall be EPDM rubber ring. The sealing ring shall be with ISI mark.

In case of imported EPDM Ring, such rings shall conform to relevant International Standards or the Standards of country of origin, which are equivalent or higher than the Bureau of Indian Standard Specifications. In case of manufacturers who have applied for getting a BIS certification mark, it would be mandatory for such bidders to produce the BIS certification license on or before the date of opening of the price bids. An undertaking in this regard shall have to be provided along with the technical bid.

The rubber sealing rings shall be vulcanized from Ethylene Propylene (EPDM) with strengths as per table 2 of IS 5382-1985.

type test:

Type test capacity, test for effect on water, test for resistance to Sulfuric Acid, internal Hydrostatic pressure test for 1000 Hrs. shall be carried out at least once at any time during the contract. Or shall be taken at least once during every six months irrespective of the ordered quantity.

color of pipes:

The color of the pipes shall be as per IS 4985-2000.

The pipes shall bear ISI mark confirming to IS:4985-2000 or its latest amendment/revision if any.

test for pvc resin & pipe:

Test For PVC Resin

It shall be sufficient to show the certificate of chemical test (in accordance with IS 4669) to the inspecting authority to confirm the 'K' value to be 64 to 67 as per clause No. 6.1.2. of IS 4985-2000

Specific Gravity and Ash Content Tests:

a) Density:

These tests shall be carried out by the inspection agency as per the IS:4985-2000 OR its latest revision OR amendments. The value shall be between 1.40 and 1.46 as per the ISS clause No. 10.6

b) Sulphate Ash content:

When tested as per Annex B, of IS 4985-2000, the sulphated ash content in the pipe shall not exceed 10 percent.

c) Other test shall be carried out as per ISS 4985-2000 or its latest revision or amendment

tolerance in weight of pipes:

(-) 1% tolerance in actual weight of pipes shall be allowed but in overall weight there should not be any minus tolerance i.e. minus tolerance may be compensated in overall weight. If the tolerance is in minus, the consignment shall be outright rejected. The weight of pipes as given in Appendix-I shall be considered. If required the consignee can weight the whole lot of supply for verification.

Quality Assurance

Unit weight and minimum wall thickness of un plasticizes ring fit type PVC pipes are as per IS 4985-2000.

The Quality assurance plan (QAP) shall be approved by concerned Executive Engineer,

The bidder shall have to arrange for testing of pipes in factory in the presence of TPI and G.W.S.S.B. representative. The payment for TPI shall be made by contractor.

The bidder shall have to arrange for post inspection of pipes brought on site. Random testing of pipes brought on site shall be done in CIPET and on satisfactorily report from the CIPET the payment of pipes will be made.

Price Variation: - Price variation shall be followed as per Clause no. 59 of General Contract condition.

METHOD OF MEASUREMENT OF PIPES:

The measurement shall be recorded in running meter of pipe length laid along center line or axis of pipe line including tees, enlarges, reducers and bends correct up to 0.01M. length. No payment shall be made for overlaps etc. .

Mode of measurement and payments

Payment will be paid as per Rmt.

Sr. No.	Stage of works	Amount payment	admissible

1	2	3
1	On Receipt of materials duly inspected on site or store with maximum limit of 5000 Rmt (for One supply) irrespective of pipe dia.(size)	65%
2	After lowering, laying & jointing of Pipe line.	15%
3	On Hydraulic testing	10%
4	On refilling and disposal of surplus stuff	5%
5	After Commissioning	5%
	Total....	100%

Item No 3:-

Providing & Supplying P.V.C. Fittings suitable for P.V.C. Pipes at store or at site of work incl. freight, loading, unloading, stacking, insurance and all taxes etc. complete.

1. Scope of Work

The scope includes the sourcing, procurement, and delivery of Polyvinyl Chloride (PVC) fittings to the designated store or site of work. The rate shall be inclusive of the material cost, manufacturing, quality testing, packaging, freight, transit insurance, loading, unloading, and stacking at the site, including all applicable taxes (GST, duties, etc.).

2. Material Specifications

- **Material Quality:** All fittings shall be manufactured from high-quality unplasticized PVC (uPVC) resin. The material must be virgin, free from lead (where potable water is concerned), and resistant to corrosion, chemical erosion, and bacterial growth.
- **Standard Compliance:** Fittings must comply with relevant national/international standards (e.g., IS 7834 for pressure pipes or IS 14735 for SWR drainage systems).
- **Pressure Rating:** Fittings must have a pressure rating (PN) equal to or higher than the pipes with which they are to be used (e.g., 4 kgf/cm², 6 kgf/cm², or 10 kgf/cm²).
- **Surface Finish:** Both internal and external surfaces shall be smooth, clean, and free from grooves, blisters, or other surface defects. The ends shall be cleanly cut and square to the axis.

3. Types of Fittings

The supply shall include, but is not limited to:

- Couplers, Elbows (90° & 45°), Tees (Equal & Reduced).
- Reducers, End Caps, and Unions.
- Service Saddles and Solvent Cement (if specified).

4. Transport and Handling

- **Freight & Insurance:** The supplier is responsible for all transportation costs and must provide transit insurance to cover damages during movement.
- **Loading/Unloading:** Materials must be handled with care using appropriate equipment. Dropping fittings from heights or dragging them on the ground is strictly prohibited.
- **Stacking:** Fittings must be stacked in a shaded area, protected from direct sunlight (UV degradation), and organized by size and type for easy inspection and inventory management.

5. Inspection and Testing

- **Manufacturer's Certificate:** Each batch must be accompanied by a manufacturer's test certificate (MTC).
- **Visual Inspection:** Any fitting showing cracks, chipping, or distortion will be rejected.
- **Dimensional Check:** Fittings will be checked against standard diameter and wall thickness tolerances.

6. Measurement and Payment

- Unit of Measurement: Payment will be made per piece (Numbers) or by weight (Kilograms) as specified in the Bill of Quantities (BOQ).
- Price Inclusion: The quoted rate is "All-Inclusive," meaning no extra payment will be made for transportation, labor for unloading, or tax fluctuations unless explicitly stated in the contract.

Item No.4

**Providing and supplying ISI mark CI D/F Sluice Valves as per IS:14846(Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete
100 mm dia Sluice valve PN 1.0 with ISI mark**

GENERAL

The valves shall be supplied by the contractor. Every care shall be taken in carting them to site. Contractor shall have to pay for any damage to the valves carting, loading, unloading etc. or in fixing.

2.0 JOINTING MATERIAL

2.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool etc.

2.2 All tools and plant required for installation of sluice valve shall be provided by the contractor.

3.3 All jointing materials shall be approved from the engineer-in-charge before use.

4.0 INSTALLATION

4.1 The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.

4.2 If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.

4.3 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.

4.4 The flange faces thoroughly greased.

4.5 If flange faces are not free, the contractor shall use thin fibres of lead wool.

4.6 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

4.7 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.

4.8 Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

4.9 The sluice valve/butterfly valve shall be installed in such a way that its Spindle shall remain in truly vertical position.

4.10 The other end of tailpiece shall be fitted with pipes so that continuous lines can work.

4.11 Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

5.0 TESTING

Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

6.0 MODE OF PAYMENT

The rate shall be for a unit of one number. The payment shall be made only for satisfactorily work done with all respect.

Item No.5

Providing and supplying ISI mark CI D/F Reflux Valves as per IS:5312(Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to

departmental stores, stacking etc. complete.

Reflux valve class PN 1.0 80 mm dia

GENERAL

The valves shall be supplied by the contractor. Every care shall be taken in carting them to site. Contractor shall have to pay for any damage to the valves carting, loading, unloading etc. or in fixing.

2.0 JOINTING MATERIAL

2.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool etc.

2.2 All tools and plant required for installation of sluice valve shall be provided by the contractor.

3.3 All jointing materials shall be approved from the engineer-in-charge before use.

4.0 INSTALLATION

4.1 The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.

4.2 If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.

4.3 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.

4.4 The flange faces thoroughly greased.

4.5 If flange faces are not free, the contractor shall use thin fibres of lead wool.

4.6 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

4.7 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.

4.8 Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

4.9 The sluice valve/butterfly valve shall be installed in such a way that its Spindle shall remain in truly vertical position.

4.10 The other end of tailpiece shall be fitted with pipes so that continuous lines can work.

4.11 Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

1. Scope of Supply

The contractor shall provide and supply **ISI-marked Cast Iron Double Flanged (D/F) Reflux Valves** conforming to **IS:5312 (Latest Edition)**, including:

- Manufacturing and testing
- All taxes and duties
- Insurance charges
- Transportation and freight charges
- Octroi and inspection charges
- Loading, unloading, conveyance to departmental stores/site
- Stacking and handling

Supply shall be **complete in all respects**.

2. Valve Details

- **Type:** CI Double Flanged Reflux Valve (Non-return valve)
- **Nominal Diameter (DN):** 100 mm
- **Pressure Class:** PN 1.0
- **Standard:** IS:5312 (Latest Edition)
- **Marking:** ISI certification mark embossed on valve body

3. Materials of Construction (MOC)

Component Material Specification

Body & Cover Cast Iron (CI), conforming to IS:210, minimum Grade FG 200

Disc/Clapper Cast Iron (CI) with rubber facing or equivalent sealing arrangement

Hinge Pin Stainless Steel (SS 304/316) or Bronze, machined for durability

Seat Ring Bronze / Gunmetal / Stainless Steel, securely fixed to ensure leak-tight performance

Bolts & Nuts Mild Steel (MS) or High Tensile Steel, conforming to IS:1367

Gaskets Compressed fibre / rubber sheet as per IS:638, thickness 1.5 mm to 3 mm

Hinge Bush Bronze / Gunmetal

Coating Internal and external surfaces coated with anti-corrosive epoxy paint

4. Design & Performance Requirements

- **Working Pressure:** PN 1.0 (10 Kg/cm²)
- **Hydraulic Test Pressure:**
 - Body: 15 Kg/cm²
 - Seat: 10 Kg/cm²
- **Flow Direction:** Unidirectional (non-return function)
- **Flanges:** Drilled as per IS:1538 / IS:5312, suitable for PN 1.0 rating
- **Leakage:** Valves shall be leak-tight under specified test conditions

5. Inspection & Testing

- All valves shall be **hydrostatically tested** as per IS:5312 requirements.
- Manufacturer shall furnish **test certificates** and inspection reports.
- Valves shall bear **ISI mark** and manufacturer's identification.

6. Delivery & Payment Terms

The rate shall be for a unit of one number. The payment shall be made only for satisfactorily work done with all respect.

Item No.6

Providing and supplying C. I. Temper proof Air valves with SS 304 Float gun metal- nozzle of approved make & quality of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

Without Isolating Sluice Valve PN 1.0

50 mm dia DOUBLE ACTING (DS2)

➤ **General**

- Tamper proof air valve confirming to AWWA C 512, having outlet for admission and release of bulk volume of air during emptying and filling of the pipeline. The ball sealed orifice shall always remain open while air is exhausting and is immediately closed when Water rises in the chamber, lifts 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) ball to drop into when the valve 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 to 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 all air escape at 300 m/sec.
- The total impact force on the 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 low pressure cover shall be massive and 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.

➤ **Testing**

- All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure. Test pressure as per AWWA C512 or API 598.

➤ **Positive material Identification (PMI Test)**

- PMI test shall be checked at random for Stainless steel parts.

➤ **Test Certificates**

- When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

➤ **Marking**

- Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size, 'PN' rating, Heat Number and Serial number.

➤ **Painting**

- Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide and then black bituminous paint for minimum of 150 micron DFT on surfaces before dispatch.

➤ **Datasheet:**

TAMPER PROOF AIR VALVE				
Sr No	Component	PN- 1.0	PN-1.6	PN-2.0
1	Body	CI IS 210 Gr. FG260	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB
2	Cover	CI IS 210 Gr. FG260	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB
3	Float	SS 410	SS 304	SS 304
4	Seat	EPDM	EPDM	EPDM
5	Float Guide	SS 410	SS 304	SS 304
6	Orifice	SS 410	SS 304	SS 304
7	Gasket	EPDM	EPDM	EPDM
8	Nut Bolt	Carbon steel	Carbon steel	Stainless Steel
9	Flange End	IS 1538	IS 1538	ASME/ANSI B16.5 Class 150

MODE OF MEASUREMENT AND PAYMENT

Measurement shall be paid on number basis as per relevant dia of the item as per payment schedule.

Item 7: -

Excavation for pipe line trenches for water supply, sewerage line, manhole etc. all with shoring and strutting if required as per required gradient and line including safety provisions using site rails and stacking excavated stuff including up to all required lead cleaning the site etc. complete for all lifts and strata as specified. Upto 1.50 Mt depth from avg GL

- all sorts of soil
- Hard Murrum
- Soft Rock

1.0 General

1.1 The excavation for trenches will generally refer to open excavation for trenches in wet / dry conditions for pipe laying work.

2.0 Clearing of Sites

2.1 The site on which the pipelines are to be laid and shown on plan and the area required for setting out and other operations shall be cleared and all obstruction loose stones and materials, rubbish of all kinds, stumps, brushwood as trees shall be removed as directed. The roots shall be entirely grubbed up.

2.2 The products of the clearing to restacked in such a place and in such a manner, as directed by the engineer in charge.

2.3 All holes or hollows whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well watered, well rammed levelled off, as may be directed.

2.4 The agency has to obtain necessary permission for diverting the traffic or public as per requirement from competent authority for carrying out the work.

3.0 Setting Out

The centre lines of all pipe trenches shall be given by the Engineer-in-charge and it will be the responsibility of the contractor to install substantial reference marks, bench marks, etc. and maintain them as long as required true to line, level curve and slopes. The contractor shall assure full responsibility for alignment, and dimension of trench.

The labour, materials etc. required for setting out and establishing benchmarks and other reference marks shall be arranged by the contractor at his own cost.

4 Excavation

4.1 The excavation incl. Bailing out of water for the pipe trenches shall also include removal of all materials of whatever nature and whether wet or dry condition necessary for laying of pipelines exactly in accordance with alignment, levels grades and curves shown on the plans or as directed by the Engineer-in-charge.

Trenches shall be excavated to the exact width and depth according to the size of pipe and the sides shall be left vertical as far as possible or according to the angle of repose of various soils. Unless there is a specific extra provision in the contract for shoring and strutting or for cutting side slopes the contractor shall at his own cost do the necessary shoring and strutting or cutting of slopes to the angle of repose or both approved by the Engineer-in-charge. The contractor shall notify the Engineer before starting excavation to enable him to take cross sectional levels for purpose of measurements before the ground is disturbed. The bottom of the trenches shall be levelled both longitudinally and transversely or slopped as directed by the

Engineer. The contractor shall at his own cost to remove such portions of boulders or rocks, as are rectified to make the bottom of the trench level. No filling shall be allowed to bring the trench to level. If by contractor's mistake excavation is made deeper than shown on the plans and if ordered by the Engineer the extra depth shall have to be made with selected excavated stuff only with watering, ramming etc. as directed, by the Engineer and at the cost of the contractor. Other hard excavation shall be cleared of all sorts including loose materials and cut to firm surface, either level, stepped as directed by the Engineer. The Engineer may order such changes in the dimensions and alignment of pipe trench as may be deemed necessary to secure satisfactory cover over pipeline. The contractor shall, at his own expense, make provision for bailing out or draining water and the trenches shall be kept free of water, during laying work.

After each excavation is completed, the contractor shall notify the Engineer to that effect and no laying of pipeline will be allowed to be laid until Engineer has approved the depth and dimensions of trenches, level and measurements.

5.0 Shoring and Strutting

5.1 Shoring & strutting if required shall have to be carried out by the contractor, for which any extra charge will not be paid.

5.2 During excavation if water connections, sewage connections, telephone lines khalkuva (soak pits) etc. are damaged by the contractor, the same shall have to be restored by the contractor without any extra cost.

6.0 Protection

6.1 The trenches shall be strongly fenced and red light signal shall be kept at night and arrangement of watchman to prevent accidents should be done. Sufficient care and protective measure shall be taken to see that the excavation shall not affect or damage the adjoining structure. 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, caution boards etc. shall be provided by the contractor.

7.0 The excavation in all sorts of soil, hard murrum, soft rock or hard rock or any type of soil shall have to be carried out up to the required depth by the agency.

8 Disposal of Excavated Stuff

8.1 No excavated stuff from trench are to be placed even temporarily nearer than 1.5 meter or greater distance up to 90 meter or as prescribed by the Engineer from the outer edge of trench. All excavated material will be the property of the owner. The rate of excavation includes sorting out of useful materials and stacking them separately as directed within specified lead. The excavated stuff suitable and useful for refilling or for other use shall be stacked at convenient places. The materials not useful in any way shall be disposed off as directed by the Engineer from the outer edge of trench.

8.2 The site should be cleared off on completion of work.

9.0 Additional Requirements

9.1 At the joints of pipes, the trench shall be excavated to an additional depth of 15 cm. and width of 30 cm. And length of 15 cm. beyond the edge of collar on both the sides or as directed. The rate include for such extra excavation made at the joints. The trenches shall be excavated perfectly in straight line. The bottom of the trench shall be kept as per invert level or as directed. To maintain the proper slope the usual method of site rails and boning rods shall be adopted. The contractor shall have to provide and fix and maintain sight rails and boning rods without any extra cost.

If the contractor fails or makes delay to give hydraulic test of the pipe line laid in any of the section, without any genuine reason, he shall be responsible to get any part of the length trenches refill in such case (i.e. before testing) for safety of pedestrian and/or vehicular traffic as found necessary by the engineer-in-charge without any extra cost. If found necessary and directed by the Engineer-in-charge, the contractor shall have to excavate the refilled trenches, during hydraulic test without any extra cost.

At all road crossings, trenches shall be excavated only for half width of the road and pipe shall be laid. The other half shall be excavated only after back filling over the laid pipeline is done so as to make it suitable for the traffic. The contractor shall provide diversion when the pipeline is to be laid along the road as required and shall maintain the diversion or any part of it, without any extra cost. At all road crossings, the pipe shall be laid below the crest of road.

9.2 The contractor shall break the road surface only after prior permission form competent authority by chiselling or method specified by competent authority to the exact width and length as shown on the drawing or as directed by the Engineer-in-charge. The excavated stuff shall be deposited in uniform layers to avoid mixing with other kind of materials at non-objectionable place or as directed by the Engineer-in charge.

10 Measurement and Payment

10.1 The mode of measurement shall be made for a unit of one Cu. M.

10.2 Payment shall be made for a unit of one Cu. M.

10.3 The rate for the item of excavation shall include the following unless and otherwise mentioned.

- (a) Clearing of site
- (b) Setting out work including all materials and labour
- (c) Providing and subsequently removing, shoring and strutting outing slopes etc.
- (d) Excavation and removal and staking of all excavated stuff as directed.

- (e) Necessary protection including labour materials equipment etc. to ensure safety and protection against risk or accident.
- (f) Providing facilities for inspection and damage to property if caused during progress of work.
- (g) Compensation for injury to life and damage to property if caused during progress of work.
- (h) Restoring of water supply connections, sewer connections, telephone lines, khalkuva soak pits etc. if damaged by contractor without extra payment.
- (i) Dewatering of excavated pit trench during the progress of work.
- (j) Clearing the site on completion of works directed by the Engineer.

Item No.8:-

Lowering, laying, fixing and jointing PVC/uPVC/cPVC pipes and specials of following class and diameter including cost of conveyance from stores to site of works including cost of labour, material, cement solvent, giving satisfactory hydraulic testing as per ISI code.

140 mm dia 6Kg PVC Pipeline

90 mm dia 6Kg PVC Pipeline

(1) LAYING AND JOINTING :

This items for laying and jointing pipe lines and does not include the work of excavation. Every pipes and specials shall be cleared properly and examined for any cracks or defects. The rejected pipes and fitting shall have to be removed from site by the contractor immediately and stacked as directed at his own cost. Before lowering laying the pipe into the trenches, the excavation shall be got checked and approved. Necessary solvent cement for P.V.C. Pipes shall be applied with brush inside the fittings and out side the end of pipe after using the pipes sand comb with sand paper the coupler shall then be pressed till there remain no recess between the ends of pipes. The joints shall be protected from direct sun as they finished.

The refilling shall be done after necessary hydraulic testing carried out according to the instruction of Engineer-in-Charge.

The interior of the pipe already laid must be kept clean as the work under process. The ends of pipe shall be closed with a wooden plug the temporary stop of the work.

(2) TESTING :

The Contractor shall give at his own cost necessary hydraulic testing section by section. Minimum length of 500 mt. per section pipe line should with stand the required highest pressure in the section without showing leakage any where in the pipe joints specials valves etc. if any defects are found the contractor shall be made good the same at his own cost.

The contractor shall have to make necessary arrangement for pressure meter and plugging all ends of pipes without claiming extra cost. If the pipes are broken during testing due to test pressure, the contractor shall be responsible to replace the pipe without any extra claim however the pipes shall be supplied by the Department Free of Cost. The pressure water shall be installed at appropriate place as directed by Engineer-in-Charge. Before actual testing the pipe section shall be filled with water for a period of at least 24 hours. The required pressure subject to class of pipe shall be maintain for at least 30 minutes in presence of Engineer-in-Charge. No extra claim shall be maid to contractor for pumping and pressure arrangement and plugging the pipe section.

(3) The payment for untested section part rate at 70% of the tendered rate for the item shall be paid in R.A.Bill.

(4) Balance amount will be paid after the satisfactory test of the pipes line is given by the contractor as prescribed above.

(5) The rate shall be paid per R.M.T of complete work in all respect.

Item No.9

Providing CC M:10 for encasing pipes using trap metal size 12 mm to 50 mm including form work curing consolidation etc complete for various location on pipeline

... By using trap metal 40 mm size

- For all practical purpose and in absence of proportioning of concrete on base of preliminarily tests, C.C. 1:3:6 may be provided as a levelling course i.e. one part of cement three parts of sand and six parts of black trap kapachi. Specification for various ingredients of concrete such as sand, cement, kapachi, water shall be as these given in specification for C.C. M 100.
- 2.2 While laying base concrete for levelling course the concrete shall not be dumped from above but shall be carried out to the bottom and gently placed from a height not exceeding 1.5 meter. If concrete is transported by chutes,

then the same shall be remixed at bottom of chutes to overcome any segregation that might have occurred.

1. General

The concrete shall consist of one part of ordinary Portland cement conforming to IS 269-1976 Three parts of well graded angular best quality river sand free of dust and organic matter and size 1 mm. To 3 mm and Six parts of approved quality black trap kapachi of size 12 mm to 25 mm. All C.C. work shall be carried out as per I.S.S. regulation and as per standing practice and ordered prevailing in PWD. All the items are to be carried out as per details supplied and as required and directed by the engineer in charge or his authorized agencies. The work will have to be strictly as per approved design and as directed by the engineer in charge.

2. Aggregate

The coarse aggregate and the fine aggregate for the concrete shall be hard, clean, tough & durable and shall be free from all deleterious matter such as dust, lump of clay, soft & flaky pieces, shale alkali, organic matter.

The materials shall be got approved by the Engineer-In-Charge or his agent.

3. Proportion

The proportion of coarse and fine aggregate shall be that one part of cement, three parts of fine aggregates & Six parts of coarse aggregates by volume. The proportion of cement & water of the water cement ratio shall be as specified having regard to the nature of work & strength to be developed.

4. Mixing

Whether the concrete is mixed by hand or in a mechanical mixture, it shall be thoroughly mixed and the concrete placed in its final position with the minimum of delay. Every piece of aggregate shall be uniformly coated by cement paste.

5. Laying & Consolidation

The concrete must be laid gently (Not dumped) from height so as not to prevent segregation of aggregates. After placing it shall be well compacted by tamper and/or mortar to cream up. In no case ramming shall be prolonged after the cement has begun to take its initial set. In no case, more water be added in order to reduce the work of completion.

6. Curing.

As soon as the concrete has set sufficiently the surface shall be protected from rapid drying by being covered with wet sand, wet gunny bags or where possible by forming shallow pools of water on the top. The setting shall be continued for at least 10 days & usually two to three weeks.

7. 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 stop 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.

8. Mode of payment

80% payment if necessary shall be made after laying of concrete & 20% payment shall be released after completion of curing period of exposed surface.

The rate shall be paid per cum. of completed work.

ITEM NO : 10

Refilling the pipeline trenches incl. ramming, watering, consolidating disposal of surplus stuff as directed within a radius of 3 km.

The contractor shall do refilling in a systematic manner. Before refilling, the trenches the contractor shall get checked the trenches, ready for refilling.

- All space between pipeline and the sites of excavation shall be refilled to the original surface with earth or selected materials in layers of 20 cm. well rammed.
- Each layer shall be completed before the upper layer is laid till the final level is reached to form a thoroughly compacted base.
- Trenches for pipeline shall be back filled after the pipeline is laid to a depth of 30 cm. above the pipe accepted the joint portion. The ramming filling shall be done after hydraulic testing of pipeline.
- Refilling on top of pipe shall be carried out carefully with selected soft stuff out of the excavated stuff. The filling shall be raised about 5 cm. to take care of subsequent settlement.
- The contractor shall be responsible for any settlement during passage of time or during monsoon and the same shall be refilled with stuff brought from the outside, if necessary.
- The process of refilling trenches, ramming, shall be carried out in such a way as not to endanger the pipeline already laid.
- The contractor shall carry out refilling 15 cm above road surface to take care of any settlement till completion of work and handing over to local body.
- Surplus earth after refilling at the trenches shall be removed from the site within a radius of 3 km as directed by engineer in charged. No extra payment shall be made for clearance the site.
- Mode of Measurement and Payment
The rate shall be per Cubic Meter of refilled volume.
The Payment shall be made as per cum.

ITEM NO- 11:-

Lowering, laying and jointing in position following C. I. / D/F Reflux valves, Butterfly valves, Sluice valves and Air valves including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete

1) 100mm dia sluice valve

2) 50 mm Air valve

1.0 JOINTING MATERIAL

- 1.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool C. I. tailpiece etc.
- 1.2 All tools and plant required for installation of sluice valve shall be provided by the contractor.
- 1.3 All jointing materials shall be approved from the engineer-in-charge before use
- 1.4 The nut and bolts shall conform to Item No MSP-19 of specification of materials.
- 1.5 The rubber packing shall conform all specifications as narrated in Item No MSP-20 of specifications of materials.

2.0 INSTALLATION

- 2.1 The sluice valve/ butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- 2.2 If necessary tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.
- 2.3 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.
- 2.4 The flange faces thoroughly greased.
- 2.5 If flange faces are not free, the contractor shall use thin fibers of lead wool.
- 2.6 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

- 2.7 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.
- 2.8 Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.
- 2.9 The sluice valve/butterfly valve shall be installed in such a way that its Spindle shall remain in truly vertical position.
- 2.10 The other end of tailpiece shall be fitted with pipes so that continuous lines can work.
- 2.11 Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

3.0 TESTING

- 3.1 After installation of sluice valve/ butterfly valve the same is tested to 1 1/2 times of its test pressure.
- 3.2 The joints sluice valve/butterfly valve shall withstand the test pressure of pipelines.
- 3.3 Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

4.0 MODE OF MEASUREMENT AND PAYMENT

Measurement shall be paid on number basis as per relevant dia. of the item as per Schedule-‘B’

AIR VALVES

➤ SUPPLY OF MATERIAL

- 1.1 Cast iron double-flanged Air valves with two tailpieces suitable to pipe shall be supplied and carted by the contractor as per latest IS. The rate shall include loading, unloading and stacking at site.
- 1.2 The sluice air valves and tailpieces shall be examined before laying for cracks and other flows. They shall be undamaged in all respect.
- 1.3 All grits and foreign materials shall be removed from the inside of the valves before placing.
- 1.4 All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.
- 1.5 The tightening of gland shall be checked with a pair of inside-calipers. Clearance between the top of stuffing box and the underside of the gland shall be uniform all the sides.

➤ JOINTING MATERIAL

- 1.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool C. I. tailpiece etc.
- 1.2 All tools and plant required for installation of air valve shall be provided by the contractor.
- 1.3 All jointing materials shall be approved from the engineer-in-charge before use
- 1.4 The nut and bolts shall conform to Item No MSP-19 of specification of materials.
- 1.5 The rubber packing shall conform all specifications as narrated in Item No MSP-20 of specifications of materials.

2.0 INSTALLATION

- 2.1 The air valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- 2.2 The flange faces thoroughly greased.
- 2.3 If faces are not free, the contractor shall use thin fibers of lead wool.
- 2.4 After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.
- 2.5 The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.
- 2.6 Each bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.
- 2.7 Extra excavation required for facility of lowering and fixing air valve shall not be paid for.

3.0 TESTING

- 3.1 After installation of air valve the same is tested to 1.5 times of its test pressure.
- 3.2 The joints air valve shall withstand the test pressure of pipelines.
- 3.3 Defects noticed during test and operation of Air valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

4.0 MODE OF MEASUREMENT AND PAYMENT

Measurement shall be paid on number basis as per relevant dia. of the item as per Schedule-‘B’

Item No.12

Construction of valves chambers in brick or Bela stone masonry, locally available in C. M. 1:6. Foundation concrete 150 mm thick in C. C. 1:4:8 of trap metal size 25 mm to 40 mm thick, inside cement plaster in C. M. 1:3 and cement pointing outside in C. M. 1:3 and top cover of precast RCC slab 100mm thick (with key hole in two parts, each with handles or MS bar etc. complete as given size) up to 1mt depth from GL to pipe invert level incl. complete civil work excl. cost of excavation & refilling. With cast in situ RCC slab

size of chamber 0.60X0.60X1 mtr deep

With precast slab with single piece 10 cm with fixing M. H. cover

Scope of work:

The Brick or Bella masonry valve chambers of size mentioned in Schedule-B shall be constructed at various places including all materials and labours.

1. Location

Valve chambers shall be constructed at places as shown on relevant drawings or as directed by the Engineer-in-charge.

2. Excavation

Excavation, shoring, dewatering etc. for the pits of chamber, laying of pipes and fittings/specials shall be done as requirement of work or directed by engineer in charged.

3. Plain Cement Concrete (1:4:8):

The water, sand, cement & stone aggregate of 25mm to 40 mm nominal size shall be used of approved quality as per standard specification in I.S. 456.

3.1 Workmanship: Before starting concrete the bed of foundation trenches shall be cleared of all loose materials, levelled, watered and rammed as directed.

3.2 Mixing: The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quality of work if approved by the Engineer-in-charge. When hand mixing is permitted by the Engineer-in-charge in case of breakdown of machineries and in the interest of the work, it shall be carried out on a water tight platform and shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mixing in mechanical mixer shall be done for a period of 1.5 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose.

3.3 Transporting and placing the concrete: The concrete shall be handed from the place of mixing to the final position in not more than 15 minutes by the method as directed and shall be placed into the final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences. The concrete shall be laid in layers of 15 cm to 20 cm.

3.4 Compacting: The concrete shall be rammed rapidly with heavy iron rammers to get the required compaction and to allow all the interstices to be filled with mortar.

3.5 Curing: After the final set, concrete shall be kept continuously wet, if required by pounding for a period of not less than 7 days from the date of placement.

4. Cement Mortar

Valve chamber shall be constructed in brick masonry/bella stone masonry with cement mortar (1:6) unless otherwise specified.

5. Brick Masonry

The valve chamber shall be constructed by locally available brick or bella stone. Brick or Bella stone shall conform to its standard specification. 230 mm thick masonry work shall be carried out for valve chamber of size mentioned in schedule – B in cement mortar CM 1:6. Workmanship for masonry work shall conform to its standard specification.

6. Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green

and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water. Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days. Plastering shall be done on inner face of brick/Bella stone masonry in cement mortar 1:3 and 20 mm thick unless otherwise specified. Plastering work shall be carried out in two layers, to the inner face the first layer being 12 mm thick and the second layer being 8 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

7. Scaffolding For masonry work in chamber, necessary scaffolding shall be carried out.

8. Precast Manhole Frame & cover shall be fixed on cast in situ slab.

9. Deformed / TMT bars conforming to relevant IS of grade Fe 415 shall be used with RCC work for fixing M.H. frame & cover on M.H.

10. Top slab concrete

Precast reinforced concrete slab shall be casted on top of valve chambers in two parts with locking arrangement.

11. Measurement

The payment for valve chamber will be made on No. basis of relative item mentioned in Scheduled-B.

Item No.13

Erection of airvalve riser by installing new MS pipe of 6 mm thick and 3.2 mt length with necessary fittings such as flange of appropriate size, nut bolts and embed the pipe in RCC M:15 with offset of 10 cm around pipe with necessary steel etc complete

Dia of Airvalve 50 mm & MS pipes

- 1The materials shall be carted to store or site of work including all freight, loading, unloading including all taxes, insurance, including necessary jointing materials such as G.I Nipple saddle pieces shall be brought by the contractor for fixing of air valve.
- 1.2A suitable hole shall be drilled on the pipeline. The pipeline shall be of any type such as AC, PVC or CI pipes. A clamp shall be got prepared with a nipple welded on it. The clamp shall be fixed on pipe with bolts and nuts in such a way that the part of nipple fixed in the clamp shall remain in the hole drilled in pipe. The rubber packing shall be provided between the clamps and the pipe. White zinc spun yarn shall be used for fixing the nipple of air valve.
- 1.3Bolt holes shall be drilled according to center- lines. Bolt heads and nuts shall be hexagonal and shall conform to IS: 1363 (specification for black hexagonal bolts, nuts and lock nuts and black hexagonal screws).
- 1.4The neoprene seat ring shall be held security in place under the low pressure cover by jointing support ring to prevent it from sagging when the ball is not soaking the orifice.
- **2.0JOINTING MATERIAL**
- 2.1Jointing material shall be brought by contractor with all necessary joint rings, nuts, bolts and washers for completing the joints on all the flanges of valve supplied under this contract including these flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing material supported under the contract shall be inclusive of rates.
- 2.2Joint rings shall be of flat section at least 3 mm thick. They shall be of rubber in accordance with Is: 638-1965 or its latest edition (specifications for rubber and insertion jointing) of hardness proven in practice so as form a water tight joint and use of jointing paste shall not be allowed.
- Specifications for Air Riser for Pipeline are as under;

For all dia of pipe

- 1) The work of Air valve riser shall be carried out as per the approved drawing and as per the instruction of Engineer in charge
- 2) The work shall be carried out as per the description of the Item
- 3) The M.S. pipe of 6 mm thick shall be 3.20 m Long of As per Drawing dia
- 4) Necessary reinforcement @0.12 % at cross section Area shall be placed in footing and column as per the Grade of RCC Work will be **M:15**
instruction of Engineer in Charge
- 5) Necessary flanges, Nuts, bolts, Clamp and all type jointing materials shall be provided and fixed by agency
- 6) Air valve shall be fixed by agency with jointing materials
- 7) Item includes all type labors, excavation, refilling etc.
- 8) Item includes necessary cost of form work etc.
- 9) Minimum 10cm Offset has to be Provided Both Side of shaft and water main pipeline
- 10) PCC has to be provided at bottom of the Foundation as instruction of Engineer in Charge

18.0 MODE OF MEASUREMENT AND PAYMENT

Measurement shall be paid on number basis as per relevant dia of the item as per payment schedule.

Item 14: -

Excavation for foundation up to 1.5 M. depth including sorting out and stacking of useful materials and disposing of the excavated stuff up to 50-meter lead

Loose or soft soil

Dense or hard Murrum

- (A) Loose or soft soil
 - 1.0. General
 - 1.1. Any soil which generally yields to the application of pickaxes and shovels, phawaras rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam, clay, peat etc., fall under this category
 - 2.0. Clearing the site
 - 2.1. The site on which the structure is to be built shall be cleared, and all obstructions loose stone, materials and rubbish of all kind bush wood and trees shall be remove! as directed The materials so obtained shall be property of the Government and shall be conveyed und stacked as directed within 50 m lead. The roots of the trees coming in the sides shall be cut and coated with a hot asphalt
 - 2.2. The rate of side clearance is deemed to be included in the rate of earth work for which no extra will be paid.
 - 3.0. Setting out After clearing the site the center lines will be given, by the Engineer-in-charge. The contractor shall assume full responsibility for alignment, elevation and dimension of each and all 'parts of the work. Contractor shall supply labours materials, etc. required for setting out the reference marks and bench 'marks and shall maintain them as long as required and directed.
 - 4.0. Excavation The excavation in foundation shall be carried out in true line and level and shall have the width and depth as shown in the drawings or as directed. The contractor shall do the necessary shoring and shutting or providing necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately it not specified. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required No. earth filling will be allowed for bringing it to level If by mistake or any excavation is made deeper or wider than, that shown on the plan or directed. The extra depth or width shall be made up with concrete of same proportion as specified for the foundation concrete at the cost of the contractor. The excavation up to 1.5 m depth shall be measured under this item.
 - 5.0. Disposal of the excavated stuff
 - 5.1. The excavated stuff of the selected type shall be used in filling the trenches and plinth or leveling the ground in layers including ramming and watering etc.
 - 5.2. The balance of the excavated quantity shall be removed by the contractor from the site of work to a place as directed with lead up to 50 M. and all lift.
 - 6.0. Mode of measurements & payment

- 6.1. The measurement of excavation in trenches for foundation shall be made according to the sections of trenches shown on the drawing or as per sections given by the Engineer-in-charge. No payment shall be made for surplus excavation made in excess of above requirements or due to stopping and sloping back as found necessary on account of conditions of soil and requirements of safety.

- 6.2. The rate shall be for a unit of one cubic meter

B) Hard murrum.

The hard murrum shall be clean of good binding quality and of approved quality obtained from approved quarries of disintegrated rocks which contain son's materials and natural mixture of clay of clastic origin. The size of hard murrum shall not be more than 20 mm.

- 2.0. Workmanship The relevant specification of item No.12 (A) shall be followed except that the excavation work shall be carried in hard murrum.
- 3.0. Mode of measurements & Payments
- 3.1. The relevant specifications of item No.12 (A) shall be followed.
- 3.2. The rate shall be for a unit of one cubic meter.

Item No 15: -

Providing and laying cement concrete 1:3:6 (1- Cement: 3- Coarse sand: 6- Graded brick bat aggregate 40mm normal size) and curing complete excluding cost of formwork in (A) Foundation and Plinth

- 1.0. Materials:

- 1.1. Water:

Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of concrete or cause efflorescence or attack the steel in R.C.C. Potable water will generally be found suitable for curing, mortar or concrete.

- 1.2 Sand:

Sand shall be natural sand, clean, well graded hard strong, durable and gritty particles free from injurious amounts of dust, clay kankar nodules, soft or flaky particles shale, alkali salts organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-Charge.

- 1.3 Stone Aggregate:

Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

The aggregate shall generally be cubical in shape unless special stones of particular quarries are mentioned. Aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement and ordinary reinforced cement concrete shall be generally as per IS 456.

Cement:

Cement shall be ordinary Portland slag cement as per I.S.269-1976 or Portland slag cement as per I.S. 455-197

- 2.0 Workmanship:

- 2.1 General:

Before starting concrete bed of foundation trenches shall be cleared of all loose materials, levelled, watered and rammed as directed.

- 2.2 Proportion of Mix: The Proportion of cement, sand and coarse aggregate shall be one part of cement, 3 parts of sand, 6 parts of stone aggregates and shall so measured by volume.

- 2.3 Mixing: The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quantity of work if approved by the Engineer-in-charge. When hand mixing is permitted by the engineer-in-charge in case of break-down of machineries and in the interest of the work, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mixing in mechanical mixer shall be done for a period 1 to 2 minutes. The quantity of water shall be sufficient to produce a dense concrete of required workability for the purpose.

- 2.4 Transporting & placing the concrete: The concrete shall be handled from the place of mixing to the final position in not more than 15 minutes by the method s directed and shall be placed into its final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences. The concrete shall be laid in layers of 15 cms to 20 cms.

- 2.5 Compacting: The concrete shall be rammed with heavy iron rammers and rapidly to get the required compaction and allow all the interstices to be filled with mortar.
- 2.6 Curing: After the final set, the concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.
- 3.0 Mode of measurement and Payment:
The concrete shall be measured for its length breadth and depth, limiting dimensions to those specified on plan or as directed. Measurement are taken per Cubic meter.

Item No.16 :-

Uncoursed Rubble Masonry with hard stone of approved quality in foundations and plinth in Cement Mortar 1:6 (1-cement : 6-coarse sand including levelling up etc. complete

1.0. Materials:**1.1. Water:**

Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of concrete or cause efflorescence or attack the steel in R.C.C. Potable water will generally found suitable for curing, mortar or concrete.

1.2 Sand:

Sand shall be natural sand, clean, well graded hard strong, durable and gritty particles free from injurious amounts of dust, clay kankar nodules, soft or flaky particles shale, alkali salts organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-Charge.

1.3 Stone Aggregate:

Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

The aggregate shall generally be cubical in shape unless special stones of particular quarries are mentioned. Aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement and ordinary reinforced cement concrete shall be generally as per IS 456.

Cement:

Cement shall be ordinary Portland slag cement as per I.S.269-1976 or Portland slag cement as per I.S. 455-197

2.0. Workmanship**2.1. Dressing of stones:**

Stone used for Uncoursed rubble masonry work shall be hammer dressed on the sides, and beds in which such a way as to close with the adjacent stone in the masonry work as strongly as possible. The face stones shall be dressed in such a manner as to give a specified pattern such as polygonal facing etc. The face of the stones shall be so dressed that bushing on the exposed face shall not project by more than 40 mm. from the general wall surface and on the face to be plastered, it shall not project by more than 19 mm., not shall have depressions more than 10 mm. from the average wall surface.

2.2. Laying:

All the stone shall be sufficiently wetted before laying to prevent absorption of water from mortar. The wall shall be built true to plumb (or true to required batter when so specified). All connected walls in a structure shall be raised up informally and regularly. However if for any specific reason, one part of masonry is required to be left behind, the wall shall be racked back at an angle not steeper than 45. Vertical toothed joints in masonry shall not be allowed. The work shall be carried out regularly and masonry of any day wall not be raised by more than 1 meter in height.

- 2.3. The stone shall be laid in an Uncoursed fashion, or random facing etc. However the masonry is required "4 to be brought to level at various stages viz. plinth level window sill level, roof level and any other level specifically shown line the drawings. This may be done first by adjusting the laying of stone to one level and then by providing leveling course of cement concrete 1:6:12 (1 cement: sand: 12 graded stone aggregate 20 mm. nominal size) or as otherwise specified.

- 2.4. Proper bonding shall be achieved by closely filling in adjacent stones as well as by using bond stones or through stones as described herein below. Face stones shall extend back sufficiently, and bond well with the masonry. The stone shall be carefully set so as to break joints and avoid formation of vertical joints. The depth of stone from the face of wall inwards shall not be less than weight or breadth at the face. The hearing or interior filling of the wall shall consist of rubble stones which may be of any shape. Neither the face stone nor the hearing stone shall be so small to pass through circular ring of 150 mm. internal diameter in any direction nor shall any of them shall have minimum thickness 100 mm.

- 2.5. All stone shall be carefully laid, hammered down by a wooden mallet into position and solidly embedded in mortar, chips and spawns of stone may be used wherever necessary to avoid thick mortar bends or joints at the same time ensuring

that no hollow space is left anywhere in the masonry. The chips used shall not be more than 20% by volume of masonry. The hearting shall be laid nearly level with face stones except that at about one meter intervals vertical bond stone or plumes projecting about 150 to 200 mm. shall be firmly embedded to from vertical bounding in masonry.

2.6. Bond stone:

Bond stones or through stones running right across the thickness of the wall shall be provided in wall upto 600 mm. thick. In thicker walls two stones overlapping each other by atleast 150 mm. shall be provided across the thickness of the wall to form bond stones. There shall be atleast one bond stone for every 0.5 sq. mtr of wall surface. The bond stone shall be marked by a distinguishing letter during construction for subsequent verification and shall be laid staggered in subsequent layers.

2.7. Quoins:

The quoins or corners stones shall be selected stone neatly dressed with hammer and/or chisel to form the required corner angle and laid header and stretcher alternatively. The bed top surface of quoins shall be chiseled dressed to give horizontal joints. The quoins shall have a uniform chisel draft of atleast 25 mm. width at four edges of each exposed face, all the edges of the same face being in one plane. No quoins stone shall be smaller than 0.025 cum. in volume.

2.8. Jamb Stones:

The jamb stone shall be made with stone specified for quoins, that the stone provided on the jambs shall have their length equal to thickness of wall upto 600 mm. and a line of headers shall be provided for walls thicker than 600 mm. as specified for bond.

2.9 Mode of measurement and Payment:

Measurement are taken per Cubic meter.

Item No 17: -

Filling available excavated earth (excluding rock) in trenches. plinth, sides of foundations etc. in layers not exceeding 20 cm. in depth consolidating each dispirited layer by ramming and watering.

Workmanship

The earth to be used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken.

As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc., and filled with earth in layers not exceeding 20 cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with but ends of crow-bars, where rammer cannot be used.

The plinth shall be similarly filled with earth in layers not exceeding 20 cms adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

The finished level of filling shall be kept to shape intended to be given to floor.

The excavated stuff of the selected type shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.

Mode of Measurements & Payment

The payment shall be made for filling in plinth and trenches. No deduction shall be made for shrinkage or voids, if consolidated as instructed above. The rate shall be for a unit of one cubic meter.

Item No 18: -

Precast concrete block masonry (including quoin blocks jamb blocks closer etc.) with solid concrete blocks of approved size made of cement concrete 1:3:6 mix (1- Cement: 3 coarse sand: 6- graded stone aggregates of 20 mm and down grade) cement mortar 1:6

- in foundation and plinth
- For Super structure above plinth

Stone Coarse Aggregate for Nominal Mix Concrete

coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar

The aggregate shall generally be cubical in shape Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement and ordinary reinforced cement concrete shall generally be as per the table given below.

However, in case of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6- mm. less than the cover whichever is smaller.

I S. Sieve	Percentage passing for single Designation Sized aggregates of Nominal size				I S. Sieve	Percentage passing for single Designation Sized aggregates of Nominal size			
	40 mm	20 mm	16 mm		40 mm	20 mm	16 mm	80 mm	
-	12.5 mm	-	-	- 63 mm	100	-	-	-	-
0.20	40 mm	85-100	100	-	4.75 mm	-	0.5	0.5	20 mm
0.20	85-100	100	2.35 mm	-	-	16 mm	85-100		

Note: This percentage may be varied some what by the Engineer-in-charge when considered necessary for obtaining better density and strength of concrete.

The grading test shall be taken in the beginning and at the change of source of materials. The necessary tests, indicated in I.S. 383-1970 and 456~197f shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If she aggregates are covered with dust, they shall be washed with water to make them clean.

(b) Sand as per Item No. 10s

(c) Cement

Cement shall be ordinary Portland slag cement as per I.S.269-1976 or Portland slag cement as per I.S. 455-1976

- 1.1. The solid cement concrete blocks shall be precast with concrete of 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate)
- 1.2. A block shall be deemed to be solid if the solid materials is not less than 75% of the total volume of the blocks calculated from overall dimensions.
- 1.3. The concrete mix used for block shall be one of the following:
- 1.4. The actual size of the block shall be one of the following: Size: A. 39 x 30 x 19 cms. Size-B 39 x 20 x 19 cms. Size C 39 x 10 x 19 cms. The size other than those specified above may be used with the approval of Engineer-in-charge.
- 1.5. The blocks may be either machine made or hand made. The concrete mix, the mixing of concrete the manufacture of blocks, curing and drying shall be in accordance with para-6 to 10 under I.S.: 2185-1967.
- 1.6. Faces of blocks shall be flat and rectangular Surface finish shall be rendered smooth or plastered with cement mortar 1:3 coarse sand)
- 1.7. The average compressive strength of eight blocks when determined in the manner described-in I.S. 2185 - 1967 shall not be less than 50 Kg/Sq. Cm. of gross area. The strength of lowest individual block shall not be less than 75 percent of average compressive strength of eight blocks.
- 1.8. Concrete blocks shall be stored and stacked properly in such a way as to avoid any contact with moisture at site. They shall be stock plied on planks or other supports free from contact with ground and covered to protect against wetting. Cement mortar of proportion 1:6 shall conform to M-11. As per
- 2.0. Workmanship
- 2.1. The blocks need not wetted before or during laying in the walls. In case climatic conditions so required, the top and the sides of block may only be slightly moistures so as to prevent absorption of water from the mortar and ensure the development of required bond with mortar.
- 2.2. Operations of laying precast cement concrete block masonry shall be carried out in accordance with instructions detailed in I.S.: 6042 -1952. The mortar shall not be spread so much ahead of the actual laying of the units that it tends to stiffen and loose, its plasticity, thereby resulting in poor bond. For most of the work, the joints, both horizontal and vertical shall be 10 mm. thick except in the case of extended joint, construction, the mortar joints shall be struck off flush with wall surface and when the mortar has stated stiffening, it shall be compressed with rounded or U-shaped tool. The mortar shall be

- pressed against the units with a jointing tool after the mortar has stiffened in effect intimate contact between the mortar and the masonry unit and obtained a weather tight joint. 61
- 2.3. Quoins and closures: Special quoins blocks (with a return face equal to half the length of normal face) shall be cast for all building blocks and slabs for external work. Proper half closures shall be cast and not cut from full size blocks. The returned ends of blocks for door windows reveals and quoins shall be finished with a fair face in the mould.
- 2.4. Only double scaffolding shall be used. The scaffolding be strong and sound. No holes in the masonry for supporting shall be allowed.
- 2.5. curing: The curing of concrete block masonry shall be carried out for 7 days.
- 3.0. Mode of measurements & payment
- 3.1. All work shall be measured on the basis of finished dimensions and measured net except where otherwise specified. Only specified dimensions shall be allowed. Anything extra shall be ignored. The masonry work in foundation and plinth shall be measured under this item. No deduction shall be made, not extra payment made for the following:
- (a) Ends of joints, beams, spots, girders, rafters, purlins, trusses, corbels, etc. each up to 500 sq. cm. in section.
 - (b) Opening each up to 0.1 sq.mt.
 - (c) Wall plates and bed plates, bearing of chhaja and like up to 10 cm. depth (bearing of floor and roof slabs shall be deducted from masonry).
 - (d) Drain holes and recesses for cement concrete blocks to embed hold fasts for doors windows.
 - (e) Building in the masonry iron fixtures pipes up to 300 mm. dia. hole fasts of doors and windows.
 - (f) Forming theses in masonry up to section of 350 sq.cm.
- 3.2. The work of concrete block masonry in foundation and plinth shall be measured under this item.
- 3.3. The rate shall be for a unit of one cubic meter

Item No 19: -

Providing and laying cement concrete flooring 1:2:4 (1-cement: 2-coarse sand: 4-graded stone aggregate 20mm nominal size) laid in one layer and finished with a floating coat of neat cement. (B) 50mm thick

1.0. Materials:

1.1. Water:

Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of concrete or cause efflorescence or attack the steel in R.C.C. Potable water will generally found suitable for curing, mortar or concrete.

1.2 Sand:

Sand shall be natural sand, clean, well graded hard strong, durable and gritty particles free from injurious amounts of dust, clay kankar nodules, soft or flaky particles shale, alkali salts organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-Charge.

1.3 Stone Aggregate:

Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

The aggregate shall generally be cubical in shape unless special stones of particular quarries are mentioned. Aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement and ordinary reinforced cement concrete shall be generally as per IS 456.

1.4 Cement:

Cement shall be ordinary Portland slag cement as per I.S.269-1976 or Portland slag cement as per I.S. 455-1976

2.0 Workmanship:

2.1 General:

Before starting concrete bed of foundation trenches shall be cleared of all loose materials, levelled, watered and rammed as directed.

2.2 Proportion of Mix: The Proportion of cement, sand and coarse aggregate shall be one part of cement, 2 parts of sand, 4 parts of stone aggregates and shall so measured by volume. total thickness of the flooring shall be kept 50mm.

2.3 Mixing: The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quantity of work if approved by the Engineer-in-charge. When hand mixing is permitted by the engineer-in-charge in case of break-down of machineries and in the interest of the work, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However such

cases 10% more cement than otherwise required shall have to be used without any extra cost. The mixing in mechanical mixer shall be done for a period 1 to 2 minutes. The quantity of water shall be sufficient to produce a dense concrete of required workability for the purpose.

- 2.4 Transporting & placing the concrete: The concrete shall be handled from the place of mixing to the final position in not more than 15 minutes by the method s directed and shall be placed into its final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences. The concrete shall be laid in layers of 15 cms to 20 cms.
- 2.5 Compacting: The concrete shall be rammed with heavy iron rammers and rapidly to get the required compaction and allow all the interstices to be filled with mortar.
- 2.6 Curing: After the final set, the concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.

3.0 Mode of measurement and Payment:

The concrete shall be measured for its length breadth and depth, limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one square meter.

The concrete shall be consisting of one part of approved quality cement with two parts of clean and angular sand without parts of coarse aggregates of 12mm to 20mm size.

Portable water shall be added as per required quantity and shall be mixed in best work manlike manner.

Necessary form work shall be done by the contractor. Lining work shall be carried out as per instruction of Engineer-in-Charge.

The entire work shall be cured at least for 14 days the total thickness of the flooring shall be kept 50mm.

The rate includes all materials labour for mixing finishing, lining curing form work etc. complete

The rate shall be paid per one square meter.

ITEM NO 20: -

Providing 15mm thick cement plaster in single coat on Rough (Similar)side of single or half brick walls for interior plastering upto floor two level and finished even and smooth in (i) Cement mortar 1:4 (1-cement:4-sand)

1.0 Materials

- 1.1 Water: Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of concrete or cause efflorescence or attack the steel in R.C.C. Potable water will generally found suitable for curing, mortar or concrete.

- 1.2 Cement mortar of proportion 1:6 shall conform to its relevant IS

2.0 Workmanship

- 2.1 Scaffolding: Wooden bullies, bamboos, planks, trestles and other scaffolding shall be sound. These shall be properly examined before erection and use. Stage scaffolding shall be provided for ceiling plaster which shall be independent of the walls.

- 2.2 Preparation of back-ground: The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing.

Smooth surface shall be toughened by wire brushing if it is not hard and by hacking if it is hard. In case of concrete surface, if a chemical retarded has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the readers if left on the surface. Trimming of projections on brick/concrete surfaces where necessary shall be carried out to get an even surface. Raking of joints in case of masonry where necessary shall be allowed to dry out for sufficient period before carrying out the plaster work. The work shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry, such area shall be moistened again. For external plaster, the plastering operation shall be started from top floor and carried downwards. For internal plaster, the plastering operations may be have started wherever the building frame and cladding work are ready and the temporary supports of the ceiling resting on the wall of the floor have been removed. Ceiling plaster shall be completed before starting plaster to walls.

2:3 Application of plaster:

The plaster about 15x15 cms shall be first applied horizontally and vertically at not more than 2 meters intervals over the entire surface to serve as gauge. The surfaces of these gauges shall be truly in plane of the finished plastered surface. The mortar shall then be applied in uniform surface slightly more than the specified thickness, then brought to a true surface

by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally, the surface shall be finished off true with a trowel or wooden float according as a smooth or a smooth or a sandy granular texture is required. Excessive troweling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Hounding or chamfering, corners, arises junctions etc. shall be carried out with proper templates to be size required. Cement plaster shall be used within half an hour after addition of water. And mortar or plaster which is partially set shall be rejected and removed forthwith from the site. In suspending the work at the end of the day, the plaster shall be left out clean to the line both horizontally and vertically, when recommencing the plaster, the edges of the old work shall be scraped clean and wetted with cement putty before plaster is applied to the adjacent areas to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and nearer than 15 cm. to any corners or arises. It shall not be closed on the body of features such as plaster bands and cornices not at the corners or arises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakage. No portion of the surface shall be left out initially to be packed up later on. Each coat shall be kept damp continuously till the next coat is applied or for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking of walls shall be avoided and only as much water as can be readily absorbed shall be used, excessive evaporation on the sunny or windward side of building in hot air or dry weather shall be prevented by hanging matting or gunny bags on the outside of the plaster and keeping them wet.

3.0. Mode of measurements & payment

The rate shall include the cost of all materials, labour and scaffolding etc. involved in the operations described under workmanship. All plastering shall be measured in square meters unless otherwise specified. Length breadth or height shall be measured correct to a centimetre. This item includes plastering up to floor two levels.

The rate shall be for a unit of one sq. meter.

ITEM NO 21:-

Finishing wall with water proofing cement paint of on wall surfaces (Two coats) to give an approved brand and manufacture and of required shape even shade after thoroughly brushing the surface to remove all dirt and remains of loose powered materials.

1.1. Materials

1.1. The clear colle shall be made from glue and boiling water by mixing. 1 Kg mixture shall be suitably tinted where required for use under coloured distemper if directed. Glue shall conform to I.s. 852-1969

(Specifications for animal give).

1.2. Lime used shall be Freshly burnt class "C Lime (fat lime) and white in colour conforming to I.S .712- 1973. Water shelf conform to M-1 Best quality of gum shall be used in the preparations of white wash. Ultramarine blue or Indigo: This shall conform to f.S. 55-1970 for points, and shall be used for preparation of white was, Pigments. Mineral colours, not affected by lime shall be used in preparing colour wash.

2.0. Workmanship

2.1. Preparation of white v/ash solution: Surface already white or colour; The fat lime shall be slaked as site and shall be mixed and stirred with about five liters of water for 1 kg. of unslaked lime to made a thin cream. This shale be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth, 4 Kg. of gum dissolved in hot water shall be added to each cubic meter of lime cream. Small quantity of ultramarine blue (Up to 3 gms. per kg. of lime) shall also be added to the last two coats of white wash solution and the whole solution shall be stirred thoroughly before use

2.2. Preparation of surface:

2.2.1. The surface shall be thoroughly cleaned of all dust, dirt, mortar cropping's and other foreign matter before white wash is to be applied.

2.2.2. The surface spoiled by smoke soot shall be scrapped with steel wire brushes or steel scrapers or shall be rubbed with over-burnt surkhi or brick bats. The surface shall be then boomed to remove all dust, dirt and shall be washed with clean water.

2.2.3. Oil or grease spots shall be removed by suitable chemical and smooth surface shall be rubbed with wire brushes -

2.2.4. All unsound portion of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the masonry joints properly. Such portion shall be wetted and allowed to dry. They shall then be given one coat of white wash.

2.2.5. All unnecessary nails shall be removed, the holes, cracks, patches etc. shall be made good with material similar in composition to the surface to be prepared

2.3. Scaffolding:

Wherever scaffolding is necessary it shall be erected in such a way that as far as possible on part of scaffolding shall rest against the surface to be white r>r colour washed. A properly secured strong and well tied suspended platform (Zoie) may

be used for white washing. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the floors and walls. For white washing of ceilings, proper stage scaffolding shall be erected where necessary.

2.4. Application of white wash :

2.4.1. On the surface so prepared the white wash shall be applied with 'Moon' brush. The first stroke of the brush shall be from top downwards, another from bottom upwards over the first stroke and similarly one stroke from the right another from the left, over the first stroke brush before it dries. This will form one coat. Each coat shall be allowed to dry before and uniform finish free from brush marks and it should not come off easily when rubbed with finger.

2.4.2. Splashing and dropping if any on the doors and windows, ventilators etc. shall be removed and the surface cleaned.

2.4.3. Priming and Alkali resistant treatments, scraping of surface washing etc. surface spoiled by smoke soot removed of oil and grease spots, treatment for infection with efflorescence moulds, mosses, fungi, algae and Kitchen and patch repairs to plaster wherever done shall not be paid extra.

The rate shall be for a unit of one sq. meter.

Item No 22:-

Providing and fixing at site of work MS Door, Window etc with Rly freight, loading, unloading, carting & all taxes etc complete as directed including paints 2 coats etc completed.

M.S. Door and window to be supplied and fixed in this pump room shall be of ISI marked only. Door and window shall be designed for manual operations, unless specified otherwise. These will be tested at the manufacturer's shop and such test certificate shall be provided on demand. All packing glands shall permit replacement of packing while the Door and window is on lines. MS Door and window should have open/close rotational directions marked clearly on the wheels. Manual operation of Door and window shall be possible against the maximum unbalanced head. Oil paints shall be of the specified colour and as approved. The ready mixed paints shall only be used. However, if ready mixed paint of specified shade or tint is not available white ready mixed paint with approved stainer will be allowed. In such a case the contractor shall ensure that the shade of the paint so allowed shall be uniform. 2 coat of paint shall be applied on MS Door and window. There is no extra payment for colour work. The Door and Window shall be fixed at the site of work and no extra payment will be made for replacement of old Gate. The rate shall include the cost of all materials and labour involved in all the operations described above.

The rate shall be paid per Kg.

Item No 23: -

Providing corrugated G.I. sheet of class-3 roofing fixed with galvanized iron J or L Hooks, Bolts and nuts 8mm diameter with bitumen and G.I. limpet washer or G.I. limpet washer. filled with white lead complete excluding the cost of purlins, Rafters and Trusses. (1) 0.80 mm thick sheet

1.0. Materials

1.1. The G.I. sheet overall in galvanized plain sheet of 0.8 mm. thickness shall be of class-3. The sheet shall be wide overall and flashing shall be 380 mm. wide overall. There shall be bent to the required shape without damage to the sheets in the process of bending.

2.0. Workmanship

2.1. Spacing of purlins: One purlin shall be provided at the ridge and one at the eaves. The spacing of other purlins for 0.8 mm. thick G.I. sheets shall not exceed 1.80 meters. The purlin shall coincide with the center line of the end lap. The ridge purlins shall be placed in such a way that the ridges can be fixed properly. The portion overhanging the wall support shall not be more than one fourth of the 'spacing of purlins'.

2.2. The top surfaces of the purlins shall be painted before the sheets are fixed over them. Embedded portions of purlins shall be finished with two coats of coal-tar.

2.2. Wherever the edge of a roof sheeting or valley gutter is turned up against a wall, the edge shall be weather proofed with a flashing. Flashing shall be bent to shape and fixed. Lap over the sheet shall be not less than 150 mm. over the roofing sheets. The end between the flashing sheets shall not less than 225 mm.

2.3. The flashing shall be inserted into brick work or masonry joints to a depth of 50 mm. These joints shall be filled with cement mortar (1:3). The flashing shall be well secured to the masonry. Whenever flashing has to be laid at a slope, it shall be stepped at each course of masonry, the step being out back at angle or not less than 30 degrees to the vertical.

2.4. Sheet shall be bent to shape and shall have end lap projection on either side under C.G.I. sheet not less than 225 mm. Sheet shall be fixed to the roof member below, with same 8 mm. dia. G.I. hook, bolts and nuts and bitumen and G.I. limpet washer which fix the sheets to these members. At least one of the fixing bolts shall pass through the end laps of the valley

piece. If necessary extra bolts shall be provided for this purpose.

3.0. Mode of measurements and payment

3.1. The measurements for valley shall be taken for finished work in length along their center lines.

3.2. No laps shall be measured.

3.3. The rate excludes the cost of boarding underneath which shall be paid separately.

3.4. The rate of flashing includes the cost of mortar for fixing in wall and other labour and materials required for it.

3.5. The rate shall be for a unit of one Square meter.

~~SPECIFICATIONS~~

~~SECTION – B3 PUMPING MACHINORY~~

~~VOLUME – II (E)~~

~~TECHNICAL SPECIFICATIONS (SITC SECTION)~~

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Brief Description of the Project

The mechanical & electrical part of the project covers design, engineering, manufacture, supply, installation, testing & commissioning of **Horizontal mono submersible pump set** as specified here in along with associated mechanical and electrical equipment, instruments & accessories.

Extent of Work

The scope includes design, engineering, supply, installation, testing & commissioning of **Horizontal mono submersible pump set** at various pumping stations (head works/sub head works) of regional water supply scheme included in the scope of the tender.

Designing, procuring, erection & Commissioning of Pumping machinery & allied works

Sr. no.	Details of Pumping Station	Type of pump	Head in m.	Discharge in CUM/HR	No. of W+SB	Min. KW	Total KW
±	AS PER SCHEDULE						

MECHANICAL WORKS

- (a) ~~Design & supply of Horizontal mono submersible pumpsets shall be as per relevant IS.~~
- (b) ~~Valves {Butterfly / Sluice valve / Reflux (Non Return)} with Pressure Nomenclature of **PN 1.0** as the case may be.~~
- (c) ~~M S pipe work (individual discharge – common discharge header and by pass line) with specials.~~
- (d) ~~MS pipe work on individual discharge – common discharge header with specials.~~
- (e) ~~pressure gauges on individual pump discharge & common discharge header.~~
- (f) ~~Installation, testing, pre commissioning checks and commissioning of the above equipment and accessories.~~
- (g) ~~Submission of data sheets, QAP, GA drawing, cross section drawing, layout drawings of all equipment and to get final approval from Executive Engineer (Mechanical).~~

ELECTRICAL WORKS

~~(a 1) Automatic power factor correction panels with capacitor banks in required steps at **Various Pumping Stations.**~~

~~(c) Grounding (earthing) system with accessories.~~

~~(f) Power (HV & LV) and control cables with jointing kits and accessories including cable carrier system.~~

~~(g) General lighting arrangement with accessories.~~

~~(h) Safety accessories with exhaust fans. (If applicable)~~

~~(i) Installation, testing & commissioning of all above equipment & accessories.~~

~~(j) Liaison with power utility i. e. GEB & other concerned department, carry out entire procedure for approval including preparation of electrical installation drawing and procuring NOC from Electrical Inspector for release of power etc.~~

~~(k) Submission of data sheets, QAPs, GA drawings, cross section drawings, layout drawings of all equipment and to get approval of same.~~

CIVIL WORKS

~~(a) Construction of cement concrete foundation blocks for pump and motor sets, thrust blocks and supports for pipe work.~~

~~(b) Drawing of holes in sumps, pump house etc. for pipes & plugging them properly.~~

~~(c) Construction of pedestal (plate form) for transformer, grouting blocks for DP structure & chain link fencing.~~

CONCEPTUAL DESIGN REPORT

~~The scope includes preparation of conceptual design report furnishing all details regarding design & engineering of Horizontal Mono Submersible Pump sets with motors for CLEAR WATER including all associated mechanical & electrical as per relevant & applicable governing standards & as per prevailing best engineering practices.~~

~~Duty parameters of Horizontal Mono Submersible Pump type pumps along with rating of prime mover including total quantities with working + standby configuration for all pumping stations and pumping sections are as per detail site survey. All associated and required electrical & mechanical equipment, accessories etc. of required capacities / ratings / sizes / quantities are deemed to have been included in the scope of the tender.~~

~~Sizes and ratings of all major equipment, components and accessories keeping in view the duty parameters i. e. Q (flow) & (H) head of each pump set of concerned pumping stations are in tender documents. In case of any change in these parameters subsequently, all other dependent associated mechanical, electrical etc. will also change to suit the actual requirements. Any and all such required/desired changes/modifications/improvements shall have to be incorporated in CDR. Unit for payment is on as per price bid basis and hence payment shall be made as per actual total KWs for relevant pumping station. However, claim either in the form of excess quantities or extra items on account of any item shall not be admissible and shall not be entertained by the department under any circumstances. All major items are enlisted herein. All sub-assemblies, components and minor items like packing/jointing sheets materials, fasteners, sundry items etc. are deemed to have been included in the scope of this turnkey project. Any item(s) not included or specified explicitly but is required to complete the project & also give stated performance is (are) deemed to have been included & shall fall within the scope of work without any additional cost to GWSSB.~~

~~CDR is to be designed assessing all particular requirements of water supply pumping system as per best prevailing practices and all relevant and applicable latest standards of all equipment & accessories. The same shall be submitted to the designated PMC for scrutiny & acceptance. PMC shall submit the same with recommendation for final acceptance & approval to the designated Executive Engineer (Mechanical). Final approval shall be accorded by the Executive Engineer (Mechanical), the overall project execution in charge. EE (Mechanical) may suggest modifications, improvements & required changes which the agency shall incorporate in the CDR before getting final approval.~~

MECHANICAL SECTION

~~HMSF AS PER ATTACHED DATA SHEETS:~~

~~NOTE:~~ Duty parameters of **~~HMSF~~** type pumping machinery are based on preliminary data and may change depending on several factors. Detailed working survey (post award of tender) as well as accurate measurement of reference levels, locations of pumping stations, L section of proposed new rising main & pipe lines as well as addition / deletion / modification of required flow may result in change in duty parameters i. e. Discharge (Q) and Head (H) necessitating consequent change in kW rating of drive motors. Efficiency of pumps shall not be less than that of minimum acceptable efficiency as per HIS. Reserve power margins shall be applicable as per CPHEEO guidelines and minimum acceptable efficiency for motors shall be efficiency class 3 (IE 3) except polder & SCF pump motors.

~~VALVES, EXPANSION BELLOWS, PIPE MANIFOLD SYSTEM & SPECIALS~~

~~Sluice and Reflux valve on individual delivery side; and, Sluice valve and Reflux valve are to be provided on common discharge header as per relevant governing standards of minimum pressure nomenclature of PN 1.0.~~

~~All sluice valves of size 600 mm & above shall be electric actuator operated only.~~

~~Velocity to be considered for sizing of valves on suction side shall be less than 1.5 meters/second and for individual discharge it shall be comfortably less than 2.5 meters/ second. For common suction header and & common discharge header pipes the same shall be respectively less than 0.75 and 1.20 meters/second. Sizing of valves & pipes shall be carried out on liberal basis.~~

~~Single metallic (Stainless Steel) corrugated expansion bellows of PN 1.6/1.0 class on suction, delivery and common discharge header are to provided matching exactly the size & PN rating of valves. (If applicable).~~

~~All valves and expansion bellows shall be double flanged with required flange drilling as per relevant governing standards.~~

~~Sluice valve on by pass pipe on common discharge header shall be provided which shall not be less than 25% of cumulative flow of working pumps. For by pass pipe line on common discharge headers velocity shall not exceed 3 meters/second.~~

~~Size of suction header, suction, individual delivery and common discharge header pipe shall match with that of valves. MS pipes as per relevant governing standards are to be provided of required thickness. Sizing of pipes shall be carried out on liberal basis.~~

~~Size of individual suction pipe shall always be greater than individual delivery pipe for all pumps.~~

~~All required flanges & specials shall be made from MS. Specials include suction bell mouth, suction strainers, concentric & eccentric reducers/enlargers, bends, flanges of required thickness etc.~~

ELECTROMAGNETIC FLOW METER (If applicable)

~~Full bore electromagnetic flow meters on common discharge headers are to be provided of identical size (Diameter NB) of common discharge header with matching PN rating i.e. PN 1.6/PN 1.0. Each common discharge header of each pumping section must be provided with full bore (i.e. identical size) flow meters.~~

~~Constant voltage stabilizer (CVT) has to be provided with each flow meter. Length of shielded cable shall be as per actual requirement and must be in single piece only.~~

MATERIAL HANDLING SYSTEM (If applicable)

~~Electrically operated single girder crane (EOT) of capacity as mentioned below with all accessories including crane rails and fixtures and shall conform to IS: 15560 or relevant nationally/internationally approved standards along with provision for suitable remote operation is also to be made at 1. Various Pumping Stations, Capacity of EOT (circular type if needed) shall be Minimum as per price bid.~~

ELECTRICAL SECTION**HV & LV POWER, CONTROL & INSTRUMENTATION CABLES, CABLE CARRIERS & ACCESSORIES**

~~Suitably sized HV XLPE insulated multi stranded Aluminium conductor armoured 3 core 11 KV (E) grade power cables are to be provided in single length along with indoor/outdoor standard termination/jointing kits in required quantities.~~

~~A spare HV cable along with indoor/outdoor jointing kits duly fitted (ie ready to use) as directed by Engineer in charge/Electrical Inspector/UGVCL etc. shall also be within the scope of electrical works.~~

~~Suitably sized LV XLPE insulated multi stranded Aluminium conductor armoured 3.5 core power cables in required number of runs are to be provided in single length from transformer to PMCC panels along with jointing kits.~~

~~Suitably sized LV XLPE insulated multi stranded Aluminium conductor armoured 3 core power cables in required number of runs are to be provided in single length from PMCC panels to individual motors along with jointing kits.~~

~~Suitably sized LV XLPE insulated multi stranded copper conductor 4 core power cables in required number of runs are to be provided in single length from PMCC panels to individual auxiliaries like EOT, Actuators, Plant & Premises lighting etc. along with jointing kits.~~

~~Sizing of cables are to be done by considering all applicable de-rating factors (viz. temperature, bunching spacing thereof, short circuit current, method of installation etc.) as per governing standards. Further voltage drop of the selected size of cables shall also be within the permissible limits as prescribed in governing standards.~~

~~Suitable sized Aluminium/Copper cable glands & lugs in required quantities shall also have to be supplied.~~

~~Suitable sized copper control & instrumentation cables shall also be provided as per actual requirements.~~

~~All cables within pump house shall be erected on suitably sized FRP/GI cable trays of required thickness & width sufficient to accommodate cables properly.~~

~~HV & LV POWER, CONTROL CABLES, CABLE CARRIERS & ACCESSORIES~~

~~Suitable sized HV XLPE insulated multi stranded Aluminium conductor armoured 3 core 11 KV (E) grade power cables are to be provided in single length along with indoor/outdoor standard termination / jointing kits in required quantities. Spare line of HV cable with joint kits (in ready to use condition) shall also be provided from Discom's i.e. UGVCL's two pole structure to Client i.e. GWSSB's two pole structure.~~

~~Suitable sized LV XLPE insulated multi stranded Aluminium conductor armoured 3.5 core power cables in required number of runs are to be provided in single length from transformer to PMCC panels along with jointing kits.~~

~~Suitable sized LV XLPE insulated multi stranded Aluminium conductor armoured 3 core power cables in required number of runs are to be provided in single length from PMCC panels to individual motors along with jointing kits.~~

~~Suitable sized LV XLPE insulated multi stranded copper conductor 4 core power cables in required number of runs are to be provided in single length from PMCC panels to individual auxiliaries like EOT, Plant & Premises lighting etc. along with jointing kits.~~

~~Sizing of cables are to be done by considering all applicable de-rating factors (viz. temperature, bunching, spacing thereof, short circuit current, method of installation etc.) as per governing standards. Further voltage drop of the selected size of cables shall also be within the permissible limits as prescribed in governing standards.~~

~~Suitable sized Aluminium/Copper cable glands & lugs in required quantities shall also have to be supplied.~~

~~Suitable sized copper control & instrumentation cables shall also be provided as per actual requirements.~~

~~All cables within pump house shall be erected on suitably sized FRP/GI cable trays of required thickness & width sufficient to accommodate cables properly.~~

GROUNDING (EARTHING) & LIGHTENING PROTECTION SYSTEM

~~Earth pit of minimum bore dia. 150mm size with earthing electrode consisting pipe in pipe technology (Outer dia. of 50mm & inner dia. of 25mm with length of 2.0 meters with back filling compound of minimum 25 Kg for each) as per IS: 3043 for all HV/LV equipment viz. two pole structure, transformer including gate & chain link fencing, VCB HV switchgear panel, RMU panel, PMCC APFC panels, main motors in adequate numbers/sets along with grid of Copper/GI strip to suit maximum short circuit current & design criteria to develop earthing grid resistance $< 1 \Omega$ at all pumping stations.~~

~~Maintenance free UL listed earthing system made of copper bonded rod of 3.0 meters approximate length (17.2mm dia. with minimum copper bonding of 0.25mm suitable for 25 KA fault current with 95 % pure carbon based earth enhancement material of 30 Kg for each with pit cover) as per relevant IS for LA of two pole structure and transformer neutral in adequate numbers/sets along with grid of Copper strip of minimum 25mm x 6mm size or as required @ concerned pumping stations.~~

~~Maintenance free UL listed earthing system made of copper bonded rod of 3.0 meters approximate length (17.2mm dia. with minimum copper bonding of 0.25mm suitable for 25 KA fault current with 95 % pure carbon based earth enhancement material of 30 Kg for each with pit cover) as per relevant IS for instrumentation panels 01 set along with grid of copper strip of minimum 25mm x 6mm size or as required @ concerned pumping stations.~~

~~Earth pit of minimum bore dia. 150mm size with earthing electrode consisting pipe in pipe technology (Outer dia. of 50mm & inner dia. of 25mm with length of 1.0 meters with back filling compound of minimum 15 Kg for each) as per IS: 3043 for all LV equipment viz. motors & PMCC panel Minimum 03 sets at all pumping stations with grid of GI strip to suit maximum short circuit current & design criteria.~~

~~All grounding (earthing) pits are to be interconnected with suitably sized earthing grids of GI and copper strips.~~

~~Lightening protection system for all buildings in the plant premises as per relevant IS/IEC: 62305 (2013) have to be provided in line with design criteria & specification requirements.~~

LIGHTING SYSTEM

~~Lighting system suitable for indoor & outdoor lighting shall be provided considering the actual illumination requirements considering area & size. It will be controlled by lighting panels installed in respective station areas which will be energised from the main lighting distribution board.~~

SAFETY ACCESSORIES & TOOLS

~~Propeller exhaust fans as per IS: 2312 of heavy duty with minimum noise operation, ring mounted to give maximum volume under free air flow condition of 450 mm size and maximum speed of 900 rpm operating on single phase are to be provided in pump house (panel room). The same shall be in required/adequate numbers depending on actual requirement to suit the size of pump house. All safety accessories like are to be provided as per actual requirement and as instructed by EIC and properly mounted in the pump house for all pumping stations.~~

- ~~1) rubber mattings as per relevant I S of required thickness for all HV Panel, LV PMCC, APFC etc. electrical panels in proper length & width;~~
- ~~2) 11/22 KV hand gloves;~~
- ~~3) Shock treatment charts (In English & Gujarati);~~
- ~~4) HV/LV danger notice boards;~~
- ~~5) Fire buckets along with floor mounted stand only @ all Pumping Stations~~
- ~~6) 02 sets of first aid box @ all pumping stations.~~

~~4.5 Kg Co₂ based 02 numbers of fire extinguishers at pumping station.~~

GENERAL TECHNICAL CONDITIONS & REQUIREMENTS

1 SCOPE OF CONTRACT

- 1.1 This specification covers the design, engineering, manufacturing, testing at manufacturers' site, delivery at site(s), unloading, handling and storage at site, complete erection, final checks, painting, testing and commissioning of Horizontal mono submersible pupsets for various pumping sections at various Pumping Station with mechanical and electrical equipment, various auxiliaries & accessories like, LV power motor control centres with automatic power factor correction panels & power, control cables wiring and grounding (earthing) & lightening protection systems, lighting systems, safety accessories etc. with valves, suction and discharge pipes with specials, drain pump, EOT/MCPB and associated accessories to be supplied under this contract and **subsequent trial operational run of one months (30 days)** followed by comprehensive operation & maintenance for ten years to achieve a guaranteed performance coordinated with commercial conditions of the contract to the entire satisfaction of GWSSB.
- 1.2 Any item of work either supply and/or erection of materials/equipment which have not been specifically mentioned in the specifications but are necessary to complete the work for trouble free and efficient operation and guaranteed performance of the entire plant/system/equipment offered shall deemed to be included within the scope of this contract and shall be provided by contractor without any extra cost to the GWSSB. Entire mechanical & electrical systems & accessories, components are to be carried out on a turn-key basis.
- 1.3 The project information is indicated in the enclosed specification. It is advisable that the bidder should visit the site(s) and familiarise/apprise himself of all the site conditions prior to preparing the bid.

2 EQUIPMENT AND SERVICES TO BE INCLUDED BY CONTRACTOR UNDER THESE SPECIFICATIONS

- 2.1 Mechanical, electrical & instrumentation works required at **Various Pumping Stations**.
- 2.2 Pumping machineries at **Various pumping station** with all the accessories as per detailed specifications and sample data sheets, suction and discharge MS pipe work including fittings from sump outlet to pump house outlet is in to the vendor's scope as indicated by the GWSSB with necessary pipe support etc. shall be included in the offer.
- 2.3 Sluice Valves, Reflux Valves, expansion bellows etc. as per specifications. The individual delivery of each pump shall be provided with Sluice Valve and Reflux valves, with velocity in delivery piping and valves not exceeding 2.5 m/sec, while velocity for suction shall be <1.5 m/sec, common suction header shall be < 0.75 m/sec and for common discharge header shall be <1.2 m/sec.
- 2.4 Pressure gauges of suitable range of Glycerine filled as per specifications with installation.

- ~~2.5 — 11 KV Distribution Transformers (including standby), RMU, HV switchgear panel, LV motor control centre panels, Automatic/Fixed power factor correction panels with required APP type power capacitor banks as per specifications.~~
- ~~2.6 — Power (HV& LV), control & instrumentation cables with cable tray & accessories etc. as per specifications and requirement for the pumping stations.~~
- ~~2.7 — Earthing and lightening protection system, lighting systems for all electric equipment within pumping station & buildings & plant area as per specifications and requirement.~~
- ~~2.8 — LV electrical wiring with required cable & accessories etc.~~
- ~~2.9 — The contractor shall take the responsibility for all the testing and inspections at manufacturers' works to be conducted in manner as specified in this specification in the presence of GWSSB's representative. The inspection will be at the cost of contractor. Third party inspection shall also be carried out in the presence of the GWSSB's representative i.e. jointly. Inspection charges shall be paid to designated third party inspection agency by the contractor & contractor shall bid accordingly. —~~
- ~~2.10 — Transportation of all equipment packed in the specified way from the manufacturer's works to the project site(s) inclusive of all intermediate handling.~~
- ~~2.11 — Unloading of equipment from railway wagons/trucks at site handling and proper storing at site(s) in the approved way under security.~~
- ~~2.13 — Opening of package, checking, tallying, sorting out and inspection of equipment received at the site(s) and lodging of insurance claims if any.~~
- ~~2.14 — Taking delivery of equipment/materials from contractor's site stores, transportation to erection site(s). If erection is delayed arrange for proper storage of the equipment/material in approved ways.~~
- ~~2.15 — Erection, inspection, testing, pre commissioning checks, commissioning, trial run of the equipment and complete plant at guaranteed performance.~~
- ~~2.16 — Erection of pipe and valves including all necessary hot deep GI bolts, nuts, sleeves, insert plate etc. to complete the piping system. —~~
- ~~2.17 — Furnishing all erection and commissioning supervision service. The contractor shall also arrange for maintenance & repairs (as required) of equipment(s) during guarantee and commissioning period.~~
- ~~2.18 — The contractor shall also arrange technical expert of equipment from proprietary supplier to site as and when felt necessary until the commissioning & trial run of the plant is completed.~~

- ~~2.19 — The contractor must ascertain duty parameters of each pump set, especially required head of pump before submitting CDR and QAPs of pump for approval. Independent study of the pumping system @ all pumping stations are within the scope of this tender. It shall invariably, be carried out by the contractor to finalise the duty head in consultation with the designated PMC & the Executive Engineer, Bhuj. In case of change in the motor rating (specified above & in price bid) on account of change in head etc. rating of the associated electrical equipment (s) viz. Transformer, HV VCB panel, RMU, PLC PMCC & APFC panels & cables shall be upgraded/modified accordingly.~~
- ~~2.20 — Initial filling of oil lubricants, grease etc. for the equipment.~~
- ~~2.21 — Complete list of commissioning and maintenance spares parts for first 12 months trouble free operation and maintenance of the mechanical & electrical equipment with instrumentation systems.~~
- ~~2.22 — Complete list of recommended spare parts for operation and special tools and tackles for erection and regular operation and maintenance of the mechanical and electrical equipment shall be furnished as per schedule of spare parts and accessories tools.~~
- ~~2.23 — Required Nos. of all relevant drawings, data and instruction manuals.~~
- ~~2.24 — All ancillary work as per actual site requirement & price bid.~~
- ~~2.25 — Regular routine maintenance, break down maintenance inclusive of cost of replacement spares & materials of pumping station by qualified technicians & electricians during 30 days of trial operation run from the date of commissioning.~~
- ~~2.26 — Any item of work either supply and / or erection of material equipment which have not been specifically mentioned in the specification but is necessary to complete the work for trouble free and efficient operation and performance of the entire plant/system/equipment offered, shall deemed. To be included within the scope of this contract and shall be provided by contractor without any extra cost to the GWSSB.~~

RESPONSIBILITY

- ~~— It is the intention of the GWSSB to achieve coordinate effect. The installation & erection of machinery is to be carried out in intake well/pump houses in nine different pumping stations i.e. head works/sub head works, however note that pumping station(s) testing and subsequent commissioning work is linked up with continuous water supply to the covered villages under the scheme. GWSSB no doubt will be doing his best to give shut down for required days appropriate to the requirement of proposed works. However, contractor is not~~

~~entitled for any claim, escalation of whatsoever commissioning at a date later than the stipulated time. Necessary extension of time will be granted in case if it is established that the erection/testing/ commissioning could not be achieved in stipulated time on account of reasons beyond control of contractor. This factor should be carefully noted as no claim what so ever nature will be entertained on an account of such situations.~~

GUARANTEE

~~The contractor has to furnish guarantees for all the equipment supplied by him and complete pumping station for a period of at least 12 months from the date of handing over the head works to GWSSB.~~

DELIVERY

~~The contractor has to furnish the BAR Chart & PERT Chart for the pumping station and the same followed strictly so as to commence the pumping station as per the schedule.~~

CO-ORDINATION BETWEEN DIFFERENT AGENCIES

~~It is the responsibility of the contractor to co-ordinate with different agencies i.e. sub suppliers and vendors, civil contractor so as to commissioning the pumping station in scheduled time.~~

3.0 EQUIPMENT & SERVICE TO BE EXCLUDED FROM THIS SECTION

3.1 Rising main beyond the battery point.

3.2 Construction of the Positive Suction Type Pump House and HV & LV Panel Rooms.

4.0 THIRD PARTY INSPECTION

~~Inspection and testing of the major Mechanical, Electrical equipment such as HSCF Pumps, Induction Motors, HMSM Pumpset, Electromagnetic, All Types of Valves, Distribution Transformer, RMU, DG set HV VCB switchgear panels, PMCC & APFC Panels, PLC panels, EOT/MPCB, Expansion Bellows shall be carried out by the PMC/third party inspection agency in the presence of GWSSB's representative (i.e. jointly) at manufacturers' works. QAPs along with manufacturers' cross sectional drawings, characteristic curves (if any), material(s) of construction etc. for all items shall have to be submitted by the bidder & get them approved prior to their procurement invariably. Designated PMC shall scrutinize all QAPs etc. & submit it to the Executive Engineer, P. H. Mechanical Division, Bhuj for approval who will approve them as per technical specifications & requirements of the project in conformance with the governing standards. Only in case of any deviation from the approved technical specifications QAPs etc. shall be submitted to the Executive Engineer, P. H. Mechanical Division, Bhuj for~~

~~acceptance & approval if required & if found acceptable. For all other items like cables, MS pipes with specials, pressure gauge, PC, UPS, portable measuring instruments etc. internal test/quality/calibration certificates shall have to be furnished for review/acceptance.~~

~~Contractor shall have to offer complete pump & motor set for third party inspection @ pump manufacturers' premises. Prior to that motors shall have to be inspected at original manufacturer's premises for conducting routine tests as per relevant governing standards. Type test of one motor of the highest rating in this tender shall also be witnessed at original manufacturer's premises. Such tested & approved motors shall be sent to pump manufacturer for required job motor testing. All pumps in have to be performance tested by job motors & not the shop (test) motor. Base frames (plates) shall also be fabricated by the pump manufacturer and shall be offered for visual & dimensional check at the time of joint inspection @ pump manufacturers' premises. All pumps & motors shall be tested irrespective of quantities offered i. e. 100% inspection is mandatory.~~

~~4.1 That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.~~

~~4.2 That all items operate efficiently and quietly to meet the specified requirements.~~

~~4.3 That all non-current carrying metal work is properly and safely grounded in accordance with the specifications.~~

~~The contractor shall provide all necessary instruments and labour for testing and shall make adequate records of test procedures and readings, shall repeat any tests requested by the PMC/ GWSSB and shall provide test certificates signed by a properly authorised person such test certificates shall cover all works.~~

~~4.4 It tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements, or retesting will be considered. GWSSB's decision as to what constitutes a satisfactory test shall be final. The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.~~

~~5 GWSSB reserves right to ask for the corporate guarantee from any or all the bidder for the performance and overall completeness in accordance to GWSSB's requirements. Specifically, for in time completion of contractual works in accordance to the technical requirements in best workmanship manner.~~

~~5.1 GWSSB reserves the right to split the work/distribute the works among bidders.~~

~~5.2 GWSSB reserves the right to accept or reject the tenders with technical deviation, at the discretion of competent authority.~~

GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENT**1.0 — GENERAL**

— This part covers conditions pursuant to the contract and will form an integral part of the contract. The following provisions shall supplement general conditions, detailed specification and requirements.

2.0 — LIMIT OF CONTRACT

— Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the technical specification, unless included in the list of exclusions. All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another.

3.0 — ENGINEERING DATA

3.1 — The contractor shall furnish complete engineering data of each set of equipment such as name of manufacturer, the type of model of each principal item of equipment proposed to be furnished and erected in the annexure, standard catalogues design, the specification number and the name of the project. If, the standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings, and writing on the drawing shall be in English. All dimensions should be in metric units.

3.2 — All manufactured fabrication works in connection with equipment prior to the approval of the drawing shall be at the contractor's risk. The contractor may make any changes in the design which are necessary to make any equipment conform to the provisions and intent of the contract and such changes will again be subject to the approval by the GWSSB. Approval given to the contractor's drawing or works by the GWSSB shall not relieve the contractor from any of the responsibility and liabilities under the contract.

3.3 — Drawings shall include all installation and detailed piping drawings wherever applicable. All piping 100 millimetre and larger shall be routed in details and smaller pipe shall be shown schematically or by isometric drawings. All drawings shall be fully corrected to agree with actual "As-Built" construction.

4.0 — DESIGN IMPROVEMENTS

4.1 — GWSSB may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specifications shall be modified accordingly.

~~4.2 If any such agreed upon change is such that it affects the price and schedule of completion, the party shall agree in writing as to the extent of any change in the price and/ or schedule of completion before the contractor proceeds with the change. The following such agreement provision thereof shall be deemed to have been amended accordingly.~~

~~5.0 The following documents shall be Sent by registered post to the GWSSB by contractor within 3 days from the date of dispatch, to enable the GWSSB to make progressive payments to the contractor:~~

~~INVOICE (3 copies)~~

~~PACKINGLIST (3 copies)~~

~~TESTCERTIFICATE (3 copies)~~

~~5.1 The contractor shall prepare detailed packing list of all packages and containers, bundles & loose material forming each and every consignment dispatched to site. The contractor shall further be responsible for making all necessary arrangements or loading, unloading and other handling right from his work till the site and also till the equipment is erected, tested and commissioned. He shall be solely responsibility for proper storage and safe custody of all equipment.~~

~~5.2 All fine, rental, demurrages, warfare and other expenses incurred due to delayed clearance of the material or any other reason shall be to the account of the contractor.~~

6.0 PROTECTION TO PLANT

~~6.1 All coated surface shall be protected against abrasions impact, discolorations and any other damages. All exposed hreaded portion shall be suitably protected with either a metallic or non-metallic protecting device. All ends of all valves and pipe manifold and conduit equipment connections shall be properly sealed with suitable device to protect them from damage. The parts which are likely to get rusted due to exposure to weather, shall also be properly treated and protected inasuitable manner.~~

7.0 MATERIALS HANDLING AND STORAGE

~~7.1 All the equipment furnished under the contract and arriving at the site shall be properly received, un-loaded transported and stored in the storage spacesby the contractor at his cost.~~

~~7.2 Contractor shall be responsible for examining all the dispatches and notify the GWSSB immediately of any damage, short age discrepancy etc. for the purpose of the GWSSB~~

~~information only. The contractor shall submit to the GWSSB every week a report detailing all the receipts during the work. However, the contractor shall be solely responsible for any shortages or damage in transit, handling and/or in storage and erection of the equipment at the site.~~

~~7.3 The contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the GWSSB at any time.~~

~~7.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, string etc. shall be used for unloading and/or handling of the equipment stored. It shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location of the appropriate times as to avoid damage of such equipment at site.~~

~~7.5 All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, sliprings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and shall be periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.~~

~~— All the electrical equipment, such as motors etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and record of such measured insulation values maintained by the contractor. Such records shall be kept open for inspection by the GWSSB.~~

~~7.6 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.~~

~~7.7 All the materials stored in the open or dusty location must be covered with suitable waterproof and flameproof covering material wherever applicable.~~

~~7.8 The contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally all the electrical equipment, such as motors, control gears, generators, exciters and consumable like electrodes, lubricants etc. shall be stored in the closed storage space. The GWSSB in addition may direct the contractor to move certain other materials which in GWSSB opinion will require indoor storage, to indoors storage area which the contractor shall strictly comply with.~~

8.0 — ~~CONTRACTOR'S MATERIALS AT GWSSB SITE~~

~~8.1 — The contractor shall bring to site all equipment, component, parts, materials, including construction equipment, tools and tackles for the purpose of the works under intimation to the GWSSB all such goods from the time of their being brought shall not on any account be removed or taken away by the contractor or his sub-contractor without the written permission of the GWSSB. The contractor shall never the less be solely liable and responsible for any loss or destruction hereof and damage thereto.~~

~~8.2 — The GWSSB shall have the lien on such goods for any sum or sums which may at any time be due to owing to them by the contractor, under in respect of or by reasons of the contract. After giving a fifteen (15) days' notice in writing of his intention to do so, the owner shall be at liberty to sell and dispose of any such goods in such as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfactions of such or sums due as a fore said After the completion of the works, the contractor shall remove from the site under the direction of the purchaser the materials such as construction equipment, erection tools, and tackles scaffolding etc. with the written permission of the GWSSB if the contractor fail store move such materials. GWSSB to do so then the GWSSB shall have the liberty to dispose of such materials and credit the proceeds there of to the account of the contractor.~~

9.0 — ~~FACILITIES TO BE PROVIDED BY THE GWSSB~~**9.1 — ~~SPACE:~~**

~~—— The contractor shall advise GWSSB within fifteen (15) days from the date of acceptance of the letter of intent, about his exact requirement so space for carrying out electro mechanical erection activities viz. storage area, pre-assembly and fabrication areas etc. The above requirement shall be reviewed by the GWSSB and as available will be given to the contractor. It will not be binding to owner GWSSB to spare the space if not available. In that case contractor shall have to make his own arrangements. The material once supplied shall have to be stored and preserved by agency up till the commission Agency may deploy the person to protect the materials supplied by agency at their own cost.~~

10.0 — ~~CONSTRUCTION MANAGERMENTS~~

~~10.1 — Time is the essence of the contract and the contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at anytime the contractor is falling behind schedule, he shall make necessary action to make good for such delays by~~

~~increasing his work force or by working over time or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the GWSSB satisfying that his action will compensate for the delay. The contractor shall not be allowed any extra compensation for such action.~~

~~11.0 CONTRACTOR'S COOPERATION WITH THE GWSSB~~

~~In case where the performance of the erection work by the contractor the operation of the system facilities of the GWSSB such erection work of the contractor shall be scheduled to be performed only in the manner stipulated by GWSSB and the same shall be acceptable at all times to the contractor. The GWSSB may impose such restrictions on the facilities if provided to the contractor such as electricity, water etc. as the GWSSB may think fit in the interest of itself and the contractor shall strictly adhere to such restrictions and cooperate with the GWSSB it will be the responsibilities of the contractor to be provided all necessary temporary instrumentation and other measuring devices required during the start-up and operation of equipment systems which are erected by him. Before commissioning of any machine all old lubricants, greases etc. shall be thoroughly removed, the part cleaned of all deleterious material and shall be freshly lubricated by sealed lubricants, of exact specifications.~~

~~12.0 COOPERATION WITH OTHER CONTRACTORS (If Any) & FOR GWSSB~~

~~The contractor shall agree to cooperate with the GWSSB other contractor and consultants of GWSSB and freely exchange with them such technical information and economical design features to avoid unnecessary duplication of efforts. The contractor shall attend design coordination meetings at his own cost whenever required.~~

~~13.0 FIELD OFFICE RECORDS~~

~~13.1 The contractor shall maintain at his site office up to date copies of all drawings, specifications and other contract documents and any other supplementary data complete with all the latest revisions there to. The contractor shall also maintain in addition, the continuous records of all changes to the above contract documents, drawings, specifications, supplementary data etc. Affected at the field and on completion of his total assignment under the contract shall incorporate all such changes on the drawings and other engineering data to indicate as installed conditions of the equipment furnished and erected under the contract. Such drawings and engineering data shall be submitted to the GWSSB in required number of the copies.~~

~~14.0 DESIGN COORDINATION~~

~~14.1 The contractor shall be responsible for the selection and design of appropriate equipment to provide the basic coordinated performance of the entire system. The design requirements are detailed out in technical specifications. The design of various components, sub-assemblies and assemblies shall be done in such a way that it facilitates easy field assembly and maintenance. All the relating components shall be so selected that their natural frequency of the component is not critical at or close to the operating range of the unit.~~

~~15.0 QUALITY ASSURANCE PROGRAMME~~

~~— To ensure that the equipment and services under scope of this contract whether manufactured or performed, within the contractor's work or at his subcontractor's premises or at the owner's site or at any other place of work are in strict accordance with the specifications. The contractor shall adopt suitable quality assurance programme for such activities at all points & such programme shall be outlined by the contractor and shall be finally accepted by the purchaser after discussions before the start of contract, and such agreed programme shall form part of the contract.~~

~~16.0 DEFECTS IN WORK OF OTHER CONTRACTOR~~

~~16.1 The GWSSB shall be notified promptly by the contractor of any defects in the other contractor works (if any), the GWSSB shall determine the corrective measures if any required to rectify this situation after joint inspection work and such decision by the GWSSB shall be binding on the contractor.~~

~~17.0 UNFORSEEN WORKING CONDITIONS~~

~~17.1 The contractor shall confirm all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects, during inclement weather conditions, monsoon, storm setc. And during other unfavourable construction condition. No field activities shall be performed by the contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precaution or measures are taken by the contractor in a proper and satisfactory manner in the performance of such works and with the concurrence of the purchaser. Such unfavourable construction conditions will in no way relieve the contractor of his responsibility to perform the work as per schedule.~~

~~18.0 PROTECTIVE GUARDS~~

~~18.1 Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spaces and accessories shall be designed for easy installation and removal for maintenance purposes.~~

~~19.0 WELDING~~

~~19.1 If the manufacture has special requirement relating to the welding procedures for welds at the terminals of the equipment to procedure procured by the owned separate specifications. The requirement shall be submitted to the GWSSB in advance of commencement of erection work.~~

~~20.0 NOISE AND VIBRATIONS~~

~~20.1 The equipment supplied and erection by the bidder will comply with best design and erection and its working shall be within permissible noise and vibration levels.~~

~~21.0 EQUIPMENT BASES~~

~~21.1 A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed by the GWSSB. each base plate shall support the unit, and its drive assembly shall be of neat design with anchoring the units.~~

~~22.0 SHAFT ALIGNMENTS~~

~~—— All the shaft so rotating equipment shall be properly aligned to these of the machine equipment to as per fact and accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid over heating of bearing or other conditions which may tend to shorten the life of the equipment. All bearings shafts and other rotating parts shall be the roughly cleaned and suitable lubricated before starting.~~

~~23.0 DOWELLING~~

~~—— All the drive motors and other equipment shall suitable owelled after alignment of shaft with tapered machined owels as per direction of the GWSSB.~~

~~24.0 PAINTING~~

~~—— All exposed metal parts of the equipment including piping, structures railings etc. Wherever applicable after installation unless otherwise specified shall be surface protected and shall be first painted with atleast primer paint used, after thoroughly cleaning all such parts of all dirt, rust Axles greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved or sandblasting and the same being inspected approved by the board for painting. After wards the above parts shall be finished with two~~

~~coats of alloyed resin machinery enamel paints. Quality of the finished paints shall be as per standards. So require valent and shall be of the colour as approved by the GWSSB.~~

~~25.0 COLOUR CODE FOR PIPE SERVICES~~

~~—— All pipe services wherever applicable are to be painted accordance with the owner's standard colour scheme by the contractor.~~

~~26.0 LUBRICATION~~

~~—— Equipment shall be lubricated by system suitable for duty of the equipment. Lubricant level indicators wherever provided shall be furnished and parked to indicate proper levels under both stand steel and operating conditions.~~

~~27.0 FIRST FILLING OF CONSUMABLES OIL AND LUBRICANTS~~

~~—— All the first fill of consumables such as oils, lubricants and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications into successful trial operation. They shall be furnished by the contractor unless specifically excluded under their these specification and documents.~~

~~28.0 CHECKOUT CONTROL SYSTEMS~~

~~—— After completion of wiring and cable furnished under separate specifications and laid as per the terms noted by the board the contractor shall check out the operation of all control system for the equipment furnished and installed under these specification and documents.~~

~~29.0 EQUIPMENT PERFORMANCE GUARANTEE~~

~~—— The performance guarantees of the equipment under the scope of the contract are detailed separately in the technical specifications. These guarantees shall supplement the general performance guarantee provisions covered under general terms and conditions.~~

~~30.0 GUARANTEE~~

~~—— In the event of any emergency where in the judgment of the Board delay would cause serious loss or damage, repairs or adjustments may be made by the GWSSB or a third party chosen by the GWSSB without notice to the contractor or by surety. In the event such action is taken by the purchaser the contractors will be notified promptly and he shall assist whenever possible in making the necessary corrections. This shall not extinguish the contractor's liability under the terms and conditions of the contractor.~~

~~—— The cost of any special or general overhaul rendered necessary during the maintenance period due to the defect in the plant or defective work carried out the contractor the same shall be borne by the contractor.~~

~~———— In case of this effective parts which are not repairable at site but are essential for the commercial operation of the equipment, the contractor and the GWSSB shall naturally agree to a programme of replacement or renewal which will minimise interruption to the maximum extent, into operation of the equipment. At the end of guarantee period the contractor's liability except for the latest defects in respect of goods supplied by sub-contractor to the contractor where a longer guarantee (More than 12 months) is provided by sub-contractors, the owner shall be entitled to the benefit of such longer guarantee. Then provisions contained in this clause will not be applicable.~~

~~———— If the owner has not operated the equipment according to generally approved industrial practice and in accordance with the conditions of operation specified and in accordance the operating manuals, if any.~~

~~31.0 RECOMMISSIONING TRIALS TESTS START-UP~~

~~———— On completion of erection of the equipment and before start up each items of the equipment shall be thoroughly cleaned and then inspected jointly by the GWSSB and the contractor for correctness and completion of installation and acceptability for start-up, leading to initial pre-commissioning tests at site(s).~~

~~———— The list of pre-commissioning tests to be performed shall be as mutually agreed and include in the contractor's quality assurance programme. The contractors commissioning / start-up board specifically identified as far as possible and the contractor shall be responsible for carrying out all pre-commissioning tests. On completion of inspection checking after pre-commissioning tests are satisfactorily over, the complete shall be placed on initial operation during which period the complete equipment shall be operated integral with sub systems and supporting equipment as complete plant.~~

~~32.0 TRIAL RUN & OPERATION~~

~~The plant shall then be on trial operation during which period all necessary adjustments shall be made while operating over the full load range enabling the plant to be made ready for performance and guarantee tests. —~~

~~The duration of trial operation of the complete equipment should be **three month (90 days)** of initial operation or any other duration as may be agreed to between the contractors. The trial operation shall be considered successful provided that each item of equipment can operate continuously at the specified operating characteristics, for the period of trial operation.~~

- ~~For the period of trial operation, the time of operation with any load shall be counted. Minor interruptions not exceeding four (4) hours at a time caused during the continuous operation shall not affect the total during of trial operation.~~
- ~~However, if in the opinion of the, purchaser, the interruption is long, the operation shall be prolonged for the period of interruption. A trial report comprising of observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by contractor. This report, besides recording the details of the observation during trial run shall also including the dates of starts and finish of the trial operation and shall be signed by the representative of both the parties.~~
- ~~The report shall have sheets, recording all the details of interruptions occurred adjustment made and any minor repairs done during the trial operation, based on the observation necessary modification/repairs to the plant shall be carried out by the contractor to the full satisfaction of the GWSSB, to enable the latter on to accorded permission to carry out performance and guarantee tests on the plant.~~

~~33.0 PERFORMANCE AND GUARANTEE TEST~~

- ~~33.1 The final test as to the performance and guarantees shall be conducted at site by the GWSSB. The contractor shall make the equipment ready for such tests and assist the GWSSB in conducting such tests free of cost, such test shall be commenced after the successful completion of trial operation.~~
- ~~33.2 These trends shall be binding on both the parties of the contract to determine compliance of the equipment with the performance guarantee.~~
- ~~33.3 The available instrumentation and control equipment will be used during such tests and the GWSSB will be calibrate, all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the GWSSB, for the requirement of these tests. The tests will be conducted for the specified duty and as near to the specified conditions as practicable. The GWSSB will apply proper correction in calculation to take into account condition, which should not correspond to the specified condition.~~
- ~~33.4 Any special equipment, tools tackles required for the successful completion of the performance and guarantee tests shall be provided by the contractor, free of cost.~~
- ~~33.5 The guaranteed performance figure of the equipment shall be provided by the contractor during these performance and guarantee cost should the results of these tests show any~~

~~depressed from the guaranteed values, the contractor shall modify the equipment as required to enable them to meet the guarantees. In such case performance and guarantee tests shall be repeated one month, from the date of equipment is ready for re-tests and all cost for modification including labour materials and the cost of additional testing prove that the equipment meets the guarantees shall be borne by the contractor.~~

~~33.6 The specific tests to be conducted on equipment have been brought out in the technical specifications.~~

~~33.7 Performance and guarantee tests shall make allowance for instrumentation error as may be decided by the GWSSB.~~

34.0 REGISTRATION AND STATUTORY INSPECTION

~~34.1 All registration and statutory inspection fees if any in respect of this work pursuant to this contract shall be to the account of the contractor. However, any registration statutory inspection fees lawfully payable under the provision of statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the owner shall be to account of the owner. Should any such inspection or registration need to be rearranged due to the fault of the contractor or his sub-contractor the additional fees for such inspection and /or registration shall be borne by the contractor.~~

35.0 WORKS AND SAFETY REGULATION

~~35.1 The contractor will not if the GWSSB of his intention to bring on the site any equipment or any container with liquid or gaseous fuel or other substance which may create hazard. The GWSSB shall have the right to prescribe the conditions for up keep of such hazardous equipment. Before the contractor connects any electrical appliances to any plug or socket belonging to the other contractor or owner shall:~~

~~Satisfy the Engineer in charge of GWSSB that the appliance is in good working conditions.~~

~~(a) Inform the GWSSB of the maximum current rating voltage and phases power factor the appliances.~~

~~(b) Obtain permission of the Board detailing the sockets to which the appliances may be connected.~~

~~35.2 The GWSSB shall not grant permission to connect until it is satisfied that~~

~~(a) The appliance is in good condition and is fitted with suitable plug~~

~~(b) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheet surrounding the cores.~~

~~35.3 No electrical cable in use by the contractor / GWSSB shall be disturbed without prior permission. No weight of any description will be placed on any such cable and no ladder or similar equipment will rest against or be attached to it, under which such equipment or container may be handled and used during the performance of the work and the contractor shall strictly adhere to such instruction. The GWSSB shall have the right to inspect any construction plant and to forbid its use if in its opinion it is unsafe. No claims due to such prohibition shall be entertained by the GWSSB.~~

~~35.4 Where it is necessary to provide and / or store petroleum products petroleum mixtures and explosives, the contractor shall be responsible for carrying out such provision and/ or storage in petroleum Act explosives Act 1948 and petroleum inspector of Explosive of India. All such storage shall have prior approval so the GWSSB in case any statutory authority the contractor shall be responsible for obtaining the same.~~

~~36.0 ELECTRICAL SAFETY REGULATIONS~~

~~36.1 In no circumstances shall the contractor interfere with fuse and electrical equipment belonging to the GWSSB or other contractors.~~

~~36.2 No work shall be carried out on any live equipment. The equipment shall be made safe by the GWSSB and a permit to work be issued before work is carried out.~~

~~36.3 The contractor shall employ the necessary number of qualified full time electricians to maintain temporary electrical installation.~~

GENERAL REQUIREMENTS (ADDITIONAL)

1. DRAWINGS

- ~~1.1. The drawings as per tender specifications & requirements of the project are to be provided by the bidder as illustrative of the specifications.~~
- ~~1.2. All data and information furnished in the drawings by the bidder is to be given in completeness and accuracy thereof. The same shall be verified by the Engineer-In-Charge (EIC) for any errors or discrepancies thereof.~~

2. Drawings Furnished by the Employer

- ~~2.1. The contractor shall carefully check all drawings and/or instructions furnished by the Engineer in charge before commencing any Work, and shall inform the EIC in writing, within a day from the receipt of the same, of any errors or omissions discovered, or of the difficulty to execute any works or part thereof in compliance with these drawings and/or the written instructions received from the EIC. Failing to do this, he shall be liable to execute at his own cost the necessary alterations to any works resulting from these errors or omissions.~~
- ~~2.2. The contractor will be furnished with 2 copies of any such drawings prepared by the Engineer. The contractor will also be furnished with two copies of all instructions as may be issued by the Engineer. One copy of all such drawings and instructions issued to the contractor shall be kept in his office at the site. No drawing or instruction shall be considered valid unless it has been signed by the Engineer.~~

3. Drawing Sheet Format

- ~~3.1. All drawings provided by the contractor shall be on standard size sheets, prepared on computer with Auto Cad 14 and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title:~~
- ~~A blank space of 90 mm x 100 mm shall be provided for the Engineer's approval stamp and provision shall be made for details of revisions to be recorded.~~
- ~~3.2. All drawings submitted by the bidder/contractor shall use the English language and preferably SI units. All drawings shall be clearly and fully cross referenced to the other drawings as relevant.~~

4. ~~Tender/Contract Drawings~~

4.1. ~~Drawings submitted by the bidder shall show all the essential items of the plant offered together with sufficient details to enable the general arrangement of the Plant to be determined.~~

4.2. ~~The outline dimensional drawings submitted by the contractor shall include the following in addition to overall dimensions:~~

~~Parameters of equipment~~

~~Load details~~

~~Support details~~

~~Foundation pocket details~~

4.3. ~~The drawings to be provided by the Bidder/Contractor shall include the following, but shall not be limited to those listed~~

~~(* Indicates the drawings/documents to be submitted)~~

Sr. No.	Description	To be submitted with the Tender	To be submitted after the award of the Contract
Outline Dimensional Drawing			
1	Pumping Machinery (HMSP)	*	
2	Induction motor with separate terminal box for		*
(a)	Line/Neutral side terminals with phase segregation		*
(b)	Resistance temperature detectors		*
Cross Sectional Drawing with Materials of Construction			
1	Pump		*
2	Motor for above		*
3	Pump Performance curves at rated RPMQ Vs. H, P & NPSH		*

4	Q Vs. H curves super imposed on system resistance curves		*
5	Performance Test Records of 2 pumps (same as the offered model)		*
6	Pump ISO efficiency Curve		

5. ~~Submission and Approval of Drawings~~

~~5.1. The following shall be the procedure for submission and approval of drawings:~~

~~5.1.1. The contractor shall submit 3 copies of the drawings to GWSSB. All the drawings are to be signed by the contractor or his authorized representatives~~

~~5.1.2. The Engineer in charge's (EIC) representative will review the drawings and, if found fit for approval, the Employer will return 2 copies to the contractor duly approved.~~

~~5.1.3. In case the drawings/documents are not fit for approval but worth for review, the EIC's representative will mark the comments on the drawings and return 2 copies to the contractor. In such case, the contractor shall resubmit the revised drawings within two weeks as per sub clause 5.1.1 above and the same shall be repeated till the drawings are finally approved as per sub clause 5.1.2 above.~~

~~5.1.4. If the submitted drawings/documents are not worth for review, the contractor will be informed accordingly.~~

~~5.1.5. On receipt of the approved drawings as per sub clause 5.1.2 above, the contractor shall submit floppy and documents to the employer.~~

~~5.1.6. After tests on completion, the contractor shall submit, within 15 days of the conclusion of the tests, CD's of the "As Built Drawings" to GWSSB.~~

~~5.2. When the drawings are received by the EIC's representative after revision by the contractor, he will only review the revision made and hence the contractor shall carefully identify all the revised details/dimensions and also describe the revisions in the revision block.~~

~~5.3. No drawings, with corrections made after taking the prints, will be accepted.~~

~~5.4. Approval of drawings by the Engineer shall not relieve the contractor of his responsibility in terms of the contract.~~

6. ~~Operation and Maintenance Manuals~~

- ~~6.1. The operation and maintenance manuals shall be arranged to provide separate volumes for each principal section of the Works and they shall relate to as built conditions and shall include all necessary drawings and diagrams for a proper understanding of the works.~~
- ~~6.2. The operation and maintenance manual shall be approved in draft form initially prior to commencement of erection by the EIC's representative and shall cover all items of the Works. For this purpose, three draft copies shall be submitted to the EIC's representative. A mere collection of manufacturers' descriptive leaflets will not be acceptable in satisfaction of this clause. The operation and maintenance manual shall comprise both operating instructions and maintenance instructions.~~
- ~~6.3. The manuals shall include, but not be limited to the following information:~~
- ~~6.3.1. Descriptive overview of the whole of the works.~~
- ~~6.3.2. Descriptions of all systems installed, including mechanical, electrical, instrumentation, control systems with relevant design and operating parameters.~~
- ~~6.3.3. Descriptions of all equipment supplied including manufacturer's leaflets, which shall be scheduled for easy reference.~~
- ~~6.3.4. Schedules and manufacturer's catalogues for all equipment supplied, giving duties, electrical load, etc.~~
- ~~6.3.5. Schedules of all equipment suppliers (and their local agents) including names, addresses, telephone & facsimile numbers and e-mail ID.~~
- ~~6.3.6. Start up, operation and shut down instructions for all parts of the works. These shall include step by step directions on setting the plant to work listing all adjustments and settings necessary for the current functioning of the plant.~~
- ~~6.3.7. Instructions on monitoring of plant performance and sample log sheets for each plant item, to be filled by operators on a routine basis.~~
- ~~6.3.8. "Dos" and "Don'ts" in plant operation: Operator's attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the plant.~~
- ~~6.3.9. Procedures to deal with breakdown and emergencies~~
- ~~6.3.10. Safety requirements~~
- ~~6.3.11. Checking, testing and replacement procedures to be carried out on all plant items on a daily weekly and monthly basis or at longer intervals to ensure trouble free operation. Full maintenance instructions for all equipment including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly, annual overhaul instructions together with recommended lubricants and spares. These shall also include details of~~

~~routine maintenance work that will be within the competence of the normal maintenance staff and notification of maintenance work that will have to be done by the manufacturer, his agent or other specialist operator.~~

~~6.3.12. Fault locations and remedy charts to facilitate tracing the cause of malfunctions or break down and correcting faults.~~

~~6.3.13. Complete list of recommended lubricants and lubrications charts.~~

~~6.3.14. A 'spares schedule' which shall consist of a complete list of item wise spares for all plant items with ordering references and part numbers.~~

~~6.3.15. A complete list of manufacturer's instructions for operation and maintenance of all bought out equipment. The list shall be tabulated in alphabetical order giving the name of supplier/ manufacturer, identification of the Plant item giving the model number and the literature provided including instruction leaflets and drawing numbers.~~

~~6.3.16. Step by step procedure for the dismantling, repair and re assembly of all items of equipment.~~

~~6.3.17. Part list and drawings or exploded diagrams for each item of plant with construction particulars, materials of construction, mating components, clearances and tolerances, maximum wear permitted before replacements are to be done etc.~~

~~6.3.18. Record drawings of all systems installed, including general arrangements, conduit and wiring trunking systems, wiring diagrams, control schematics and valve charts, etc., to a reduced scale.~~

~~6.4. The contractor shall furnish 3 copies of the Operation and Maintenance Manual for each pumping station. Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the GWSSB. They shall permit the subsequent incorporation of revisions to be necessary during the defect liability period.~~

~~7. Protection and Packing for Transportation~~

~~7.1. Before any plant is dispatched from manufacturer's works it shall be properly prepared and packed and the contractor shall give GWSSB at least 14 days' notice that these preparations are to commence.~~

~~7.2. Prior to dispatch the plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight rain, high temperatures and humid atmospheres. The contractor shall be responsible for the plant being so packed and/or protected as to ensure that it reaches the Site intact and undamaged. The plant~~

~~shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.~~

~~7.3. The contractor shall be deemed to have included in the schedule of prices for all materials and packing cases necessary for the safe package, conveyance and delivery and storage of the plant with all protective and preservation measures.~~

~~7.4. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 50 kg gross per case. No one package or bundle shall contain items of plant intended for incorporation in more than one section of the works. All items of plant shall be clearly marked for identification against the packing list.~~

~~7.5. Eye bolts, lifting hooks and brackets shall be provided for lifting the boxes, crates and packages. Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of the packing list shall be sent by post to the EIC's representative at site.~~

~~7.6. All crates, packages, etc. shall be clearly marked with a waterproof material to show the weight and where the slings should be attached, and shall also have an indelible identification mark relating them to the packing lists. Packing cases shall be nonreturnable. Contractor shall have to clear the site including packing material.~~

~~7.7. Electrical equipment shall be enclosed in sealed air tight package with hygroscopic material, before being placed in packing cases on shock absorbent materials and secured by means of battens.~~

8. ~~Delivery, Unloading and Storing at Site(s)~~

~~8.1. The Contractor shall be responsible for checking all materials delivered to Site and shall keep the EIC or his representative fully informed of the state of deliveries. The contractor shall carry out, at his cost, all instructions of EIC or his representative for proper unloading, preservation, maintenance, storage and security of materials delivered to site until he fulfils all his obligations under the contract.~~

~~8.2. The contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the EIC. If built up shed or area is provided by the Employer depending upon availability, the contractor shall have to pay rent as finalised by the EIC.~~

~~8.3. Multiple handling and movement of materials during storage and retrieval shall be avoided.~~

MATERIALS AND WORKMANSHIP

1. Introduction

- 1.1. This part of the specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Employer. Particular attention shall be paid to a neat, orderly and well arranged installation carried out in a methodical competent manner.

2. Reference Specifications and Standards

- 2.1. Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S.') issued by the British Standards Institution of 2, Park street, London W.1., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American National Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Akasaka, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard at the tender opening date.
- 2.2. The contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard.
- 2.3. All details, materials and equipment supplied and workmanship performed shall comply with the specified Standards. If bidder offers equipment to other Standards, the equipment / material should be equal or superior to those specified and full details of the difference shall be supplied.
- 2.4. In the event of conflict between this specification and the codes for equipment, provisions of this specification shall govern. Certain specifications issued by national or other widely recognised bodies are referred to in this specification. In referring to the Standard Specifications the following abbreviations are used:
- IS : Indian Standard
- ANSI : American National Standards Institute
- API : American Petroleum Institute
- ASME : American Society of Mechanical Engineers
- ASTM : American Society of Testing and Materials

AWS	:	American Welding Society
AWWA	:	American Water Works Association
ISO	:	International Organisation for Standardisation
DIN	:	Deutsche Institute fur Normungs
BS	:	British Standard
IEC	:	International Electro technical Commission
IEE	:	Institution of Electrical Engineers
IEEE	:	Institute of Electrical and Electronic Engineers
NEMA	:	National Electrical Manufacturers Association
AGMA	:	American Gear Manufacturer's Association

3. Materials General

3.1. All materials incorporated in the works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

4. Workmanship General

4.1. Workmanship and general finish shall be firstclass quality and in accordance with best workshop practice.

4.2. All similar items of the plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements can be readily installed. All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load up to the maximum there shall be no vibration due to lack of balance.

4.3. All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings. All materials incorporated in the works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the plant shall be

~~supplied by the contractor unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.~~

- 4.4. ~~If, after installation, the operation or use of the materials or equipment furnished by the contractor proves to be unsatisfactory. The Employer shall have the right to operate or use such materials or equipment until correction of defects, errors or omissions, by repair or by partial or complete replacement, can be made without interfering with the plant operations. Except for any warranty provided for elsewhere in this contract or unless otherwise agreed upon in advance, the period of such operation or use, pending correction of defects, will not exceed 1 year.~~

5. ~~Welding~~

- 5.1. ~~Welding shall comply with the latest revision of the BS 5135 Code.~~

- 5.2. ~~Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the EIC does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each welded end shall clearly be identified as to its welder marking the welder's code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures, for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The EIC shall disqualify the welder whose work require disproportionate quantum of repairs. All procedures where required shall be qualified as per BS EN 283-3.~~

- 5.3. ~~Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.~~

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

- 5.5. ~~Generally, a stringer bead technique shall be used with a slight oscillation of necessary to avoid slag and to minimise the number of beads needed to fill exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm~~

~~dia., welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.~~

~~5.6. The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive “such back” etc. shall be cause for rejection of welds.~~

~~5.7. Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg lengths shall not exceed the specified size by more than 1.5 mm.~~

~~5.8. All attachments such as lugs, brackets and other non-pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.~~

~~5.9. All tack welds shall be made using qualified procedure and welders, the number of size of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouging. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.~~

~~5.10. All weld repairs shall be carried out using the approved welding procedures and welders. Re-welded areas shall be re-examined by the methods specified for the original welds and repair procedures shall be duly qualified by the EIC’s representative.~~

~~6. Pre heating and Post Heating Treatment~~

~~6.1. Pre heating and post heating treatment shall conform to the relevant application codes. Preheating not exceeding 121⁰ C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre heating will not be necessary for welds less than 6 mm size. In large~~

~~diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870 Part 1 Table 6 to represent 30 % of the long seams and each welder's performance would be mandatory.~~

~~7. Electrodes~~

~~7.1. All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.~~

~~8. Examination/NDT/Radiography~~

~~8.1. The various stages of examination and types shall be as stipulated in the respective fabrication Codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910. Ultrasonic tests where called for shall be carried out as per provisions of BS 3926, magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.~~

~~9. Stainless Steel Welding~~

~~9.1. All welding consumable such as electrodes, filler weirs, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the EIC. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.~~

~~9.2. All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.~~

~~9.3. Argon gas with purity 99.5 % shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.~~

~~9.4. Non-destructive examination of the welds shall be carried out to ensure quality of weld.~~

~~9.5. The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat~~

~~affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.~~

~~10. Castings~~

~~10.1. Cast iron shall be of standard grey close grained quality. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.~~

~~10.2. Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The EIC shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the EIC. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress relieved after such welding. Non-destructive tests as directed by the EIC will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.~~

~~11. Forging~~

~~11.1. All major stress bearing forging shall be made to standard specifications. Forging shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5 % of the finished thickness of the component, shall be reported to the EIC giving the details like location, length, width and depth. For the magnetic particle's inspection, the choice of wet or dry particles shall be at the Contractor's discretion.~~

~~11.2. All forging shall be demagnetised after test and shall be heat treated for the relief of residual stresses.~~

12. Design Life

- 12.1. The works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The contractor shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not requires the services of highly skilled personnel.
- 12.2. The plant shall be designed to provide easy access to and replacement of component parts which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years.
- 12.3. Design features shall include the protection of plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Works.
- 12.4. Plant located outside lockable areas/building shall have additional features to prevent unauthorised operation.

13. Lubrication

- 13.1. A complete schedule of recommended oils and other lubricants shall be furnished by the contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the EIC.
- 13.2. Contractor shall indicate indigenously available equivalent lubricants with complete specification, to enable the Employer to arrange for regular supply.
- 13.3. Where lubrication is affected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be

~~grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. All grease nipples shall be of the same size and type for every part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.~~

~~13.4. Where more than one type of special grease is required a grease gun for each special type shall be supplied and permanently labelled.~~

~~13.5. Oil containers shall be supplied complete with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The levels shall be clearly visible in the sight glass type from the normal access floor to the particular item of Plant and they shall be easily dismantled for cleaning. All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.~~

~~13.6. All lubrication systems shall be designed so as not to cause a fire or pollution hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential source of fire.~~

~~14. Name Plate~~

~~14.1. Each item of the plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of plants, details of the loading and duty at which the item of plant has been designed to operate, and such diagrams as may be required by the EIC. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.~~

~~14.2. Name plates, rating plates and labels shall be of a non flame propagating material, either non hygroscopic or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non corrosive screws, drive rivets or adhesives shall not be used.~~

~~14.3. Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background.~~

~~14.4. Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.~~

15. ~~Hardware, Nuts, Bolts, Studs and Washers~~

- ~~15.1. Nuts, bolts, studs and washers for incorporation in the plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut~~
- ~~15.2. Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.~~
- ~~15.3. Washers, locking devices and anti-vibration arrangements shall be provided where necessary. Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.~~
- ~~15.4. Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.~~
- ~~15.5. The contractor shall supply all holding down, alignment and levelling bolts complete with anchorages, nuts, washers and packing required to attach the plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the plant to concrete foundations without exceeding the design stresses.~~

16. ~~Allowance for Wastage~~

- ~~16.1. The contractor shall supply reasonable excess quantities to cover wastage of those consumable which will be normally subject to waste during erection, commissioning and setting to Work.~~

17. ~~Painting – General~~

- ~~17.1. The contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the plant at the place of manufacture prior to packing.~~
- ~~17.2. Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out if necessary, by washing with an approved de-watering fluid prior to surface treatment. Except where~~

~~the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.~~

~~17.3. All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.~~

~~18. Painting at Place of Manufacture~~

~~18.1. Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp corners etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition to the parts are to be provided with adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.~~

~~19. Painting at Sites~~

~~19.1. Immediately on arrival at the site, all items of plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.~~

~~19.2. After erection, such items which are not finish painted shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paint work. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.~~

~~19.3. The dry paint film thickness shall be measured by Electrometer or other instruments approved by the GWSSB. In order to obtain the dry film thickness specified, the contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm². Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.~~

20. Noise and Vibration

20.1. The Contractor shall provide a quiet installation. All items of plant and equipment shall be carefully chosen with a view to minimizing sound levels.

20.2. The Contractor shall provide and fix all material for the prevention of transmission of noise and vibration through the structure. Where appropriate all fans, A/C package unit, compressors and other motif plant shall be mounted on resilient mountings. All rotating plant shall be statically and dynamically balanced.

21. Galvanising

21.1. Wherever galvanising has been specified the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

• **Fabricated steel**

- | | | |
|----|--|----------------------|
| i | Thickness less than 2 mm
but not less than 1.2 mm | 340 Grams /Square mm |
| ii | Thickness 2 mm and above | 460 Grams /Square mm |

• **Fasteners**

- | | | |
|----|------------------------|----------------------|
| i | Up to nominal size M10 | 270 Grams /Square mm |
| ii | Over M10 | 300 Grams /Square mm |

21.2. Galvanising shall be carried out after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanising. Any Site modification of galvanised parts should be covered well by zinc rich primer and aluminium paint.

22. Support for Pipe work & Valves

All necessary supports, saddles, slings, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other equipment mounted in the pipe work shall be supported independent of the pipes to which they connect.

DETAILED & PARTICULAR TECHNICAL SPECIFICATIONS

PART I: MECHANICAL

HORIZONTAL SPLIT CASE CENTRIFUGAL PUMPS (HSCF)/MONO BLOCK PUMP (Wherever Applicable):

GENERAL

~~The Pump shall be Centrifugal, Horizontal shaft, Horizontal split case type designed manufactured for pumping liquid like raw / potable water. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts all other required accessories.~~

~~The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the 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 dia. possible for the offered pump model. The pump selected for rated performance below minimum Impeller diameter shall not be accepted.~~

~~The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSH) is less than available NPSH to ensure pump's operation without cavitation under the worst operating condition. The required NPSH at duty point throughout the range shall be at least 1.0 m 0.5 m, less than the available NPSH respectively at the lowest water level in the sump.~~

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

~~*The pump shall be designed to start with the delivery valve fully open.*~~

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

~~The pump's rotating assembly shall be statically dynamically balanced as per ISO standards and shall run smoothly without undue noise vibration. The velocity of vibration shall be within the 4.5 mm/sec. Noise level shall be limited to 85 dB A at a distance of 1.0 m.~~

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

~~Selection of pump shall be towards downward side.~~

FEATURES OF CONSTRUCTION PUMP:

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

CASING:

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

IMPELLER:

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

SHAFT SLEEVE:

Replaceable shaft sleeves shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber 'O' ring or CAF / Teflon gaskets shall be provided between impeller shaft sleeves to prevent liquid passage between shafts sleeves. In no case shaft shall be in contact with liquid. The surface hardness of the shaft sleeve shall be minimum 250 BHN.

STUFFING BOX:

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

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

Pumps required with Mechanical Seals shall be provided with necessary piping for cooling, flushing lubrication of seal faces as recommended by seal manufacturer. Seal shall be designed selected for the specified application to perform the equipment trouble free working life not less than 40,000 hours of operation. Seals shall be covered with SS 304 mechanical seal cover shall be tightened with SS fasteners as per the specifications.

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

BEARINGS:

The pump shall be provided with anti friction grease lubricated bearings. The whole rotating assembly of pump shall rest between a minimum of two bearings for smooth operation. Bearings shall be easily accessible for inspection maintenance. Bearings shall be of SKF / FAG make only.

COUPLING:

The pump shall be coupled with an electric motor mounted on a common base plate using pin bush type of KTR / Rathni make only. Coupling shall be statically dynamically balanced at rated speed.

COUPLING GUARD:

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

BASE PLATE:

The pumping unit shall be provided with a common drain rim type base plate with 25mm dia. drainpipe, terminated to nearest drain pit/trench. The base plate shall be of M.S IS 2062 and sufficient size rigid sufficient to maintain the pump motor in proper alignment position. Base plate shall be supplied by pump manufacturer only. The base plate shall be grouted on the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

MATERIAL OF CONSTRUCTION:

The specific requirement shall be considered as under:

Sr. No.	Description	Material
1	Casing	Cast Steel WCB
2	Shaft	AISI 410
3	Shaft sleeve	AISI 410 H
4	Impeller	CF8M
5	Impeller wear ring	SS 316
6	Casing wear ring (if apply.)	SS316
7	Shaft Seal	Gland Packed Stuffing Box
8	Liquid Deflector	Natural Rubber
9	Suction Strainer	SS 304

5 mm bar having 25 mm x 25 mm opening Base Plate (Drain Rim type) CI

NAME PLATE

Each pump shall be provided with a stainless steel name plate indicating the following details.

- _____ Model
- _____ Manufacturer's special number
- _____ Rated capacity in LPS / M³/HR
- _____ Total head in MWC
- _____ Speed in RPM
- _____ Weight of equipment
- _____ Material of impeller

DOCUMENT: DATA SHEET OF HORIZONTAL SPLIT CASE CF PUMP (HSCF) (If applicable)

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
1.0	LIQUID DATA		
1.1	Liquid handled	Treated Water	
1.2	Specific gravity	1.0	
1.3	Residual chlorine in ppm	2 to 3	
1.4	Temperature	Ambient temp.	
2.0	PUMP DATA		
2.1	Make	As per Approved List	
2.2	Pump type	Horizontal Split Case	
2.3	Pump Model	Pl. Furnish detail	
2.4	Number of pumps – Nos.	As per price bid	
2.5	Type of duty	Continuous	
2.6	Design capacity m ³ /hr.	As per price bid	
2.7	Total Rated Head m.	As per price bid	
2.8	Guaranteed min. Pump efficiency at rated capacity in %	Pl. Furnish detail	
2.9	Guaranteed Overall Pump set efficiency at rated capacity %	Min. w/o -ve tolerance	
2.10	Pump input at rated duty KW	Pl. Furnish detail	
2.11	Rated Speed of pump – RPM	(Synchro.) max. (FLS of Ele. Motor)	
2.12	Max. BkW @ Rated Impeller.	Pl. Furnish detail	
2.13	Reco. Drive motor rating – KW	Pl. Furnish detail (Min. as per BOQ)	
2.13.1	Guaranteed min. Motor efficiency at rated capacity. w/o coating %	Min. IE – 3 w/o -ve tolerance	
2.14	Full load speed of motor – RPM	Pl. Furnish detail	
2.15	N.P.S.H. required – m	Pl. Furnish detail	
2.16	Shut off head – m	Pl. Furnish detail	
2.17	Location	Indoor	
2.18	Pump Speed	As Per BOQ	
2.19	Minimum Efficiency	As per BOQ	
3.0	Constructional Feature		
3.1	No. of stage	Single/ Double	
3.2	Casing	Volute type	
3.3	Impeller	Pl. Furnish detail	

3.4	Impeller dia. – mm	Max. / Rated / Min.	
3.5	Shaft / Drive Transmission	Direct Coupled	
3.6	Shaft sealing	GI packed Stuffing Box sealed	
3.7	Mounting Orientation	Horizontal	
3.8	Nozzle orientation and size mm		
	Suction	mm / Side	
	Discharge	mm / Side	
3.9	Flange drilling	As per IS 1538, FF	
3.10	Direction of rotation	Pl. Furnish detail	
3.11	Type of Starter	As per standard	
3.12	Suction	Single/ Double	
4.0	MATERIAL OF CONSTRUCTION		
4.1	Pump Casing	Cast Steel WCB	
4.2	Impeller	CF-8 M	
4.3	Shaft	AISI 410	
4.4	Shaft Sleeve	AISI 410-H	
4.5	Casing /Impeller Wearing Ring	SS-316	
4.6	Strainer	SS-304 of 5 mm bar	
4.7	GI Bolt and Nuts	SS-316	
4.8	Hardware in contact with liquid / non-wetted	Wetted: SS-304 Non-Wetted: G.I.	
4.9	Liquid deflector	Natural Rubber	
4.10	G.I.	CI IS-210 Gr FG260	
4.11	Painting	Pl. Furnish detail	
4.12	Base plate (Drain rim type)	C.I.	
5.0	ACCESSORIES and SERVICES REQUIRED		
5.1	Pin Bush Type Coupling	YES	
5.2	Coupling guard	YES	
5.3	Set of foundation bolts and Nuts	YES	
5.4	Base Plate	YES	
6.0	WEIGHT		
6.1	Weight of pump kg	Pl. Furnish detail	
6.2	Weight of motor kg	Pl. Furnish detail	
7.0	DRAWINGS		
7.1	ISO efficiency Perform. curve	Pl. Furnish detail	
7.2	GAD Drawing. of Pump set	Pl. Furnish detail	
7.3	C/S Drawing. of pump with part list	Pl. Furnish detail	
7.4	Catalogue of products	Pl. Furnish detail	
7.5	QAP of products	Pl. Furnish detail	

7.6	Speed Torque curve	Pl. Furnish detail	
8.0	TESTING		
8.1	Hydrostatic test	Required for review	
8.2	Performance test	100 % qty. Witness with Job motor	
8.3	Dynamic balancing test	T.C. verification	
9	The shut-off head should not be less than	Min. 120 % of the total head of the pump	

Note:

- ~~1. Manufacturer / supplier shall submit separate data sheets for each duty.
Bidder shall refer electrical specifications for motor requirement shall offer accordingly.~~

Horizontal Mono Submersible Pump Set / Drain Pump set:

The horizontal mono submersible pump set shall be as per IS: 14220 / 1994 with latest amendments. The standard specifies the technical requirement for three phase mono submersible pump sets commonly used in sump for handling clear cold water for application in water supply etc. The duty point of the set should be located at the optimum efficiency point of the pump rating curves, there should not be steep fall in efficiency in the operating range. The pump with single stage RPM of shall be 2900 operating on $415 \pm 10\%$ volts, 3 phase and 50 Hz frequency.

Minimum motor horsepower rating, cable size, starting system delivery size shall be as specified in the data sheet.

Features of construction shall be as follows.

Pump:

The pump casing should be free from blow holes, sludge inclusion other detrimental defects. Casing should be provided with renewable wearing rings excepting radial flow pump set. Casing should be provided with wearing rings. Casing should be hydraulically tested up to 1.5 times shut off pressure. Shut off head shall be at least 120 % of rated head.

Impeller:

Impeller should be of closed type, ensuring required performance free of capitations. The material of impeller will be as per MOC shown in data sheet.

Shaft:

The pump and motor shall be unbuilt on the common shaft. Below the impeller shaft assembly, shaft protection sleeve shall be provided. It shall have surface finishing of 0.75 Microns. The material of shaft shall be as per Annexure III.

Motor:

The submersible motor shall be confirmed to IS: 9283 / 1994 with latest revision. It should be totally enclosed squirrel cage induction type water cooled water lubricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearing should be of wet type water lubricated designed to take all untoward load at most unfavorable running conditions. Front rear bearing housing thrust bearing housing should preferably be fixed separate replaceable bolts / studs (not threaded connections) to the starter to facilitate easy dismantling. Full proof sealing arrangement by s guard shall be preferred in the motor inlet body to prevent open well water impurities like s, silt from entering the motor bearing stator motor should be impregnated with a superior varnish class B thermal insulation properties by vacuum pressure or epoxy paints on stator cold rolled stamping used rotor shall be painted with Polyurethane paint and backed properly under controlled temperature condition not by manual or gravity flow to remove air pocket so that these are thoroughly filled up by varnish. The motor rotor

~~should be preferably lead shot blasted. Subsequently rotor body should be baked repeatedly under controlled conditions to ensure long life of paint hard finish to the surface to avoid corrosion before power coating.~~

~~The material for construction of rotor shaft shall be as specified in data sheet provided with sleeves having materials as per detailed material of construction in the bearing portion. The windings should be accessible to facilitate checking locating any faults without disturbing all the coils and also to enable replacement of any defective coils. It should be possible to rewind the Stator with readymade protested coils to save time during the repair. Kelvin Bridge / digital resistance meter shall be treated preferable for measurement of hot cold resistance of winding for evaluated temperature rise. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump sets. Earth leakage current should not be more than 50 Milli amperes at rated voltage.~~

~~The HP rating of motor shall be decided on minimum power margin over above the power required on duty point shall be 25 % bidder has to supply motor of minimum HP rating considering 25 % reserve power margin.~~

~~Starting method shall be direct online.~~

Cable:

~~The motor shall be provided with three core flat PVC waterproof flexible copper submersible cable in single length (approx. 15 meters) of suitable size as per actual requirement. The cross-sectional areas should be sufficient so as not to cause voltage drop of more than 2.5% of nominal voltage i.e., 10 volts at 400 volts throughout the length of the cable size of the Following points shall be applicable for the manufacture of the pump set:~~

- ~~(1) Casing individually tested to hydraulic test pressure 1.5 times of shut off pressure.~~
- ~~(2) All rotating parts should be individually balanced on machine for rated RPM according to the relevant IS (vibrations of the assembly during the testing shall not exceed 80 micron peak to peak). Impeller closed type.~~
- ~~(3) Motor Wet type~~
- ~~(4) Brass / Carbon steel drain plug provided.~~
- ~~(5) Compensating device provided.~~
- ~~(6) The stator varnished by vacuum pressure method or EPOXY painted (if cold rolled stamping used).~~
- ~~(7) Rotor varnished by vacuum pressure method or Epoxy Paint methane paint duty properly backed.~~
- ~~(8) Rotor painted baked under controlled condition or powder coated.~~
- ~~(9) Winding easily assembled.~~
- ~~(10) Winding subjected to 1.5 KV for 30 seconds.~~
- ~~(11) Matching grooves for stopping rotation shifting.~~
- ~~(12) SS / Brass suction strainer preferred.~~
- ~~(13) Stud nuts shall be of alloy steel nut shall be lock Nut.~~
- ~~(14) The Stator end ring shall be of bronze metal or MS.~~

- (15) ~~The stator is rewind able with readymade protested coils in each type of motor offered.~~
 (16) ~~Cable confirming to IS: 694.~~

Testing performance as per IS: 14220 with latest revision:

~~Pump shall be tested as per IS: 14220 motors shall be tested as per IS: 9283 at manufacturers works. Bidder shall have to give internal test report.~~

Materials of Construction

Sr. No.	Description	Material (s)
1	Shaft sleeve when used	Grade X04 Cr. 12, X12 Cr 12 or X 20 Cr 13 Conforming to IS: 1570 (part 5) 1985
2	Motor bearing housing base	Grade FG 200 of IS: 210/1993
3	Pump and Motor Shaft (Common)	Grade X04 Cr 12, X12 Cr 12 or X20 Cr 13 Conforming to IS: 1570 (Part-5) 1985 or Grade 40C8 or 45C8 Conforming to IS: 1570 (Part-2/ Sec.1) 1979
4	Bearing Bush	Leaded tin bronze Grade LTB3, LTB4 or LTB5 of IS: 318 / 1981 or resin bonded carbon or PTFE bonded carbon
5	Rotor	Electrical sheet steel electro grade copper rods conforming to IS: 613 / 1984 or Aluminum dia cast rotor conforming to IS: 617 / 1984
6	Stator Core	Electrical sheet steel PVC insulated winding wire/polymer insulated winding wires or with any suitable plastic covered wires conforming to IS: 8783 /1978
7	Winding Wire	i) For motors other than water filled motor: Enameled copper conductor conforming to IS: 4800 (Part-7) 1970 ii) For water filled motors: (a) Enameled copper conductor to IS: 4800 (Part-7) /1970or. (b) PVC insulated winding wire conforming to IS :8783 / 1978or. (c) With polymer insulated such that the test on insulated resistance satisfied
8	Breather diaphragm	Nitrile rubber

9	Cable	PVC insulated PVC sheathed 3 core flat type conforming to IS: 694/1990 or PVC insulated. polymer sheathed 3 core flat type (approx. 15 meters)
10	Cable Gl	Nitrile rubber
11	Thrust Bearing face combinations	Bronze- ferrous asbestos, Brass - Ferro tests, Carbon- Stainless steel, Bronze suitable elastomer or any other suitable combinations
12	Water drain plug	Bronze / Brass / Stainless steel / Suitable Plastic
13	Impeller	High tensile brass conforming to IS: 304 /1981 or. leaded tin Bronze LTB 2 of IS: 31 8/ 1981
14	Casing	Cast iron Grade FG 200 of IS: 210 / 1993, Allow. steel casing conforming to IS: 3444/1987
15	S-Guard	Bronze Or S.S.

DATA SHEET FOR HORIZONTAL MONO SUBMERSIBLE PUMP SET			
Name of RWSS:			
Name of Pumping Station:			
Sr. No.	Particulars	Departmental Requirement	Bidders' Data
1	Capacity	As per price bid	
2	Head	As per site Survey by contractor	
3	Type of pump	Horizontal mono-submersible	
4	Minimum submergence required in meter	Manufacturers' Standard	
5	Make	As per Approved List	
5	Motor Details		
5.1	Type of motor	Submersible	
5.2	Rated Voltage	415 Volts	
5.3	No. of phases frequency	3 Phase, 50 Hz	
5.4	Method of Starting	Up to 7.5 HP DOL, 7.6 HP to 20 HP Star Delta, 21 to 100 HP ATS, above 100 HP Soft Starter	
5.5	Class of insulation	"F" Class	
5.6	Fill of motor	Water	
5.7	Ambient reference temperature	45°	
5.8	Motor HP rating	Manufacturers' Standard	
5.9	Synchronous motor speed	3000 RPM	
5.10	Motor input at duty point	Pl. furnish detail	
5.11	Reserve power of motor	As per CPHEEO Manual	
6	Cable		
6.1	Size	Pl. furnish detail	
6.2	Maximum current carrying capacity of Cable	Pl. furnish detail	
7	Overall efficiency of pump set		
7.1	at Full Load	Pl. furnish detail	
7.2	at duty Point	Pl. furnish detail	

8	Materials of construction		
8.1	Confirm materials of construction for various pump and motor parts with accessories as per detailed technical specifications	Yes / No	
8.2	State any variation in any of above explicitly	* To be stated by the pump manufacturer / agency	
9.0	Required accessories		
4.2	Delivery Pipe	Required	
4.4	Direct online starter panel	Required	
4.6	Cable required for pump motor	Required	
4.7	Suction Strainer	Required	

- The material for construction of rotor shaft shall be as specified in data sheet provided with sleeves having materials as per detailed material of construction in the bearing portion. The windings should be accessible to facilitate checking locating any faults without disturbing all the coils and also to enable replacement of any defective coils. It should be possible to rewind the Stator with readymade protested coils to save time during the repair. Kelvin Bridge / digital resistance meter shall be treated preferable for measurement of hot cold resistance of winding for evaluated temperature rise. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump sets. Earth leakage current should not be more than 50 milli amperes at rated voltage.
- The HP rating of motor shall be decided on minimum power margin over above the power required on duty point shall be 25 % bidder has to supply motor of minimum HP rating considering 25 % reserve power margin.
- Starting method Up to 7.5 HP. D.O.L. Starter, 8 to 20 HP Star Delta 21 HP and above Auto transformer starter type.

Note:

2. Manufacturer / supplier shall submit separate data sheets for each duty.
Bidder shall refer electrical specifications for motor requirement shall offer accordingly.

L.T. MOTORS (PRIME MOVER)**1. GENERAL**

- ~~The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing commissioning of Squirrel cage induction motors complete with instrumentation controls safety devices, equipment, lubricating system oil.~~
- ~~The scope of supply shall include spares for 5 years of operation of the pumping station, special tools testing devices, all parts accessories etc. which are essential for construction, operation maintenance of all the motors even though these are nor individually or specifically stated or enumerated.~~
- ~~Corresponding components of all the motors associated equipment spares shall be of the same material, dimensions finish shall be interchangeable.~~
- ~~The motor shall perfectly match in respect of speed, runaway speed, moment of inertia overload capacities, couplings any other requirement with that of pump.~~

2. STANDARDS

Sr. No.	Standard	Description
1	IS 325	Squirrel cage induction motors
2	IS 12615	Energy efficient induction motors- three phase squirrel cage
3	IS 4691	Type of enclosures
4	IS 900	Code of practice for installation maintenance of induction motors
5	IS 6362	Method of cooling
6	IS 4029	Testing of induction motors
7	IS 2223	Dimensions of flange mounted as induction motors
8	IS 2253	Designations for types of construction — mounting Arrangements of rotating electrical machines.
9	IS 2254	Designations of vertical shaft motors for pumps
10	IS: 4722	Rotating electrical machines
11	IS: 4728:1975	Terminal marking direction of rotation for rotating electrical Machinery.
12	IS: 6362:1995	Designation of methods of cooling for rotating electrical Machines.
13	IS: 7816:1975	Guide for testing insulation resistance of rotating machines.
14	IS: 12065:1987	Permissible limits of noise level for rotating electrical machines.
15	IS: 12075:1987	Mechanical vibrations of rotating electrical machines
16	IS: 4889:1968	Method of determination of efficiency of rotating electrical Machines.
17	IS: 12802:1989	Temperature rise measurement of rotating electrical machines.
18	IS: 12824:1989	Types of duty classes of rating for rotating electrical machines

3. TECHNICAL PARAMETERS

Sr. No.	Description	Technical Parameter
1	Motor Rating	As per the requirement of Pump.
2	Type of motors	3 Phase Induction Motor, TEFC
3	Quantity	
4	Motor duty	Continuous, S1
5	Application Standard	IS-325
6	Motor Energy efficiency class	EFF2 as per IS-12615 (94%)
7	Design Temperature	50 Deg C amb.
8	Rated Speed	Contractor to specify
9	Supply voltage and frequency Conditions Voltage: Frequency: Combined V and F Variation	415 V \pm 10% 50 Hz \pm 5% \pm 10%
10	Insulation class	Class F temperature rise as per class B
11	Starting Method	Star-Delta up to 50 kW Soft Starter for Above 50 kW
12	Cable termination details	Al conductor, XLPE / PVC insulated, armored. 0.433 kV grade cable
13	Cable termination box protection	Class IP 55
14	Space heater	230 V
10	Bearing temperature sensing	Required
15	Winding temp. sensing	6 Nos. required for each motor
16	Minimum Efficiency	As per Manufacture

4. DESIGN CRITERIA**4.1 Rating and Temperature rise**

- All motors shall be of continuous rated type.
- The motors shall be designed for maximum ambient temperature of 50°C; with the temperature rise of the stator winding by resistance method over the ambient air temperature not exceeding 70°C for both class B class F insulation.
- In case of continuous operation at extreme supply voltage variation limits, the temperature rise limits as specified above shall not exceed by more than 10°C for motors of output up to including 200KW. \pm 10%
- Each motor shall be assigned a maximum continuous rating (MCR) corresponding to this temperature rise.
- Wherever the basis for motors ratings is not specified in the corresponding mechanical specification sections, maximum continuous motor ratings shall be at least 50% above the

~~maximum load demand of the driven equipment under entire operating range as specified elsewhere including voltage frequency variation.~~

- ~~f) The rated supply voltage, voltage and frequency variations in the supply are mentioned elsewhere. Motors shall be capable of delivering its maximum continuous rating with supply variations. The motor can start satisfactorily under extreme conditions.~~
- ~~g) All motors shall be so designed that the maximum inrush currents, locked rotor pull out torques developed by them at highest voltage frequency limits do not endanger the motor the driven equipment.~~
- ~~i) Induction motors shall be designed to be capable of withstand the voltage torque stresses developed due to the difference between the motor residual voltage incoming supply voltages equal to 150% of the rated motor voltage during changeover of buses.~~
- ~~j) The voltages at all motors during start up shall be maintained at a value which ensures that there is sufficient accelerating torque developed by the motor to give a safe run up time.~~
- ~~k) The maximum system transient impedance shall be used in calculating voltage drops relating to motor starting, restarting re acceleration requirements.~~
- ~~l) During starting or re acceleration of a motor, either individually or in a group, the voltage dip at the motor terminals shall not vary more than 15% from rated voltage when started direct online under the worst operating scenario i.e. largest motor started with minimum number of power sources minimum fault level.~~

5. TORQUE REQUIREMENTS

- ~~a) The accelerating torque at any speed with the lowest starting voltage shall be at least 10% of rated full load torque of the motor.~~
- ~~b) The pull-out torque at rated voltage shall not be less than 205% of the full load torque.~~

6. NO. OF STARTS

~~Continuous duty motors shall be suitable for two starts in succession three equally spread starts in an hour under the specified conditions of load, torque inertia, with the motor initially at its normal running temperature.~~

7. STARTING CURRENT

~~The ratio of starting Current/rated current (MCR corresponding to the specified temperature rises) shall not exceed 6. In case of DOL starter. But with soft starter it shall be between 2 to 3 times.~~

8. STARTING TIME

- ~~a. For motors with starting time up to 20 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be~~

at least 2.5 seconds more than starting time.

- ~~b. For motors with starting time more than 20 seconds but not exceeding 45 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.~~
- ~~c. For motors with starting time more than 45 seconds at minimum permissible starting voltage, the locked rotor withstand time under hot conditions at highest voltage limit shall be more than the starting time by at least 10% of the starting time.~~

9. CONTROL

~~All the motors shall be suitable for control through circuit breaker / MCCB as specified.~~

10. ENCLOSURE METHOD OF COOLING

~~The motors shall be totally enclosed closed Fan Cooled, (TEFC).~~

11. VIBRATION LEVEL and NOISE LEVEL

~~— The vibrations as measured at motor bearings shall be within the limits specified in IS: 12075/ BS: 4999 Part 142. The motor shall also be capable of withstanding the vibration produced by the driven equipment. The Noise levels shall comply with IS: 12065.~~

12. CONSTRUCTIONAL FEATURES

- ~~a) Motor its components (such as stator, rotors, end shields, terminal boxes, and bearings heat exchangers) shall be designed to be readily interchangeable as integral units for the same design rating.~~
- ~~b) All nonmetallic components used shall be resistant to flame propagation.~~
- ~~c) All enclosures shall be designed to provide effective sealing between the primary secondary air circuits. All totally enclosed types of motors shall have suitable means of breathing drainage to prevent accumulation of condensation. Drain holes diameter shall not exceed 6mm.~~
- ~~d) The cooling fans shall be capable of being connected for rotation in either direction or due care for cooling etc., especially where identical motors are to be provided for opposite direction of rotation, such as for a pair of conveyors without replacing or removal of fans or any other parts.~~
- ~~e) Motors shall preferably be capable of being connected for rotation in either direction with due care for cooling etc., specially where identical motors are to be provided for opposite direction of rotation, such as for a pair of conveyors without replacing or removal of fans or any other parts.~~

- ~~f) All heavy parts of the motors shall be provided with necessary arrangement: such as lifting lugs/eye bolts for lifting or handling during erection or overhaul.~~
- ~~g) All motor rotors shall be dynamically balanced. Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.~~
- ~~h) Space heaters or internal electric heaters shall be provided on motors rated above 30 KW to maintain the windings in a dry condition during periods of still. The heaters shall be suitable for use on 240 volts, 50Hz AC Supply.~~

~~— Space heater shall remain ON when motor is in operation.~~

~~j) Temperature Detectors~~

~~— At least six nos. of simplex or duplex platinum resistance type embedded temperature detectors, evenly distributed around the stator, and shall be provided for all HT motors. These shall be located at locations where high temperatures are expected during operation. Resistance of the temperature detector at 0°C shall be one hundred (100) ohms. Temperature detector lead insulation class shall be the same as stator winding insulation class. Detector leads, external to the slot shall be provided with a protective covering. These RTDs shall be wired to PLC controls for monitoring temperature rise.~~

13. WINDING INSULATION

- ~~a) Winding insulation shall be of class B or better for LT AC motors. It shall be of proven high quality reliability.~~
- ~~b) All windings insulation shall be non hygroscopic, oil resistant resistant to flame propagation. All windings shall be impregnated suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site.~~
- ~~c) All winding overhangs leads shall be adequately supported, braced blocked.~~
- ~~d) Cage windings for all joints shall be designed to give an adequate safety factor on the fatigue due to thermal mechanical stresses, considering the specified starting running conditions. All electrical joints connections shall be of brazed or welded construction.~~

14. BEARINGS

- ~~a) Bearings shall be of roller type, except where motor speed shaft loading dictates otherwise. Vertical motors shall normally have rolled type guide thrust bearings. The latter may however be of Kingsbury tilting pad type where heavy axial loads are to be supported.~~
- ~~b) Temperature of lubricating oil as it leaves the bearing shall be not exceeding 71 degree C.~~
- ~~c) Bearing shall comply with the relevant Indian or International Standards. The bearings housing shall be correctly packed with lithium-based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.~~

15. TERMINAL BOXES ASSOCIATED FITTINGS

- ~~a) The cable boxes terminations shall be designed to enable easy disconnection replacement of cables. Leads from terminals to the windings shall be adequately sized braced to withstand the heating forces produced by maximum fault current.~~
- ~~b) Terminals shall be suitable for receiving aluminum conductor XLPE/PVC insulated cables. Motor shall be supplied with compression type tinned brass cable gland crimping type tinned copper lugs for the termination of cable. The termination lugs shall conform to DIN46329.~~
- ~~c) Clearance between the lugs/bare live parts of different phases between lugs/bare live parts earth shall be as per relevant standard. The terminal boxes shall be capable of withstanding a system fault level. A suitable provision of releasing the pressure developed during faults shall be made. Terminal boxes shall be suitable for top bottom entry of cables.~~
- ~~d) LT motor terminal box shall be capable of being turned through 360° in step of 90 degree C.~~

16. EARTHING TERMINALS

- ~~— Two independent earthing points shall be provided in accordance with IS: 3043, on opposite sides of the motor for bolted connection.~~

17. RATING PLATE

- ~~— In addition to the requirements as called for in relevant IS, the rating plating plate shall indicate the following:~~
- ~~a) Maximum continuous rating in KW corresponding temperature rise, as applicable for cooling medium temperature as specified.~~
- ~~b) Bearing identification numbers (in case of ball / roller bearing recommended lubricant.)~~

18. PAINT and FINISH

- ~~a) All external parts shall be finished painted to produce a neat durable surface which would prevent rusting corrosion. The equipment shall be thoroughly deoiled, sharp edges scales removed treated with one coat of primer two coats of enamel paint shade no 631 as per IS:5 for indoor motors shade no. 632 as per IS: 5 for outdoor motors. Motor fans shall also be painted to withstand corrosion.~~
- ~~b) All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plate. Current carrying fasteners shall be either stainless steel or high tensile brass or copper.~~

19. PRE-COMMISSIONING TEST OF PUMP and MOTOR:

- ~~• The test shall be carried out as per IS: 9137 code of acceptance test of pump Class C, in general as started below in particular.~~
- ~~• The purpose of the field test is not to ensure whether pump performance as regards~~

parameter i.e., H, Q and power etc. is within acceptance limit as per IS: 9137. The purpose is to ensure that the pump performance is generally acceptable or otherwise.

— Final acceptance shall be as per the following criteria.

- i) As regards H/Q characteristic for acceptance it shall be checked whether motor is not getting overloaded within the specified head range.
- ii) Flow measurement shall be taken by the flow meter provided by contractor.
- iii) The head shall be measured with calibrated pressure gauge of accuracy 1% or better. At least 3 pressure gauges shall be calibrated from two different institutions with prior approval of the Engineer in charge. The calibration shall be pointed to point not merely for percentage error. The gauge shall be fitted at a suitable place from the discharge nozzle. It may be noted that pressure gauge shall be installed at least 2 times diameter away from discharge nozzle delivery valve be placed at least four times diameter away from discharge nozzle. Such conditions shall be simulated at site condition no allowance for this deficiency shall be considered. The decision of Engineer in Charge shall be final.
- iv) The input power to the motor shall be measured by 2 wattmeter method. The watt meters shall be of Laboratory grade having accuracy of min. 0.5% these should be digital type.
- v) The speed shall be measured by a non contact tachometer with digital display calibrated. The field test shall be taken with entire head range in such a manner that it would cover at least 6 points (i.e., duty point, 2 above duty points, 2 below duty point shut off). The guarantee for head discharge shall be deemed to be fulfilled as per clause.

— The field performance test at the site is essential as above (i) to (v) the manufacturer shall also be asked to attend the same.

20. PRE COMMISSIONING CHECKS and TEST OF HT MOTOR:

1. Check IR and PI value. If required improve IR and PI by drying out to obtain the required insulation resistance values. Approval of the drying methods shall be obtained from the Owner before applying heat.
2. Align the motor with the pump.
3. Check cable connection at motor phase, neutral side and Circuit breaker side space heater connection.
4. Check motor earthing at two places to measure earth resistance.
5. Set winding and air temperature gauges for alarm and trip set value are as per OEM recommendation and simulate the values.
6. Carry out DC simulation test of the breaker. See that breaker trips by operating all relays one by one.
7. Test motor protection relay by secondary injection relay test set and see that settings are done as per recommendation.
8. Switch on DC supply at motor beaker keeping breaker in racked out position. See that space heater becomes "on". Measure current taken by the space heater circuit. And note down for future reference.

9. ~~Run the motor in decoupled condition, check direction of rotation, it should be as required for the pump. Note down no load current in decoupled, vibration on motor bearings in decoupled condition.~~
10. ~~Stop motor, Coupled motor with Pump. Give start kick and check direction of rotation.~~
11. ~~Run pump motor set with discharge valve in closed position. Observe and note down no load current in coupled condition, vibration at all the bearings for future reference.~~
12. ~~Run motor on load opening pump discharge valve note down no load current in coupled condition, vibration at all the bearings for future reference.~~
13. ~~Each Pump motor set is to run separately continuously for 72 hours at full load temperature of various parts including winding, bearing etc. are to be observed. Measurement of discharge at rated head is to be measured.~~

21. PRE-COMMISSIONING CHECKS and TEST OF LTMOTOR:

1. ~~Check IR and PI value. If required improve IR and PI by drying out to obtain the required insulation resistance values. Approval of the drying methods shall be obtained from the Owner before applying heat.~~
2. ~~Align the motor with the pump.~~
3. ~~Check cable connection at motor phase, neutral side and Circuit breaker side space heater connection.~~
4. ~~Check motor earthing at two places to measure earth resistance.~~
5. ~~Set winding and air temperature gauges for alarm and trip set value as per OEM recommendation and simulate the values.~~
6. ~~Carry out DC simulation test of the breaker. See that breaker trips by operating all relays one by one.~~
7. ~~Test motor protection relay by secondary injection relay test set and see that settings are done as per recommendation.~~
8. ~~Switch on DC supply at motor beaker keeping breaker in racked out position. See that space heater becomes "on". Measure current taken by the space Heater circuit. And note down for future reference.~~
9. ~~Run the motor in decoupled condition, check direction of rotation, it should be as required for the pump. Note down no load current in decoupled, vibration on motor bearings in decoupled condition.~~
10. ~~Stop motor, Coupled motor with Pump. Give start kick and check direction of rotation.~~
11. ~~Run pump motor set with discharge valve in closed position. Observe and note down no load current in coupled condition, vibration at all the bearings for future reference.~~
12. ~~Run motor on load opening pump discharge valve note down no load current in coupled condition, vibration at all the bearings for future reference.~~
13. ~~Each Pump motor set is to run separately continuously for 72 hours at full load temperature of various parts including winding, bearing etc. are to be observed. Measurement of discharge at rated head is to be measured.~~

SLUICE VALVES

DESIGN FEATURES

- ~~At the valves above or equal to the size of 300 mm nominal bore shall be gear operated.~~
- ~~It is a general requirement that the valves in the pump house shall be Sluice / Gate / Butterfly Valves and shall be motorized are of Cast iron (CI) body construction valves in the field pipelines shall be Sluice / Gate / Butterfly Valves and shall be manually operated (through a suitable gear box mechanism in case of valves above 300 mm NB) and are of Cast iron construction unless otherwise stated.~~
- ~~The valves shall be free from sharp projections, which are likely to catch hold of stringy materials.~~
- ~~Valves shall close with clockwise rotation of the hand wheel. The direction of closing opening shall be marked on the hand wheel.~~
- ~~The stuffing box gland shall be of a one piece design.~~

FEATURES OF CONSTRUCTION

- ~~The pump house valves shall be preferably with a mechanical and electrical indication of valve position and indication of the valve percentage opening. The valves for the field pipeline shall be manually operated. The valves shall be provided with a valve position locking arrangement (mechanical type).~~
- ~~Sluice / Gate Valves shall be provided with back seating arrangement.~~
- ~~Renewable body wedge rings shall be provided.~~
- ~~Valve shall be of double flanged type. Holes drilling flange thickness of valve flange mating companion flanges shall generally conform to the standard IS 1538 1976.~~
- ~~The valves shall be completely overhauled before placing them in position.~~
- ~~Necessary joining materials viz. bolts, nuts, washers, packing etc. shall be provided by the~~

contractor at his cost. The valves associated with piping shall be fixed to have axis perfectly horizontal. The Valves associated piping shall be supported on RCC pedestals and the associated piping shall be secured with suitable clamping arrangement. For an easy access to the valves" manual operating wheel, necessary approach with operator's sting space shall be provided for all the valves of the pump house of the field pipelines.

- If required, the contractor shall also carry out drilling of holes of appropriate diameter in flanges in required numbers.
- A wheel shall be provided for emergency operation. The h wheel drive shall be mechanically independent.
- The valve design shall take care of the pressure drop across the valve disc in case of partial opening of the valve shall take care of the erosion cavitation's effect on the body disc during such operation.
- Valve(s) subjected to back pressure shall have the valve seat, disc the operator suitably designed to ensure trouble free operation.
- Valve body shall be of Cast Iron (CI) material with flanged ends in pump house.
- The shaft diameter shall take into consideration, the maximum torque required for the valve operation, the maximum differential pressure across the valve disc when the valve is closed the shock load due to accidental closure of the valve disc.
- The disc shall be designed for maximum differential pressure across the valve as well as the shock load due to accidental closure of the valve. The disc design shall offer minimum head loss. Disc shall also offer minimum resistance to flow. Disc shape shall be contoured.
- Valve seats shall be of a design that permits removal replacement at site shall be securely clamped on the body or disc of the valve.
- Seat material shall be suitable for the operating conditions handling fluid may be suitably reinforced, if required.
- The seat design shall permit easy removal for replacement purposes without the need for removing the valve from the line. No deposited or welded seat rings permitted.
- The valve bearings shall be of 'self-lubricated' type shall not have any harmful effect due to handling fluid.
- Adjustable thrust bearing(s) shall be provided to hold the valve disc securely in the center of

the valve seat.

- ~~Operator (mechanical or electrical actuator) shall be used for opening, closing, controlling or holding the valve disc at intermediate positions when required. Operator sizing shall be done based on the maximum torque requirement of the valve for seating/ unseating/ controlling/ holding the disc at the intermediate positions the time required for valve operation.~~
- ~~Irrespective of whether the valve is operated by a power actuator or not, each Sluice Valve/ Gate Valve shall be provided with a wheel for manual operation. The h wheel associated gearing arrangement shall be designed to limit the maximum manual effort to around twenty (20) kg for valve operation. Valves located at inaccessible positions, shall be provided with extension spindle floor set or h lever/ round chain to facilitate manual operation.~~
- ~~Valve to be operated through gearing arrangements / or by power actuator, shall be provided with adjustable mechanical stop limiting device to prevent over travel of the valve disc in „open“ or „closed“ position.~~

REQUIREMENT FOR VALVES

The valves shall satisfy the following requirements.

Size _____ : As per Datasheet

Body test pressure _____ : As per Datasheet

Seat pressure _____ : As per Datasheet

MATERIAL OF CONSTRUCTION (MOC)

Body (Pump House) _____ : Cast Iron –CI

Body (Field Valves) _____ : Cast Iron –CI

Spindle _____ : Stainless steel SS 410.

Operation (Pump House Valves) _____ : Motorized controlling operation through
Electric Actuator (only ON / OFF operation is not acceptable)

Operation (Field Pipeline Valves) _____ : Manual operation through a suitable gear box

Application _____ : Raw Water

Material test certificate shall be furnished.

INSPECTION PERFORMANCE TESTS

- ~~The manufacturer shall conduct all tests stage inspections required to ensure that the equipment offered by him conforms to the specification requirement.~~
- ~~Test certificates for all shop tests shall be furnished to the Engineer In-Charge for approval.~~
- ~~The Engineer In-Charge or his Representative shall witness the tests.~~

- ~~The Contractor shall arrange for inspection of valves at manufacturer's premises shall arrange for testing of valves for body test pressure seat test pressure of all the valves to be supplied in presence of Engineer In Charge in line with the approved Quality Assurance Plan.~~
- ~~Defects noted during inspection, test operation of valves shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer In Charge.~~

TESTS FOR VALVE

(a) MATERIAL TEST

- ~~Material to be used for the valve components shall be of tested quality. Chemical analysis mechanical tests on materials to be used shall be done as per the relevant standard.~~

(b) NON-DESTRUCTIVE TEST

- ~~Valve body disc shall be subjected to Non-Destructive Testing (NDT). Components subjected to NDT shall be stamped for identification.~~

(c) HYDROSTATIC TEST

- ~~Each valve body shall be subjected to hydrostatic test as specified. For valves subjected to back pressure condition, leakage test shall be carried out on both sides of the disc.~~

(d) PERFORMANCE TEST

- ~~Each valve complete with operating device shall be shop operated at least three (3) times from fully closed to fully open conditions reverse, held at intermediate positions under no flow condition, to prove the workability of the assembly.~~

(e) TESTS AT SITE

- ~~Performance of the valves shall be tested at site at actual working condition.~~

CLEANING

- ~~Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter shall be removed from interior of valve. All mill scales, rust, oil, grease, chalk all other deleterious material shall be removed from the interior exterior surfaces.~~

PAINTING

- ~~Valves shall first be given two coats of zinc base primer after completely cleaning the surface then it shall be coated with three coats of epoxy paint. The resulting coating shall be uniform smooth shall adhere perfectly to the surface.~~

TECHNICAL PARTICULARS

- a. Applicable standard : IS 14846-2000 / API 600/603/ BS1414.
- b. Application : Raw Water
- c. Liquid data : Specific Gravity 1.0kg
- d. Type : Double flanged
- e. Hand wheel : Required for operation.
- f. Bolts and nuts : Carbon steel
- g. Body test pressure : As per Datasheet

- h. ~~Seat test pressure~~ : ~~As per Datasheet~~
- i. ~~Connection~~ : ~~To be provided on pipeline in between pump~~
~~Discharge the common header.~~
- j. ~~Flange thickness and holes~~ : ~~As per IS: 1538(latest)~~

WHEEL

~~A wheel shall be provided for emergency operation. The h wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency manual operation in a reasonable time.~~

TESTS INSPECTION

- ~~All valves shall be hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried out before application of paint or other similar treatment unless otherwise agreed between the purchasers the manufacturer. There shall be no air entrapped within the part of the valves subjected to test pressure.~~
- ~~Valve shall be offered by vendor for visual inspection before shipment. Valves shall be tested as per the relevant standards.~~
- ~~The hydrostatic testing shall be witnessed by the purchaser or his representative / TPI.~~

MATERIAL OF CONSTRUCTION

- ~~All sluice valves at the pump house shall be of body Cast Iron, Spindle SS.~~
- ~~All valves shall be supplied with matching companion flanges with necessary bolts, nuts gaskets.~~

NOMINAL PRESSURES

- ~~Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (MPa) at 20 deg. C temperature as under:~~
- ~~PN 0.25, PN 0.6, PN 1.0, PN 1.6 and PN 2.5~~

TEMPERATURE RATINGS

~~All valves shall be suitable for continuous use at their PN designation within the temperature range of -10°C to 65°C .~~

BODY ENDS

~~Flanges shall be at right angles to the axis of the bore concentric with the bore. Flanges shall be drilled unless otherwise specified bolt holes shall be off centers.~~

BEARINGS

~~The bearings shall be suitable for the maximum loads imposed during service.~~

MATERIALS

~~This standard is based on materials specified in IS unless otherwise agreed; the materials shall be of a grade equivalent to those given in IS or superior. Other material may be used as per the agreement between the manufacturer the purchaser.~~

OPERATION

~~All valves shall be capable of operating at a differential pressure across the wedge. Worm gear or any other suitable type of operator can be used.~~

DIRECTION FOR OPERATION

- ~~• Unless otherwise specified, manually operated valves shall be closed by turning h wheel in a clockwise direction when facing the hand wheel.~~
- ~~• All operating devices shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.~~
- ~~• All operating devices shall be packed with grease for lifetime operation. Operating device shall be totally enclosed weatherproof for general application.~~
- ~~• Operating device shall be self-locking type. Valve shall be capable of being locked in at any intermediate position.~~

~~The operating device h wheels shall be marked „CLOSE“ or „SHUT“ to indicate the direction of closer. The operating device shall be provided with arrangements to indicate the valve position.~~

TEST CERTIFICATES

~~The manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard stating the actual pressures medium used in the test.~~

REFLUX VALVE

- ~~1.4.1 The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.~~
- ~~1.4.2 Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.~~
- ~~1.4.3 Reflux valves shall conform to IS 5312. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.~~
- ~~1.4.4 Valve of diameter greater than 400 mm shall be provided, in addition to others, feet and jacking screws. Hinge pins/shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.~~
- ~~1.4.7 Materials of construction for valve & various parts are specified in the data sheet.~~

DETAILS & REQUIREMENTS FOR ALL VALVES (DATA SHEETS)

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

ACCESSORIES INSTALLATION

a) ACCESSORIES

i) CONTROL UNITS

The Control Unit assembly, consisting of two or more control rods and stretcher plates are placed according to SS Expansion Joints from flange to flange. This minimizes possible damage of the SS Expansion Joint caused by excessive motion of the bolt line, due to failure of anchor or equipment, it also absorbs static pressure thrust developed at the joint limits the extension compression movements, if required to prevent damage to the main equipment without hampering its basic need. Inadequate support of pipelines, incorrect anchoring, considerable temperature variations may cause many abnormal movements. As such undesirable destructive movements can effectively be encountered by using control units.

ii) PROTECTIVE SHIELDS /COVER

The Protective Shields/Cover should be used on the SS Expansion Joint that carries high temperature. It protects the environment in the event of leakage/ splash and protects the SS Expansion Joint from fire during a flash fire.

iii) INTERNAL SLEEVES

A device which minimizes contact between the inner surface of the bellow and the liquid flowing it, so as to protect the inner surface from corrosion to ensure that no foreign materials remain on the corrugation.

iv) COMPANION/ COUNTERFLANGES

Companion/ Counter Flanges for the pipeline for which the SS Expansion Joint is to be fitted can also be supplied with the SS Expansion Joint, if required.

b) INSTALLATION OF ACCESSORIES

i) INSTALLATION

Piping sections where SS Expansion Joints are accommodated should be anchored properly to take care of stresses/ Reaction forces due to internal pressure.

Taking into consideration the above, solid and belting anchor points should be selected particularly where change in direction of piping elbows are near to the pump etc.

ii) ANCHORING POINTS

~~An SS Expansion Joint must always be installed between two anchoring points (fixed supports). If it is not possible to install anchoring points (support points), stabilizing devices must be used.~~

~~iii) — BUCKLING~~

~~o — In order to avoid pipe buckling, guide collars must be provided regularly along the pipe length. A guide collar must also be provided on either side of the SS Expansion Joint. Maximum service life depends on careful correct installation. Transport~~

~~o — Expansion Joints to area of installation in packed condition. Flange face of companion flanges in pipeline should be smooth without any sharp edges. For large size of Expansion Joints installed in horizontal ducts, lifting lugs welded to flanges should be used to hoist joint in position. Joints should only be fitted after all work on the pipeline flanges have been complete anchors supports have been established. This is to avoid any accidental damage due to welding splatter or sharp objects to ensure that the joints are not overstressed.~~

~~o — The bolts on the flanges must be tightened evenly. Uneven tightening may lead to hazardous leakage. Faulty fitting may lead to failure of the expansion joints.~~

~~DETAILS & REQUIREMENTS FOR ALL VALVES (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

M S PIPES & M S SPECIALS

Scope

~~Supply, fabricate, testing, painting and erection of M.S. pipes of specified ID / OD and specified wall thickness conforming to IS: 3589 (1981). This section covers pipe and specials up to battery limit for HSCF & Horizontal Mono Submersible pumping stations.~~

~~Pipes shall be erected on rollers/saddles as per the requirement. Thrust blocks shall be provided at bend and dead end.~~

Specifications

Sr. No.	Description	Particulars
1	Plates/HR coil	Plates/HR coil IS: 2062, Gr. B 250 BR/IS: 10748 Gr. III Fe 410, Minimum Thickness 6.0mm
2	Welding & Electrodes	ASME SECT IX, IS: 7310, IS: 7307, IS: 9595
3	Inside Food Grade Epoxy Coating	NACE RP 0402
4	Fabrication & Manufacturing of Pipe	IS: 3589 and/or IS: 5504

~~Specification for Inside and Outside Coating~~

~~If specified in the price bid the inside lining shall be Solvent free lining as per AWWA C210 of minimum 406 microns shall be provided. Outside coating shall be done with best quality bituminous paint.~~

~~Laying of Pipeline~~

~~The laying, jointing and testing of welded steel pipes conform to latest and relevant IS: 5822. Pedestals shall be constructed before commencing the pipe laying work in any section. The welded joints shall be tested as per IS: 3600 of 1966.~~

M-S Specials

~~Supply, testing and installing MS Specials suitable to MS pipes, valves and other fittings from steel plates at site of works tested to specified test pressure and including providing required flanges, painting inside zinc epoxy coating and outside anti corrosive red primer, coated with three coats of anti corrosive water proof enamel including freight, loading, unloading, carting, stacking as directed. The sizes and types of specials shall be as per actual requirements taking into consideration in tender items like pumps, sluice valves, non return valves, scour valves, expansion joints, dismantling joints etc.~~

~~Flanges~~

~~The flanges and their dimensions of drillings shall be in accordance with part IV and VI of IS: 1538 (Part I to XXII) 1976 (specification for cast iron fittings for pressure pipes for water, gas and sewage) or its latest revision. Fabricated M-S flanges shall be as per IS: 6392 (1971) (specifications for steel pipe flanges) wherever applicable. The flanges shall be flat faced with off~~

centre bolt holes. Prior to manufacturing process, the contractor shall have to obtain approval of EIC for all sizes and types of flange drawings.

Jointing Materials

Each valve shall be supplied with all necessary jointing rings, nuts, bolts and washers for completing the joints on all the flanges of valve supplied under this contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be suitable for jointing MS pipes. Joint rings shall be of flat section at least 3 mm thick. They shall be of rubber in accordance with IS: 638 (1965).

The jointing material shall include:

All types of flanges fabricated from MS plates/flats of required thickness and confirming to IS 2062. Pipe supports/valve supports from structural steel angles/channels of required size and confirming to IS standards shall be provided using required jointing materials, hardware like nuts, bolts, washers, gaskets etc. in required quantities & of reputed makes.

Providing following specials and installing on the pipeline including welding as required for Flanged Eccentric expander at HSFC pump discharge

Flanges with hardware and gaskets for installing various valves and expansion bellows on the pipeline. Blind flanges at the end of header and tap off for future pumps.

Fabricating and connecting specials and bends on pump discharge pipelines and common header to suite site conditions.

Providing Suitable fabricated supports with clamps & hardware for pump discharge pipelines to suit site conditions.

All pipes, fittings, bolts, nuts, jointing materials and appurtenances for piping to be required for execution of the works shall be manufactured and erected in accordance with the erection plans, specifications and directives of the department. All pipe work and fittings shall be to a class 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 equipment. All loose flanges shall be secured to fixed flanges by suitable tie bolts. 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 final outlet connection of the pipe work shall match the connecting point of the transmission main.

~~Flanged joints shall be full face, fabric reinforced rubber gaskets, pierced to take the bolts, and the face of all flanges shall be machined to give a true angle of 90° to the centre line of the pipe or fittings. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valves, meters and other devices mounted in the pipe work shall be supported independently of the pipes to which they are connected.~~

~~The whole of the jointing work and materials necessary to fix and connect the pipes, including adequate and efficient pipe support shall be included in the contract. The bidder shall be responsible for ensuring that the internal surface of all pipe work is thoroughly cleaned 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 manufacturers' works, the ends of the pipes, branch pipes etc. shall be suitably capped and covered to prevent any accumulation of dirt or damage. This protection shall not 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 instruments 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 department.~~

~~Material of steel pipes and fittings shall conform to IS: 2062. Fabrication and testing shall be in accordance with IS: 1239/IS: 3589 for pipes and IS: 6392, ISO 7005 or BS 4504 for flanges. Carbon content & other chemical properties shall be within specified limits of governing IS. Minimum corrosion allowance shall be 2 mm for pipes and fittings which are not mortar lined.~~

~~The coating shall consist of one coal tar primer coat, one coal tar enamel coat, wrapping of fibre glass and one more coat of enamel and then final wrap of enamel impregnated fibre glass.~~

~~Thickness of pipe for pump house pipe system i.e. common suction header (if & as required), suction, delivery, common discharge headers & header by pass and shall not be less than what is prescribed in relevant IS standards without negative tolerance.~~

HDPE PIPE TECHNICAL SPECIFICATIONS:

Manufacture, supply and delivery of ISI Marked H.D.P.E. Pipes having pressure rating PN 10 and material grade PE 100 in approximate 100 meter coil length or as per GWSSB requirement with SS 316 Nipple at both end with SS Nut Bolt having 11 TPI threading as per specification and Drawing attached herewith duly press fitted and bolted. The pipes should be conforming to IS 4984/1995 with latest amendment in various sizes as under

- 1) ~~140 mm nominal dia-~~

Other detailed technical specifications should be strictly as per IS: 4984/1995 with latest amendment.

- 1) ~~The pipes are to be manufactured as per the terms and a condition as laid down in IS: 4984 /1995 with latest amendments.~~
- 2) ~~Further at the time of inspection. The inspection agency shall review the type test and if required as per IS the inspecting agency may suggest fresh type test.~~
 - i) ~~The HDPE pipe shall be manufactured from any of following brand or equivalent Raw material in PE-100 Grade.~~

The raw material required for manufacturing HDPE pipes shall be as per IS Specification.

The original invoice of raw material required to manufacture ordered length of pipes and batch wise test certificate of raw material, shall have to be verify and review certify by the inspecting authority.
 - ii) ~~Sample Coil from which sample is drawn for testing, the length, less than 100 meters will be accepted for such acceptance double marked coil by the inspecting authority~~
 - iii) ~~The material of SS 316 Nipple and Nut Bolt are tested chemically & mechanically at NABL Accredited Laboratory for each lot.~~
 - iv) The Nipples shall be fitted after inspection of relevant pipes.
 - v) ~~The measurement of pipes will be taken without Nipple.~~
 - vi) ~~The Testing parameter shall be as under;~~
 - a) ~~Dimensional and Visual verification as per IS 4984/1995 with latest revision.~~
 - b) ~~The main tests among others to be conducted will be as per IS: 4984/1995 with latest amendment.~~
 - c) ~~The type test certificate as per IS: 4984/1995 with latest amendment from the reputed inspection agency.~~

d) —Acceptance test consisting of

1.	Hydraulic Characteristics	As per IS: 4984/1995 with latest revision.
2.	Reversion Test	
3.	Overall Migration Test	
4.	Density	
5.	MFR Test	
6.	Carbon Black Content and Dispersion test. Carbon Content should not be within 2 % to 2.5%	
7.	Tensile tests	As per IS: 14151 (Part I)/1994

COILING:

d) —Type test as per IS: 4984/1995 with latest amendment (Once in Three Months) for Minimum 165 Hrs.

e) —All other tests shall have to be carried out as suggested in IS: 4984 with latest amendment.

The minimum diameter of coil shall be as per IS. The Pipes supplied in coils shall be wound on the drums to have minimum coil diameter according to nominal pipe diameter as mentioned in the IS ensuring that kinking of pipe is prevented.

MARKING:

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

- (1) — ISI Certification mark on each pipe.
- (2) — Manufacturers brand name and/or trade mark.
- (3) — Nominal Diameter and wall thickness of pipes.
- (4) — Any other important matter that the manufacturer or purchaser deems fit to be inscribed.
- (5) — Running length of coil in meter at the end of every meter should be Embossed / Engraved / Stenciling / Inscribed... i.e. 1M, 2M, and 3M.....100M.....

QUANTITY VARIATION:

+/- 2 % Quantity variation will be acceptable on orders placed by GWSSB.

Thrust Block

RCC thrust blocks of adequate size and shape in required grade shall be provided on bend for anchorage as per design requirement to transmit the hydraulic thrust / force to the ground, spreading over a sufficient area, depending upon the type of soil met with.

Thrust blocks shall be provided for both horizontal and vertical bends wherever required in the pipeline to effectively transfer the hydrostatic thrust developed to the surrounding ground.

The Contractor has to submit his own design with steel reinforcement details and getting approved before executing the work.

The PCC shall be in M-15 grade. The minimum 70kg/Cum. Steel shall be provided for thrust block.

Reinforcement

~~All reinforcement steel shall be CRS FE 500 conforming to relevant I.S. for all RCC structure with conforming to IS. All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust, or any other substance that will destroy or reduce bond.~~

~~The rate shall be paid per cum. of completed work As per BOQ~~

~~MATERIAL HANDLING SYSTEM (If applicable)~~**ELECTRICALLY OPERATED OVERHEAD TRAVELLING CRANE****Design**

~~The crane shall be electrically operated single girder with all accessories including crane rails and fixtures and shall conform to IS: 15560 or internationally approved relevant standards. The crane is to be designed in accordance with IS: 807, IS: 3177 (1965) code of practice for design manufacturing erection & testing of structural portion of the crane & IS: 3177 code of practice for design of over travelling crane. In the design of components adequate factor of safety as per relevant code is to be taken. Impact, fatigue, wear, stress concentration factors etc. have also to be considered whenever applicable. All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits etc. required for safe and satisfactory operation of the crane must be provided.~~

Steel

~~Steel conforming to IS: 2062 or equivalent is to be used in the manufacturing of the main load bearings members.~~

Brakes

~~Electromagnetic, hydraulic thruster type brakes are to be provided in the hoisting, longitudinal (long) travel & cross travel motion. The brakes shall be automatically released when the motor circuit is ON & shall be applied when the motor circuit is OFF. This feature has to work to ensure safety in case of power failure.~~

Bearings

~~All moving parts of the crane are to be supported on anti friction type ball / roller bearings of required size & reputed make.~~

Coupling

~~Flexible/Universal/Geared couplings are to be provided between all gear boxes & motors.~~

Operation

~~The crane is floor operated.~~

Pendent Push Button

Push button station is to be suspended from the one end of bridge at suitable height from the floor level with stepped down voltage of 110 volts.

Power

The crane is suitable for operation of 415 V \pm 10 %, 3 phase 50 cycles A C supply.

Crab

The frame work shall be from all welded construction fabricated from rolled steel frame section and plates. The hoist & cross travel mechanism is to be mounted on this frame.

Hoist

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

Rope Drum

The rope drum shall be made from mild steel fabricated construction having right handed and left handed spiral grooves properly machined to suit the hoisting ropes. The drum shall be such that there is not more than one layer when rope is fully wound and length of the drum shall be such that each lead OD drum when hook is at its lowest position & one spare groove for each rope lead when the hook is at its highest position.

Wire Rope

Wire rope shall be made from best quality & grade plough steel fibre core normally in 6x37 construction having tensile strength of 160/175 Kg/Sq.mm. The wire rope shall have minimum factor of safety in accordance with IS: 3177 depending on the class of the duty of the crane. Make of wire rope will be as per relevant IS & of reputed make.

Bottom Block

The hook shall be of single plain shank type conforming to IS: 3815 and made of forged steel or equivalent supported on thrust bearings.

Rope Sheaves

They are made from CI running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.

Limit Switches

Two number shunts/roller type reputed make is to be provided to prevent the over lowering and over hoisting.

Cross Travel Machinery

Cross travel machinery shall consist of suitably rated motor as per relevant IS and totally enclosed dust proof gear box, break etc.

Wheels

The wheel of the trolley and the end carriages shall be made from forged steel & shall be double flanged straight thread type fitted with antifriction bearings.

Bridge Girders

The girders shall be plate welded box/ISMB type construction designed to sustain all stresses arising due to vertical and lateral forces.

Trolley Track

Suitable square steel section tracks are to be provided for travel of the trolley. These shall be welded on the girders.

End Stoppers for Cross Travel Trolley

Steel end stoppers are to be provided on either side of the bridge to limit the motion of the trolley.

Platform

M-S chequered plate/anti-skid plate platform shall be provided for full length on one side of the bridge girder.

End Carriages

End carriages shall be fabricated from rolled steel section/plates with adequate diaphragms and stiffeners to give a rigid construction. The girders with gusset plates are to be set on the end carriages and jointed with bolts in rimmed holes. Rubber buffers shall also be provided on either side of the end carriage.

Long Travel Mechanism

The driving machinery for the long travel motion can be either single motor drive or twin motor drive depending on manufacturers' standards.

Paintings

The structural parts of the crane shall be thoroughly cleaned and shall be applied with one coat of red oxide and followed by two coats of enamel paints before dispatch. Exposed machinery parts such as wheels, bright bars, etc. are also to be coated with rust protective paints.

LIST OF APPLICABLE INDIAN STANDARD AND CODE OF PRACTICE

SR. NO.	STANDARD NO.	TITLE
1.	IS-5	Colors for ready mixed paints and enamels.
2.	IS-104	Ready mixed paint, brushing, zinc chrome, priming.

3.	IS—158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali and head resisting.
4.	IS—807	Code of practice for design, manufacture, erection and testing (structural portion) of cranes and hoists
5.	IS—816	Code of practice for use of metal arc welding for general construction in mild steel
6.	IS—900	Code of practice for installation and maintenance of induction motors.
7.	IS—1239	Mild steel tubes, tubular and other wrought steel fittings
8.	IS—1520	Horizontal split casing centrifugal pump for clear, cold and fresh water
9.	IS—1710	Vertical turbine pumps for clear, cold, freshwater.
10.	IS—2062	Steel for general structural purposes.
11.	IS—2629	Recommended practice for hot dip galvanizing on iron and steel.
12.	IS—2633	Hot dip galvanizing
13.	IS—3589	Seamless or Electrically welded steel pipe
14.	IS—3624	Vacuum and pressure gauges
15.	IS—3639	Fittings and accessories
16.	IS—3938	Electric wire rope hoists
17.	IS—4137	Code of practice for heavy duty electric overhead traveling cranes including special service machines for use in steel work.
18.	IS—4759	Hot dip galvanizing
19.	IS—5504	Spiral welded pipe
20.	IS—5312	Swing type Non return valve
21.	IS—6005	Code of practice for phosphate of iron and steel.
22.	IS—6511	Range of preferred safe working loads for cranes, lifting appliances and related excavators equipment.
23.	IS—6595	Horizontal centrifugal pump for clear, cold and fresh water
24.	IS—7538	Three Phase squirrel cage induction motor for centrifugal pumps for agricultural application.
25.	IS—10001	Performance requirements for constant speed compression ignition (diesel) engines for general purposes (up to 20 KW)
26.	IS—10234	Pipeline Welding

27.	IS— 10748	Hot-Rolled steel strip
28.	IS— 12661	High voltage motor starter (D.O.L)
29.	IS— 13095	Wafer type butterfly valve size from 40 mm to 2000 mm
30.	IS— 13349	Cast iron single faced thimble mounted sluice gates
31.	IS— 14845	Air Relief Valves
32.	IS— 14846	Non rising stem type sluice valve size from 50 mm to 1200 mm
33.	ASME (Section— ix)	Non Destructive Test
34.	API 1104	Pipeline Works
35.	AWWA C 512	Air Relief Valves
36.	CPHEEO	Central Public Health and Environmental Engineering Organization
37.	HIS	Hydraulic Institute Standard
38.	EJMA	Expansion Joint Manufacturer's Association

DOUBLE ACTING KINETIC AIR VALVE (Wherever Applicable):**General**

- ~~Double acting kinetic Air valve with isolation valve confirming to IS: 14845 — 2000, AWWA C 512, having one outlet of large capacity for admission release of bulk volume of air during emptying filling of the pipeline another having small outlet for escape of smaller quantities of trapped air.~~
- ~~The ball sealed orifice shall always remain open while air is exhausting is immediately closed when Water rises in the chamber, lifts the ball seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) ball to drop into when the valve opens. Turbulent air at the time of filling of pipe shall not circulate in such cavities cause the ball to be blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities cause the ball to be 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 all air escape at 300 m/sec. The total impact force on the 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 low pressure cover shall be massive 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.~~
- ~~The valve body, the orifice cover, cowl of the air valves shall be made of Cast iron as per IS: 1865 grade 500/7.~~

JOINTING MATERIAL

- ~~Each valve shall be supplied with all necessary joints on all the flanges of valve supplied under this Contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing MS pipes.~~
- ~~The cost of all jointing material supplied under the contract shall be inclusive of rates. The joint ring shall be of flat section at least 3 mm thick. It shall be of rubber in accordance with IS: 638 Or its latest edition (specification for rubber insertion jointing) of hardness proven in practice to form a watertight joint use of jointing paste shall not be allowed. Bolt holes shall be drilled according to center lines. Bolt heads nuts shall be hexagonal shall confirm to IS: 1363 (Specification for black hexagonal bolts, nuts black hexagonal Screws).~~

BALL

- ~~The ball of large orifice shall bear a calculated mathematical relation with inlet diameter of the valve (i.e., the average cross section area of escaping air stream) so that it will result in the ball being blow shut by a stream of water but held down by a stream of air. The buoyancy of the floats shall be such that it will ensure effective~~

~~sealing of large orifice even at low pressures.~~

- ~~• The weight of floats of the same size type shall not differ by more than 2%. The SS material used in the manufacture of floats shall be suitable for perfectly sitting on the large orifice. The float provided in high pressure chamber, manufactured from SS, shall be also being suitable for seating on the small orifice.~~

HIGH PRESSURE ORIFICE

~~The high pressure orifice the high pressure chamber shall be so designed that the orifice is effectively sealed in working condition by float.~~

~~The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm 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 FLANGE

~~All valve 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 (Specification of CI fittings for pressure pipes for water etc.). All flanges shall be supplied with matching companion flanges, nuts, and bolts gaskets. The matching flanges shall have drilling of holes flange thickness as per the valve flanges.~~

CLEANING

- ~~• Prior to the factory inspection, all manufacturing waste such as metal chips, debris and all other foreign material shall be removed from the interior of valve. All mill scales, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior exterior surfaces.~~
- ~~• Valves shall first be given two coats of zinc base primer after completely cleaning the surface then it shall be coated with three coats of epoxy paint. The resulting coating shall be Uniform smooth shall adhere perfectly to the surface.~~
- ~~• Valves used in pipes carrying water, the inside coating shall not contain any constituent soluble in water or any ingredient which could import any taste to the water.~~

PAINTING

~~Valves shall first be given two coats of zinc base primer after completely cleaning the surface then it shall be coated with three coats of epoxy paint. The resulting coating shall be uniform smooth shall adhere perfectly to the surface.~~

INSPECTION TESTING AT MANUFACTURER'S WORKS

All valves shall be offered for visual inspection dimensional check performance testing. Valves shall be tested as per IS: 14845.

DOCUMENTS / DRAWINGS TO BE SUBMITTED

The following documents / drawings shall be submitted.

- ~~A.~~ Preliminary outline dimensional drawings.
- ~~B.~~ Typical cross section drawings with bill of material of construction necessary supports for mountings.
- ~~C.~~ Flow v/s head loss curve for valves.
- ~~D.~~ List of spares

PART II: ELECTRICAL

Design Criteria for Electrical Equipment

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1.0 Design Criteria for Electrical Equipment

1.1 Introduction

The 'Design Criteria' of electrical equipment covers the water pumping station of Gujarat Water Supply & sewerage Board.

1.2 General Power Distribution Scheme:

1.2.1 Load Requirement

The following assumptions shall be made to arrive at the load requirement of water pumping station

a) Load Factor

i) Main motor : 0.9

ii) Auxiliary load suction valve motors etc : 0.9

iii) Lighting load : 1.0

b) Diversity Factor

i) Main motor : 1.0

ii) Auxiliary load, suction valve motors etc : 1.5

iii) Lighting load : 1.20

c) Power Factor of L.V. Motors : As per Mfr's catalogue

d) Full Load Efficiency of L.V. Motors : As specified in data sheet

1.3 Power Supply Scheme

~~———— The source of power supply to these pumping stations will be through one no. 11 kV, overhead line from Gujarat Electricity Board or LT line as the case may be for particular pumping station.~~

~~2. The short circuit apparent power of the system at the proposed main switchyards shall be as follows as per IS: 2026 (Part I).~~

~~11 kV System : 350 MVA~~

~~415 kV system : 20 MVA~~

~~e) Pumping stations with L.V. motors shall have one main step down transformer of 11 KV/ 0.433 kV with on load tap changers for a range of -15% to +5% in steps of 1.25%. Or off circuit tap changer for a range of $\pm 10\%$ in the steps of 2.50%. While the power for main pump motors as supplied at 11 kV/0.433 kV and other loads such as control valves, lighting etc. shall be supplied at 230 V (1 phase, 4 wire).~~

~~f) Power factor correction capacitors shall be provided and their capacity shall be adequate to correct the power factor up to 0.99 or more at full station load.~~

~~g) Suitable metering facility shall be provided for monitoring purposes.~~

~~h) Protections~~

~~Protective Relays For IDMT Over Current, Earth Fault, Motor Protection Relay And Transformer Differential Relay Shall Be Numerical Based Only.~~

~~———— Following protective relays are proposed for incomer, transformer, motors and other plant feeders. ————~~

~~Incomer (11 kV Main Incomer From DISCOM)~~

~~Inverse time phase over current relays~~

~~Inverse time earth fault relay~~

~~———— Main Power Transformer with OLTC above 1500 KVA/ with OCTC~~

~~———— HV side: (11 kV)~~

~~m) Inverse time over current relays with instantaneous over current element
Instantaneous earth fault relay~~

~~**Transformer Buchholz/gas pressure relay with alarm and trip contacts**~~

~~p) Winding & Oil temperature indicators with alarm and trip contacts~~

~~q) Transformer differential protection relay~~

~~r) MOG Alarm Contact~~

~~s) Transformer oil gauge (Alarm only)~~

~~L.V. side (11 KV/0.433 kV)~~

~~Inverse time phase over current relays~~

~~Inverse time earth fault relay~~

~~Restricted earth fault relay~~

~~Stand by earth fault relay~~

~~L.V. side (415 V)~~

~~415 V LV incomer shall be provided with air circuit breaker unit.~~

~~11 KV Plant Feeders~~

~~Inverse time phase over current relays.~~

~~Inverse time earth fault relay.~~

~~L.V. Main Motors:~~

~~Overload protection by thermal (bimetal) relays in all the three phases to trip~~

~~Short circuit protection in all the three phases through fuses~~

~~Moisture sensor relay (if required)~~

~~**2.3 Metering**~~

~~The following metering shall be provided.~~

~~a) Incomers (11 KV main incomer from GEB):~~

~~i) Ammeters in all the three phases~~

~~ii) Voltmeter with selector switch~~

~~2. Frequency meter~~

~~iv) kW & kWh meter~~

~~v) Power factor meter~~

~~vi) Electronic Trivector meter (if specified)~~

~~2. Main Transformer~~

~~HV Side i) Ammeters in all the three phases~~

~~LV Side: i) Ammeters in all the three phases~~

~~c) H.V. Feeders: i) Ammeter in all the three phases~~

~~d) L.V. Feeders: i) Ammeter in all the three phases~~

~~**1.5 Switchgear:**~~

~~2. H.V. Switchgear~~

~~HV switchgear shall be of sheetmetal enclosed indoor type. Incoming and other outgoing feeders shall be provided with draw out type vacuum circuit breakers. The degree of protection for switchgear shall be IP 4X for indoor installation.~~

~~2. L.V. Switchgear~~

~~415 V Powercontrol centre, power distribution boards etc. shall be of fixed,~~

~~compartmentalised double front construction, excepting circuit breaker modules which shall be of draw out type and single front construction.~~

~~———— The degree of protection for switchgear shall be IP 42 for indoor installation and IP 54 for outdoor installation.~~

~~———— H.V. indoor switchgear circuit breakers shall be suitable for 110V D.C. control power supply. Others shall be suitable for 110V/230V A.C. control power supply which shall be derived either through potential transformers or between phase and neutral.~~

1.6 Cables:

~~The H.V. Power supply from main substation to various plant sub-stations and to the equipment shall be done by using aluminium conductor, XLPE insulated, PVC sheathed and armoured type. The LV power cables shall be aluminium conductor, PVC insulated, PVC sheathed and armoured type. The control cables shall be copper conductor, minimum 1.5 sq. mm PVC insulated. PVC sheathed and armoured type.~~

~~All power cable sizes shall be based on continuous current carrying capacity, permissible voltage drop and short circuit rating. The voltage drop shall be limited to 3%. For short circuit rating of H.V. cables, the fault clearing time shall be 0.5 second for H.V. plant feeders and 0.16 second for equipment feeders. For S.C. rating of H.V. cables the fault clearing time shall be 0.5 second. For L.V. incomers and L.V. outgoing feeders to equipment, the fault clearing time shall be 0.16 second.~~

~~Rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, depth of laying etc. shall be based on the cable manufacturer's recommendations/ catalogues.~~

1.7 Lighting

~~The lighting system will comprise the following:~~

~~2. Normal A.C. lighting:~~

~~All indoor and outdoor areas will be provided with A.C. lighting and the same will be available as long as A.C. supply is healthy.~~

~~2. Emergency Lighting for Switchyard and switchyard area:~~

~~Switchyard, main substation area, control room will be provided with emergency lighting of about 10% of normal A.C. lighting.~~

~~e) 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 armored cables.~~

~~———— d) The illumination levels for various areas shall be as follows:~~

Sr. No.	Area	Illumination Level (Lux)
--------------------	-----------------	-------------------------------------

i)	Pump house	200 lux
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ii)	Battery room	150 lux
iii)	Machinery service area	150 lux
iv)	Offices/conference room	300 lux
v)	H.V./L.V. switchgear rooms	200 lux
vi)	Plant/Switchyard control rooms	300 lux
vii)	Chemical/general stores	150 lux
viii)	Chemical plant room	200 lux
ix)	Cable basement	100 lux
x)	All other indoor areas	100 lux
xi)	Outdoor platforms and walkways	50 lux
xii)	Building entrances	100 lux
xiii)	Outdoor plant areas	20 lux
xiv)	Switchyard and transformer yard	
i.	General	10 lux
ii.	On equipment	30 lux
xv)	Roads (Secondary)	10 lux

e) ~~Lighting distribution board shall be provided, and it shall supply power to various local lighting panels.~~

f) ~~Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from these lighting panels. Lighting panel shall comprise of 63A TPN MCB with ELCB for incomer and 16A/10A MCBs for each out going single phase circuits.~~

g) ~~Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.~~

h) ~~For the purpose of calculating connected loads of various lighting circuits, a multiplying factor of 1.25 will be assumed to the rated lamp wattage for mercury vapour, sodium vapour and fluorescent lamp fixtures to take into account losses in the control gear. Also a loading of 100 watts and 500 watts shall be assumed for single phase 5 Amps and 15 Amps receptacles respectively.~~

- ~~i) Lighting fixtures, receptacles, switches, conduits and junction boxes shall be properly earthed using 12 SWG G.I. wire unless specified otherwise.~~
- ~~j) Receptacles of 5A and 15A, single phase, 3 pin shall be provided with switch. Receptacles in offices and control rooms shall be decorative type and in other areas shall be industrial type. Three phase receptacles shall be associated with TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch in "ON" position. The enclosure for all outdoor receptacles shall be provided with degree of protection of IP 55.~~
- ~~k) Generally maintenance factor of 0.8 shall be considered for lighting fixtures.~~

1.8 Safety Earthing & Lightning Protection

- ~~a) The soil resistivity of the plant area has not yet been measured, the same should be carried out during detailed engineering by successful bidder.~~
- ~~b) After soil resistivity measurement; length of conductor, no. of earth electrodes and no. of test pits shall be 285 name led 285.~~

~~c) The material of earthing conductors will be as given below:~~

- ~~i) Conductors above ground shall be Galvanized steel to prevent atmospheric corrosion~~
- ~~ii) Conductors buried in ground or embedded in concrete shall be mild steel.~~

~~d) The maximum values of the earth fault current for the design of the earthing system shall be considered as below:~~

i)	11 kV system	:	26.2 KA
ii)	415 V system	:	50 KA

~~e) Fault clearing time for sizing the earthing conductor shall be taken as one (1) second.~~

~~f) Maximum allowable temperature rise for steel welded joints will be taken as 50⁰ C and ambient temperature as 45⁰ C.~~

~~g) Plant earthing system will be designed such that overall earthing resistance is less than one (1) ohm.~~

~~h) In case of different electrical systems operating at different voltages in an area/plant, the main earthing conductor for each system shall be decided on the basis of maximum fault current in that system. Earthing system for different systems shall be interconnected by inter connectors of maximum size conductor.~~

~~i) In outdoor substation area, main earthing conductors will be planned for most economic earthing of the equipment, keeping the potential gradients at earth surface within maximum allowable limit. Step and touch voltages shall be within permissible limit. Main earthing conductors in outdoor areas shall be buried 600 mm below finished ground level.~~

~~Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm~~

~~from the outer boundary of the building.~~

~~k) Main earthing conductors inside the building will be planned such that various equipments are connected to earthing system in most economical and reliable manner.~~

~~l) Earthing conductors shall be provided around the outside edge of switchyard fence at approximately 1000 mm and every alternate fence post shall be connected to the grid by one lead and gates by flexible braid to the earthed post.~~

~~i) Minimum 6000 mm spacing between rod/pipe electrodes and 8000 mm spacing between plate electrodes shall be provided.~~

~~m) The detail earthing calculation furnishing the step potential (V_s) and the touch potential (V_t) for outdoor switchyard.~~

1.9 Power Factor Improvement

~~Capacitors for 415V motor shall be provided on 415V bus with automatic switching to improve power factor up to 0.97 in case of fixed power capacitor banks & 0.99 in case of automatic power factor correction panels.~~

PART II: ELECTRICAL & INSTRUMENTATION (GENERAL)

1.0 SCOPE

~~The scope of services covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works, supply, packing, forwarding and delivery from manufacturer's works/place of storage to erection site including transit insurance, unloading, storage at site, moving from place of storage to place of installation, assembly, erection, testing, commissioning & performance demonstration and handing over along with all necessary spares of original ratings & specifications on design, build & operate basis. Contractor has to ensure that design & equipment are as per detailed specifications & as per requirement of the project. The Contractor shall prepare design calculations based on parameters/design criteria indicated in the specifications. The Contractor shall prepare detailed engineering and construction purpose drawings to make his/her own estimate of ratings & quantities (minimum requirements as per schedule, technical data sheets, governing standards & other relevant details) for entire electrical & instrumentation systems including all items, systems such as equipment, cables/cabling system, lighting, ventilation, earthing, lightning protection, main & auxiliary power distribution, instruments, civil works required for the satisfactory completion of works. Contractor shall take due care of the site seismic conditions while design of all equipment/ components used in entire electrical & instrumentation systems covered in this specification. Contractor shall furnish list of additional design parameters considered in design to fulfil above requirement. Design and detailed engineering of the materials procured by Contractor is included in scope. Contractor shall submit design drawings/calculations of each system which is included in scope to GWSSB for final review/ approval. All design documents/calculations prepared by Contractor shall be as per ISO documentation procedure duly signed by qualified authorities and stamped. Design documents/calculations prepared by sub vendors shall be approved by the contractor and stamped copy of approval along with no deviation sheet from sub vendor shall be submitted by the Contractor to GWSSB for final review/approval.~~

~~Expert or manufacturer's supervision for sub vendor supplied material(s) shall be provided by Contractor and included in offer. Contractor shall be solely responsible for any shortages or damages in transit for his supply scope, handling and/ or in storage of any materials and erection of the equipment, supply of erection tools at site. Contractor shall ensure that it~~

~~will not affect any activity or project schedule. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.~~

~~Contractor shall identify activities and mile stones of the work forecasted for next month with optimistic and pessimistic dates of work completion. Contractor shall prepare program evaluation and review techniques to identify critical path of project and activity sequences. The project schedule shall be prepared and updated fortnightly in MS Project.~~

~~Nothing in this specification shall be constructed to relieve the Contractor of his/her responsibilities towards following best engineering practices established in the country.~~

~~Obtaining approval including load sanction/release from Gujarat Energy Transmission Corporation (GETCO)/UGVCL, No Objection Certificates from UGVCL, Electrical Inspector (CEIG), relevant government agencies and statutory authority, as applicable is included in Contractor's scope.~~

~~All necessary legal fees required for various applications to GETCO/ UGVCL/Electrical Inspector (CEIG), relevant government agencies, statutory authorities shall be paid by the GWSSB. The GETCO/UGVCL deposit required to be paid for load sanction&release shall also be borne by the GWSSB.~~

~~The Contractor's scope shall include measurement of soil resistivity at site by Wenner's four electrode method as per IS: 3043-1987 (reaffirmed in 2006) at minimum four locations at site. The earthing shall be designed for the actual mean soil resistivity value obtained.~~

~~Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure that system is complete and facilitates proper operation and easy maintenance of the plant. Any and all otherworks not indicated above but necessary/required to complete the system in all aspects, are deemed to have been included in the Contractor's scope.~~

~~The Contractor shall include start up spares, essential spares, recommended spares and a set of special tools necessary for operation, routine maintenance of equipment supplied for a period as specified in this contract. Whether specifically called for or not, all accessories required for normal and satisfactory operation (as deemed by the GWSSB) of the equipment shall be a part of the Contractor's basic scope of supply and/ or work and no claims~~

~~whatsoever, for extra payment on these grounds, will be accepted.~~

~~Contractor should visit site(s) and familiarise himself/herself regarding the site conditions & scope of work for complete Electrical & Instrumentation works before submission of bid offer.~~

~~Contractor's scope shall include design, engineering, manufacture, supply, testing, commissioning and handover of following electrical equipment/systems as per tender specifications, BOQ and other relevant details.~~

~~Tariff metering equipment as applicable (as per GETCO/UGVCL requirement) & electric supply connection including necessary liaison works. Tariff metering equipment & electric supply connection shall be provided by GETCO/UGVCL for which necessary liaison shall be done by the Contractor.~~

Switchyard Equipment

~~Two pole structure (required to receive incoming 11 KV power supply from overhead line/cable and to extend out required feeders, bus bars, isolators (GOD) with operating mechanism, earth switches, lightning arrestors, incoming point of supply VCB HV breaker or as per statutory requirement & drop out fuses (wherever applicable for transformer(s) being fed directly from incoming power supply) etc. including necessary civil works, chain link fencing & gate etc.~~

~~Oil type, ONAN, Dyn11, Distribution Transformers with **on circuit circuit tap changer (± 15 %)** with accessories one working and one standby both of identical capacities & to be kept in load condition.~~

~~11KV metal enclosed switchgears indoor type with vacuum circuit breakers, load break switches fully electrical draw out including necessary control, metering & relaying devices. 415V metal enclosed switchgears including power & motor control centre (PMCC) including starter panels, PDB, Sub DB, Lighting DB, Receptacles for utilities. Local start/stop push button stations shall be provided near those motors which are not controlled from a local console/panel. LV capacitor banks with control panel consisting of automatic power factor correction (APFC) relay to improve the plant power factor up to 0.99. APFC panels shall be provided on both bus sections of the PMCC @ **Various Pumping Stations.**~~

~~Cabling system shall consist of various voltage grade, XLPE/PVC insulated, multi-stranded Al/Cu, GI round wire/flat strip armoured power, control & instrumentation cables, GI/FRP ladder/perforated type cable trays & associated accessories including support structures.~~

~~Provision for continuous monitoring of electrical power & energy parameters like voltage, current, power factor, frequency, kilo Watts, kilowatt Hours etc.~~

~~Earthing for HV/LV equipment and lightning protection system for all buildings in the plant premises. The general design shall be on the basis of following codes and standards (their latest amendments) in line with design criteria & specification requirements.~~

- | | | |
|----|-------------------------------|---|
| a) | IS: 30431987(Reaffirmed in 20 | Code of practice for Safety Earthing |
| b) | IS/IEC 62305: 2013 | Code of Practice for the protection of buildings and allied structures against lightning. |
| c) | CEA guidelines 2010 | Measures related to safety & electric supply. |

~~Lighting system for all indoor & outdoor areas of plant(s). The lighting system will be controlled by lighting panels installed in respective plant/station areas, which will be fed from the main lighting DB.~~

DC System

~~24/30V or 110V DC built in DC power pack unit shall be provided wherever applicable including 24/30V or 110V DC Battery & Battery Charger (with inbuilt DCDB) shall also be provided wherever applicable.~~

~~Contractor's scope shall also include design, engineering, manufacture, supply, testing, commissioning and handover of following instrumentation & control equipment/systems as per tender specifications, BOQ and other relevant details.~~

2.0 ENVIRONMENT & SYSTEM INFORMATION

Site/ Environmental Conditions	
Ambient temperature	50°C
Relative Humidity	5% – 95 %
Area Classification	Non Hazardous
Seismic Data	As per IS: 1893 (latest Issue)
Nominal System Voltage (Derived on Load Demand as per GERC norms)	
Contract Demand	Supply Voltage
Not exceeding 100 KVA	415V
Exceeding 100 KVA & up to 4000 KVA	11 KV, 22 KV and 33 KV
Plant Power/ Control Supply Distribution	11 KV, 3 Phase, 3 Wire, 50 Hz, AC
Voltage	415V, 3 Phase, 4 Wire, 50 Hz, AC
General Lighting & Space Heating:	240V, 1 Phase, 2 Wire, 50Hz, AC
Control, Protection & Emergency Lighting:	24/ 30 or 110V, 2 Wire DC (as applicable)
Voltage Transformer Secondary:	110 V, 3 Phase, 50 Hz, AC
Voltage Variation / Frequency Variation	± 10% / ± 5% / ± 10%
Combined Voltage & Frequency Variation	
System Earthing	11 KV, 3 Phase AC system: Neutral Solidly Earthed 415 V, 3 Phase, AC system: Neutral Solidly Earthed 240 V, 1 Phase, AC system: Neutral Solidly Earthed

3.0 ~~Design Criteria for Electrical, Instrumentation and Control Equipment/Systems General~~

The design criteria, specified herein has to be followed by the Contractor for designing/sizing of electrical, instrumentation & control equipment covered under Contractor's battery limits, However it is to be noted by the Contractor that, following this design criteria does not relieve the Contractor from adherence to the standards, regulatory requirements & prevailing best engineering practices.

Estimation of Load and Maximum Demand

~~The following considerations are to be followed to arrive at the maximum electrical demand.~~

Load Factor

- ~~a) Main motors : 0.9~~
- ~~b) Auxiliary load (valve actuators, Crane/Hoist, etc.) : 0.4~~
- ~~c) Lighting load : 1.0~~

Diversity Factor

- ~~a) Main motors : 1.0~~
- ~~b) Auxiliary load (Valve Actuators, Crane/Hoist) : 1.1~~
- ~~c) Lighting load : 1.1~~

Power Factor of Motors

~~As per the Manufacture's Data sheets~~

Efficiency of Motors

~~As per IS: 12615 (2018) including latest amendment with Efficiency of Minimum IE3 Class.~~

Power Supply Scheme

~~The source of power supply for pumping stations will be through one number 11 KV, overhead line from UGVCL. Distribution transformers of (including standby of full capacity i. e. identical rating) 11 KV/0.433 KV for pumping station i. e. Various Pumping Stations are recommended to meet the load requirement. The capacity of power transformer shall be designed to sufficiently take the full working load of only working motors with auxiliary load of concerned pumping station. Working as well as standby transformers shall be simultaneously charged and kept in working conditions by taking divided load of concerned pumping station as per directives of Engineer In Charge of GWSSB.~~

~~The short circuit apparent power of the system at the proposed main switchyards shall be as follows as per IS: 2026 (Part I).~~

11 KV Systems	:	350 MVA
415 V System	:	20 MVA

Transformer Sizing and Selection

~~Criteria 1:~~

- ~~a) The capacity of the transformers will be calculated based on the total simultaneous maximum demand (calculated based on actual kilowatts rating of motors, load and~~

~~diversity factors given above, Power Factor @ Full Load & efficiency of motor i.e. IE~~

~~3). All auxiliary loads as per actual and other loads must be considered. In case of WTP, contractor has to submit certified details of all loads i.e. of all relevant equipment including their drive motor rating & numbers thereof, power factor @ FL, Efficiency class etc. diligently to determine correct rating of transformer.~~

~~b) Additional 10% contingency shall be mandatorily considered on total simultaneous maximum demand calculated as per a) for deriving transformer sizing.~~

~~c) Similarly, after consideration of 10% contingency over maximum demand (MD), sizing of the selected transformer shall be such that maximum transformer loading shall not exceed 80% (of the MD + 10% Contingency) load.~~

Criteria 2:

~~a) The adequacy of transformer sizing shall also be proved on the basis of % Voltage dip observed at the motor terminal. % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter (VFD) & considering largest motor starting & base load (all other loads except the highest rating motor are running) the % voltage dip during starting at motor terminal shall not exceed 15%.~~

~~b) The Voltage dip and fault level calculations needs to be calculated based on following actual data collected from nearest substation and grid.~~

~~i. The fault level of HV bus from which power supply will be taken to the plant.~~

~~ii. Impedance of HV overhead line conductor/HV cable interconnecting the HV bus of substation and HV switchboards of the plant.~~

~~c) For the per unit calculation purpose, minimum starting current for various types of starter applications shall be considered as following:~~

~~i. Direct On Line Starter: 6 times the rated current.~~

~~ii. Star Delta Starter: 4.5 times the rated current.~~

~~iii. Auto Transformer Starter (ATS): 3.5 times the rated current.~~

~~iv. MP based Soft Starter: 3 times the rated current.~~

~~v. VFD Starter: 2.5 times the rated current.~~

~~Two transformers of identical capacity (including standby of 100 % capacity complete unit in all respects with all accessories) are to be kept in charged and in load condition. Load of entire plant is to be distributed in two transformers equally as per instructions of Engineer in charge. In normal condition, both the transformers shall feed their respective bus sections by keeping bus coupler close&~~

~~in case of failure of one transformer, the other transformer shall be able to take 100% load with bus coupler in open position.~~

~~Total Losses on 50% and 100% Load and Impedance (Percent Vale) of oil immersed transformers (upto rating of 2500 kVA) shall be within the values given in IS: 1180 (2014) (Fourth Revision) including Amendment dated 04.03.2021 or latest applicable revision/ amendment. Energy Efficiency Level of Transformer must be Level 2 as per prevailing version of IS: 1180 (Part 1).~~

Switchgear Sizing & Selection

Switchgear shall be sized/selected considering the following:

- ~~(a) Rating suitable for carrying full load current of the equipment.~~
- ~~(b) Suitability for Short Circuit Rating for 1 sec duration.~~
- ~~(c) Switchgear for motors shall be suitable for motor duty application.~~
- ~~(d) Switchgears for all the motor feeders shall be as per Type 2 co-ordination.~~

~~Motor starter selection shall be done as follows.~~

~~Direct On Line (DOL) Starter: For motors rated \leq 5.5 KW~~

- ~~a) Star Delta Starter: For motors rated $>$ 5.5 KW to \leq 15 KW~~
- ~~b) Auto Transformer Starter (ATS): For motors rated \geq 15 KW to \leq 75 KW~~
- ~~c) Microprocessor based Soft Starter: For all low/medium voltage motors \geq 75 KW rating.~~
- ~~d) Variable Ferequency Drive: For all VFD compliant motors irrespective of rating.~~
- ~~e) In panel de-rating of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.~~

Bus-Bar Sizing

- ~~a) The Contractor shall furnish calculations after award of contract, establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings as calculated.~~
- ~~b) The bus bars shall be sized considering the following criteria:
 - ~~i. Sleeving made of insulating material on all bus bars.~~
 - ~~ii. Design ambient temperature 50°C.~~
 - ~~iii. Final temperature of the busbars complying with requirements of IS: 8623 & IEC 60947. Reduced temperature rise limit by 5K (for indoor panels) & 10K (for~~~~

~~outdoor panels) to that of mentioned in IS: 8623 & IEC 60947 shall be considered to satisfy the final temperature.~~

~~iv. Bus bars being inside the panel, de-rating for enclosure and ventilation.~~

~~v. Bus bar suitability for carrying rated current continuously.~~

~~vi. Configuration of bus bars and proximity effect~~

~~vii. Bus bars shall withstand the short time rating of the panel for 1 sec duration.~~

Power Factor Improvement

~~APFC Panel shall be sized considering following design criteria:~~

~~Minimum 12 steps in an APFC relay shall be considered.~~

~~Capacitor shall be All Poly Propylene (APP) of double layer type.~~

~~Fixed type capacitor bank, with manual & auto switching and components as per detailed specifications and as indicated in the data sheet shall be provided in each mains incomer (LV) PMCC panel for transformer no load compensation.~~

~~For each bus section of the Main LV PMCC panel, separate APFC panel based on above design criteria are to be provided. Other requirements of APFC panel & its components shall be as per requirement provided in this specification.~~

~~Total capacity & capacitor bank sizes shall be as given in table below: (Only as a reference)~~

Capacity in KVAR	5	10	15	25	50
* kVAR	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.

~~(*) - Contractor has to calculate the capacitor rating based on the system power factor (0.85 or actual, whichever is lesser to be corrected for 0.99. Rating of APFC panel shall be based on 50% of running load on each bus section & not on the connected load basis. Number of stages/steps in a particular APFC panel shall be decided by the vendor such that minimum 8 steps & maximum 16 steps shall be provided in a particular panel. CT changeover scheme when only one transformer is running is also to be considered.~~

~~Fixed type capacitor bank, with manual & auto switching and components as per detailed specifications and as indicated in the data sheet shall be provided for power factor improvement (from built level i. e. 0.85 or less to 0.97) in PMCC MCC Panel/Individual Panel CPB for LV pumping stations.~~

~~Cable Sizing~~

~~The Contractor shall ensure that cable and wires associated with the power distribution and control systems, plant wiring and all other installations throughout the Works are adequately rated for their use.~~

~~The following main aspects shall also be considered while deciding the final size of the cables.~~

- ~~a) Supply voltage and frequency~~
- ~~b) All cables shall be selected to carry the corresponding full load current under site conditions.~~
- ~~c) Route length and disposition of cables~~
- ~~d) Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/PVC).~~
- ~~e) Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.~~
- ~~f) For cables emerging from ACB outgoing, fault clearing time shall be considered as for cables emerging from MCCB outgoing, fault clearing time shall be considered as 0.01 second~~
- ~~g) For the HV incomer cables (metering kiosk to HV switchgear/transformer) minimum fault clearing time shall be considered as 1 sec.~~
- ~~h) For cable from HV panel outgoing to transformer, fault clearing time shall be considered as 0.16 second.~~
- ~~i) Cable from transformer secondary to PCC incomer, fault clearing time shall be 1sec~~
- ~~j) Contractor to note that, the above fault clearing times are minimum to be considered & fault clearing time shall be considered as per actual relay co-ordination study.~~
- ~~k) Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:~~
 - ~~i. Ambient Air Temperature (minimum 50°C).~~
 - ~~ii. Ambient ground temperature (minimum 40°C to be considered)~~
 - ~~iii. Laid in air/ducts/directly buried in ground etc.~~
 - ~~iv. Depth of cable burial (minimum 750mm for LV and 900 mm 11KV HV)~~

- v. ~~Thermal resistivity of soil (minimum 150°C Cm/W to be considered)~~
 - vi. ~~No. of cables in a group touching each other or separated by a distance~~
 - vii. ~~No. of cable trays in tier~~
 - viii. ~~Any other de-rating factors as applicable & as per Manufacturer's catalogue.~~
- l) ~~Permissible voltage dips at the time of starting the corresponding motor load.~~
~~Vendor to ensure adherence to the Criteria-2 mentioned above.~~
- m) ~~In running condition, cumulative voltage drop (at 100 % rated load) shall not exceed 5 % (measured at load end) for the LV loads.~~
- n) ~~HV cables shall be E/UE grade (as per system requirement), multi stranded Al conductor, XLPE insulated, inner/outer extruded PVC sheath ST2, galvanized steel flat strip armoured cables.~~
- o) ~~LV cables shall be 1.1 KV grade, multi stranded Copper/Al conductor, XLPE insulated, colour coded, inner and outer extruded PVC sheathed, galvanized steel round wire/flat strip armoured cables.~~
- p) ~~Cables up to & including 4.0 sq.mm. shall be Copper multi stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi stranded conductor with galvanized steel round wire/flat strip armoured.~~
- q) ~~Single core cable shall have nonmagnetic material armouring.~~
- r) ~~Control cables shall be Copper multi stranded conductor with galvanized steel round wire/ flat strip armoured. For cables above 7 cores, minimum two spare cores shall be considered.~~

Illumination System

~~Illumination for various indoor & outdoor areas shall be conforming to the requirements mentioned below:~~

~~The illumination levels to be considered for the design of lighting system for various areas shall be as following. These are the illumination levels achieved at work plane. Work plane height shall be considered as 0.76 m from FGL.~~

Area	Illumination Level (Lux) Average values
Pump House	250
Office rooms	300

Switchgear rooms	250
Control rooms	300
Chemical and general stores	150
All other indoor areas	150
Outdoor platforms and walk ways	50
Outdoor plant areas	20
Switchyard & Transformer area	10
General on Equipment	30
Roads	15

~~Critical lighting shall be designed such that at all junctions, exit passages & strategic locations the Lux level shall be maintained above 10 Lux. Installite fixtures with built in battery backup shall be considered.~~

~~Lighting design shall be performed using Dialux Software version 4.5 or its latest version/ Original Equipment Manufacturer (OEM) validated software. The validation report along with software and data files shall be acceptable to GWSSB.~~

~~Various design factors shall be considered as following.~~

Maintenance Factor for Outdoor/ Indoor Area	0.6 (0.7 for LED) / 0.7 (0.8 for LED)
Reflectance Factor for Wall/Ceiling/ Floor	30 % / 10 % / 30 %
Uniformity (Minimum/Average)	50 % minimum for Indoor and 30 % for Outdoor

~~Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from these lighting panels. Lighting panel shall comprise of 63A TPN MCB with ELCB for incomer and 16A/10A MCBs for each out-going single phase circuits.~~

~~Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.~~

~~For the purpose of calculating connected loads of various lighting circuits, a multiplying factor of 1.25 will be assumed to the rated lamp wattage for mercury vapour, sodium vapour and fluorescent lamp fixtures to take into account losses in the control gear. Also, a~~

~~loading of 100 watts and 500 watts shall be assumed for single phase 5 Amps and 15 Amps receptacles respectively.~~

~~Lighting fixtures, receptacles, switches, conduits and junction boxes shall be properly earthed using 12 SWG GI wire unless specified otherwise. Receptacles of 5A and 15A, single phase, 3 pin shall be provided with switch. Receptacles in offices and control rooms shall be decorative type and in other areas shall be industrial type. Three phase receptacles shall be associated with TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch in "ON" position. The enclosure for all outdoor receptacles shall be provided with degree of protection of IP-55.~~

~~Generally, maintenance factor of 0.8 shall be considered for lighting fixtures.~~

Earthing & Lightning Protection System

~~The safety earthing and lightning protection system will be generally on the basis of following codes and standards (including their latest editions).~~

- ~~a) IS: 3043 (1987) (Reaffirmed in 2006): Code of practice for Safety Earthing.~~
- ~~b) IEEE 80 2000.~~
- ~~c) IS / IEC 62305 (2013): Code of Practice for the protection of buildings and allied structures against lightning.~~
- ~~d) CEA guidelines 2010: Measures related to safety & electric supply.~~

~~The fault levels considered shall be as follows.~~

System Voltage	Fault Level in kA (*)
66 KV	31.5 KA for 1 sec
11 KV	26.2 KA for 1 sec
6.6 KV	21.9 KA for 1 sec
415 V	50 KA for 1 sec

~~(*) Contractor to design on the basis of actual impedance and adequacy calculations for sufficiency of earth conductor size shall be provided.~~

~~Following factors shall be considered for sizing the earthing conductor:—~~

- ~~a) Design Ambient Temperature ÷ 50°C~~
- ~~b) Allowable temperature rise for steel welded joints ÷ 500°C~~
- ~~c) Fault clearing time ÷ 1 Second~~
- ~~d) Overall earthing resistance to be achieved as per: $\leq 1 \Omega$ for transmission~~

~~$\leq 5 \Omega$ for distribution
substation.~~

~~Measurement of soil resistivity shall be done using Wenner's four (4) electrode method as described in IS 3043 1987 (Reaffirmed in 2006) including its latest amendment.~~

~~The soil resistivity of the plant area has not yet been measured; the same should be carried out during detailed engineering by successful Contractor.~~

~~After soil resistivity measurement; length of conductor, quantity of earth electrodes and quantity of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.~~

~~Electromagnetic flow meter sizing shall be done such that velocity of fluid inside flow tube should not be less than 0.5 m/s and not generally exceed 2.0 m/s. For underground installation, water tight CC chamber with top cover shall be constructed for flowmeter.~~

DETAILED & PARTICULAR TECHNICAL SPECIFICATIONS

PART II: ELECTRICAL SYSTEMS

LV (415V) POWER – MOTOR CONTROL CENTRE PANELS (If applicable)

Applicable Standards

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between standards and this specification, this specification shall govern.

General requirements	IS: 3427 / IEC: 61439-2 (2011)
Factory Built Assemblies of switchgear and control gear for Voltages up to and including 1000V AC & 1200VAC	IS: 8623 / BS: 5486 / IEC: 439
Air Break Switches	IS: 13947 P3 / BSEN6049 / IEC: 947-3
Miniature Circuit Breakers	IS: 8828 / BSEN: 60898
Low Voltage Fuses	IS: 13703 / BS: 1362 / IEC: 269-1
Contactors	IS: 13947/ BSEN: 60947-4 / IEC: 947-1
Starters	IS: 13947/ BSEN60947-4/ IEC: 292-1 to 4
Control Switches & Push buttons	IS: 6857 / BSEN: 60947
Current Transformer	IS: 2705 / BS: 7626
Voltage Transformer	IS: 3156 / BS: 7625 / IEC: 44, 186
Indicating instruments	IS: 1248 / BS: 89 / IEC: 51
Marking and Identification of Conductors and Apparatus Terminals	IS: 11353 / BS: 159
A.C. Electricity Meters	IS: 722, 8530 / BS: 5685 / IEC 145,211
Degree of Protection	IS: 13947 / IEC: 947 P1
Selection installation and maintenance of switchgear and control gear	IS: 10118
Code of practice for phosphating iron and steel	IS: 6005 / BS: 3189
Specification for copper rods and bars for electrical purposes	IS: 613
Control transformers for switchgear and	IS: 12021

Constructional Features

The switchgear shall be metal enclosed, modular type suitable for indoor installation, dust & vermin proof, self-standing floor/plinth mounting with a height not exceeding 2300 mm and shall have following features

- a) Panels shall be complying with Form 4 as per IS: 8623 (1993) Part I/IEC 61439-1/2. The form of separation shall be minimum form 4-B for better human and equipment safety.
- b) Breaker up to 1250A shall be installed in two tiers and above 1250A, it shall be mounted in single tier.
- c) Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20 mm at any location & shall be complying with the BIL for the panel.
- d) Switchgear shall be divided into distinct vertical sections each comprising
 - i. A completely enclosed bus bar compartment running horizontally.
 - ii. Enclosed vertical bus bars serving all modules in vertical section.
 - iii. A separate horizontal enclosure for all auxiliary power and control buses.
 - iv. Vertical cable alley of minimum 250 mm wide covering entire height
- e) Operating devices shall be incorporated only in the front of switchgear.
- f) Each shipping section shall have metal sheets at both ends.
- g) Cable alley shall be provided with suitable hinged doors.
- h) All doors shall be with concealed type hinges and captive screws.
- i) Each vertical section shall be equipped with a space heater controlled by thermostat.
- j) Each switchgear cubicle shall be provided with interior lighting with 11W LED luminaries inclusive of lamp with door limit on/off switch.
- k) A power socket (240 V AC, 5/ 15 A) shall be provided in the interior of each cubicle with On-Off switch.
- l) All identical equipment and corresponding parts be fully interchangeable without any modifications
- m) Main and Auxiliary Buses
 - i. Switchgear bus bars shall be of uniform cross section throughout the length and made of electrolyte grade Aluminium (91 E- 63401).

- ii. ~~All bus bars shall be covered with heat shrinkable black PVC sleeves. Coloured polyester tapes for phase identification shall be provided at suitable locations.~~
- iii. ~~Bus bar shall be adequately supported to withstand stresses developed due to short circuits. Bus bar joints shall be provided with contact grease at the joints and shall be complete with tensile steel bolts, washers and nuts~~
- iv. ~~The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear.~~
- v. ~~Vertical bus bars shall have Short Circuit rating same as main bus bar and shall be suitable for all connected load of vertical section.~~
- vi. ~~Neutral bus bar size shall be 50% of phase bus bar.~~
- vii. ~~Termination on bus bars at ACB, MCCBs shall be as per IEC60947-2. For terminations on MCCBs, where phase-phase and phase to earth clearance are not possible, Cu spreaders of suitable size shall be used along with the use of separators.~~
- viii. ~~Bus bar supports shall only be SMC irrespective of bus bar size. The span between the two insulators shall be adequate. Joint positions and insulators shall be properly adjusted so that they don't interfere.~~
- ix. ~~For the Main PMCC, Contractor shall ensure that incoming feeders from transformer shall be suitably designed for terminating cable/bus duct as provided. Contractor shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the bus duct. Phase transposition, if required, will be done in the Main PMCC.~~
- x. ~~Wherever Cu bus bars are provided, it shall be tinned copper & not bare Cu.~~
- n) ~~All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor.~~
- o) ~~All the indoor switchgear panels shall be suitable for IP 54 degree of ingress protection for the enclosure. Outdoor panels shall be with minimum IP 55 degree of protection.~~
- p) ~~All panels shall be made up of CRCA sheet steel of following thickness.~~
 - i. ~~Load bearing members: 2.5 mm~~
 - ii. ~~Doors and partitions: Doors: 2.0 mm & Partition: 1.6 mm~~
 - iii. ~~Mounting plate: 2.0 mm~~

- ~~iv. Gland plate: 3.0 mm for both incomer and outgoing. For single core cable these plates shall be non-magnetic.~~
- ~~q) All the panel wiring shall be done with PVC FRLS, multi-stranded copper wires~~
- ~~r) Feeder shall have hinged open-able (more than 105°) type door with panel locks. All bus bar covers and other panel covers shall be screw fixed.~~
- ~~s) Suitable barriers of FRP material shall be provided between two terminals connected to different voltage supplies.~~
- ~~t) All doors and detachable components shall be earthed with flexible green coloured (with Yellow coloured band) PVC sheathed 2.5/4.0 sq.mm multi-stranded Copper cable.~~
- ~~u) The equipment shall be given tropical and fungicidal treatment.~~
- ~~v) Each compartment & component shall be provided with name plates (with white letters on black background) at front, inside & rear side.~~
- ~~w) Equipment nameplates shall be fixed by screws/ rivets and shall not be pasted.~~
- ~~x) Metallic shrouding shall be provided for the isolation of main and vertical bus as well as to avoid accidental contacts with live parts.~~
- ~~y) Drawing pocket shall be provided on the inside of incomer feeder door.~~
- ~~z) Provision for Top/Bottom cable entry shall be made to suit the site condition.~~
- ~~aa) Lifting hooks/eyes shall be provided in each shipping section of the equipment and shall be removable type.~~
- ~~bb) All the panels shall be provided with 20% extra power & control terminals.~~
- ~~cc) All unused contacts of the circuit breaker, protection, auxiliary, control relays shall be wired up to the terminal block.~~
- ~~dd) All terminals of different control voltages shall be separate from each other.~~
- ~~ee) Stud type terminals and ring type lugs shall be used for control cables.~~
- ~~ff) All the control/power wiring shall be dressed neatly & the wire running through troughs shall be provided with covers.~~
- ~~gg) Switchgear shall be easily extensible on both sides by the addition of vertical sections after removing the end covers. It shall be provided with a metal sill frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated or passivated. It shall be provided with labels on the front and rear indicating the switchgear designation.~~

- ~~hh) Any operating handle of switchgear shall not be more than 1800 mm and not lower than 300 mm from base of the panel.~~
- ~~ii) For individual feeder modules arranged in multitier formation, it is essential that the modules are integral multiples of the unit size to provide for flexibility in changes if any at site. For safety, isolation of the vertical bus bars, insulating barrier with cut outs shall be provided to allow the power slab contacts to engage with vertical bus bars. A vertical cable alley shall be sufficiently wide for motor control modules and for circuit breaker control modules.~~
- ~~jj) A horizontal separate enclosure for all auxiliary power and control buses, as required shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap off connections from these buses shall be arranged separately for each vertical section.~~
- ~~kk) All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section.~~
- ~~ll) For draw out type modules, only the handles of control and selector switches, push buttons, knobs & cut outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door.~~
- ~~mm) On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawal chassis. All cut outs shall be provided with gaskets for the purpose of dust proofing.~~
- ~~nn) Current transformers shall not be directly mounted on the buses. Current transformer on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.~~
- ~~oo) In breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control cables.~~
- ~~pp) After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the Bus bars and adjacent circuit live.~~
- ~~qq) The withdrawable chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.~~
- ~~rr) Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carryout maintenance work on cable connections to any one circuit with the Bus bars~~

~~and adjustment circuits live. Adequate number of slotted cable support arms shall be provided for cleating the cables.~~

~~ss) Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.~~

~~tt) All doors shall be provided with concealed type hinges and captive screws.~~

~~uu) The draw out contacts shall be only between copper/copper alloy/aluminium fuses, which are silver or tinplated. The contact design shall be such that there should be no arcing/ deformation under the associated peak short circuit current.~~

~~vv) Switchgear shall be designed in such a way that all components equipment and Bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubical, with reference to ambient temperature outside the switchgear cubical.~~

~~ww) Provision of ventilating louvers shall be provided with fine screened brass or GI meshes to prevent entry of vermin and dust.~~

~~xx) The various types of modules indicating the control requirements of each type together with the list of component equipment required for each type shall be as follows & as described in data sheets.~~

~~i. For Incoming Circuit: Electrical Draw Out Air Circuit Breaker for $\geq 800A$ and Microprocessor Based Fixed Type MCCB with LSIG $\leq 630A$~~

~~ii. Outgoing Feeders: ACB/MCCB/MPCB~~

~~iii. Auxiliary Services: Starters, capacitors, distribution boards and any other auxiliary load~~

~~yy) Physical size of compartment for each type of control and current rating shall be so chosen that all the basic and additional equipment can be housed in the compartment. No equipment associated with any particular circuit shall be permitted to be mounted in any other circuit module.~~

~~zz) Power Distribution Board (PDB) configuration shall be two no. *A TPN MCCB I/Cs and six no. *A TPN MCCB O/G feeders. The O/G feeders shall be supplying to Sub DBs. The configuration of Sub Distribution Board (SDB) shall be *A FP MCCB I/C and 2 nos. 63A TPN MCB & 12 nos. 20A SP MCBs as outgoing feeders. (*A) shall be decided during detailed engineering.~~

~~Separate instrument's compartment for indicators of flow meter(s), energy meter,~~

~~level and pressure controller (if any) shall be provided as per actual requirement of suitable size.~~

Control Voltages

~~Following control voltages shall be used in LV panels.~~

- ~~a) All ACBs tripping/ Closing shall be suitable for 110/240V AC (24/ 30 or 110VDC) as applicable. The trip coil and closing coils of ACBs shall operate satisfactorily under the following conditions of supply voltage,
 - ~~i. Closing coils: 85 % to 110 % of rated voltage~~
 - ~~ii. Trip coils: 70 % to 110 % of rated voltage.~~~~
- ~~b) Indications/Annunciator for LV Main PMCC: 110/ 240V AC (24/ 30 or 110VDC)~~
- ~~c) Indications for auxiliary DBs: 240V AC~~
- ~~d) Space heater, 5/15A socket, panel illumination lamp etc. 240V AC derived from AC bus~~
- ~~e) 240V AC, 110V AC and other voltages shall be segregated to avoid mix-up of voltages.~~
- ~~f) Control transformers suitably rated of voltage ratio 415/240/110 V on the Incomer/Bus shall be provided. For the control transformers, fuses shall be provided on the 415 V side and MCBs on the 240/110V side. The control transformer shall be cast resin type only.~~

Painting

- ~~a) All sheet steel work shall be painted through 7 tank electrostatic powder coating process in accordance with the required procedure and with the applicable standards. The switchgear enclosure shall be powder coated with shade as per RAL7032.~~
- ~~b) The final finished thickness of paint film on sheet steel enclosure shall not be less than 80 microns. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.~~

Interchangeability

~~All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable without having to carry out modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.~~

Drawings & Documents

~~Prior to fabrication of the switchgear, the Contractor shall submit following for GWSSB's approval the dimensional drawing and design calculations indicating bus bar size, enclosure sizing with heat dissipation details, short circuit rating of all the electrical component used, internal wiring, components mounting details etc. The Contractor shall submit manufacturers catalogues of the electrical components installed in the switchgear.~~

Inspection

~~At all reasonable times during production and prior to dispatch of the switchgear to site, the Contractor shall arrange and provide all the facilities at their plant for inspection & testing of switchgear.~~

Earthing

- ~~a) — A earth bus bars of adequate size shall be provided for the entire length of the panel. The framework of the enclosure shall be connected to this earth bus. Provisions shall be made for connection from this earth bus to the main earthing bus bar coming from the earth pit on both side of the switchgear.~~
- ~~b) — The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bus bar. The armour of cables shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bus bar.~~

Labels & Name Plate

- ~~a) — Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.~~
- ~~b) — A nameplate with the switchgear designation in bold letters shall be fixed at top of the central panel. A separate nameplate giving feeder details shall be provided for each feeder module door.~~
- ~~c) — Inside the feeder compartments the electrical components, equipment, accessories like switchgear shall be provided with stickers shall suitably identify control gear, lamps, relays etc.~~
- ~~d) — Engraved nameplates shall preferably be of 3 ply (Red-White-Red or Black-White-Black) Lamacoid sheet however black engraved perplex sheet nameplates shall also be acceptable. Engraving shall be done with square grove cutters.~~
- ~~e) — Nameplate shall be fastened by counter sunk screws and not by adhesives.~~

~~Danger Notice Plates~~

- ~~a) — The danger notice plate shall be affixed in a permanent manner on operating side of the switchgear.~~
- ~~b) — The danger notice plate shall indicate danger notice in Gujarati, Hindi and English.~~
- ~~c) — The danger notice plate, in general shall meet to requirements of local inspecting authorities.~~
- ~~d) — Caution name plate, “Caution Live Terminal” shall be provided at all the points where the terminals are likely to remain live and isolation is possible only at remote end i.e. incomer to the switchboard.~~
- ~~e) — The danger notice plate shall be made from minimum 1.6 mm thick steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.~~
- ~~f) — The letters, figures, the conventional skull and bones shall be positioned on the plate as per recommendations of latest edition of IS: 2551 (1982).~~
- ~~g) — The said letters, the figures and the sign skull and bones shall be painted in signal Red colour as per latest edition of IS 5: 1978.~~
- ~~h) — The danger plate shall have rounded corners. Locations of fixing holes for the plate shall be decided to suit the design of the switchgear enclosure.~~

~~Cable Entry~~

- ~~a) — The panel shall have provisions of cable entry from top/bottom as per site requirement. The removable cable gland plate shall be provided to make entry dust and vermin proof.~~
- ~~b) — The panel shall have provisions for fixing the multi-core cable glands.~~
- ~~c) — The cable glands support plates shall be 3 mm thick.~~
- ~~d) — Cable entries to the panel shall be from the bottom unless otherwise specified. Cable gland shall be double compression screwed type and made of brass.~~

~~Mountings~~

- ~~a) — All equipment in front of panel shall be of flush mounting type.~~
- ~~b) — All equipment shall be so mounted that the removal and replacement may be accomplished individually without interruption of services of others.~~
- ~~c) — All equipment inside the panel shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.~~

~~d) — The centre line of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise, the top lines of all meters, relays and recorders etc. shall be matched.~~

~~It is important to note that when pumping station is idle and transformer is required to be kept energized under no load/part (miniscule) load condition, the necessary LV fixed APP type capacitor bank (approx. 5% of transformer rating) shall be provided in PMCC (transformer LV incomer) panel and shall be manually/automatically switched on to maintain power factor more than 0.95 but less than 0.99 (near unity). All the components for fixed type capacitor bank (to be mounted in Main LV PMCC) panel shall be as indicated in specifications & data sheet. Responsibility to maintain the power factor under idle condition & when only miniscule/part load is required lies completely with the Contractor. Any power factor adjustment charges levied by power utility shall be recovered from the Contractor along with 5 % lump sum administrative charge by the GWSSB.~~

Air Circuit Breaker (ACB)

- ~~a) — All the incomers (02 numbers) & bus coupler ACBs shall be 4P EDO type. All other ACBs shall be TPN EDO type.~~
- ~~b) — All the ACBs shall have $I_{cs}=I_{cu}=I_{cw}=100\%$~~
- ~~c) — Up to and including 630 A, Fixed Type FP/TPN Microprocessor based MCCB shall be considered, while above 630A FP/TPN, fully draw out type ACB shall be considered in line with the electrical load requirements.~~
- ~~d) — All ACBs shall be provided with additional 6 NO + 6 NC contacts, exclusively for GWSSB's use.~~
- ~~e) — All the ACBs (except for APFC panel) shall be provided with Microprocessor based O/L + S/C + inbuilt E/F protections.~~
- ~~f) — ACBs/MCCBs for APFC panel shall be provided with thermal magnetic based O/L + S/C + E/F protections.~~
- ~~g) — Each ACB shall be provided with — On, Off, Trip, Spring Charged, Trip Coil Healthy, Service & Test Position indication lamps.~~
- ~~h) — For incomer feeders R, Y & B Phase indication lamps shall be provided.~~
- ~~i) — All ACBs shall be Schneider/Siemens/ABB/L&T/Mitsubishi OR Reputed & Standard makes from the approved make list.~~
- ~~j) — Circuit breaker shall be horizontal withdrawal type, comprising three/four identical poles operated through a common shaft.~~

- ~~k) — It shall be suitable for switching duty of transformer and motors and other devices.~~
- ~~l) — It shall be possible to push in and withdraw the breaker easily and without much effort. Insulating plugs and sockets for power as well as for control circuits shall be of robust design and fully self-aligning. Plugs and sockets for power circuits shall be silver faced, insulated with PVC or other insulating material.~~
- ~~m) — The breaker shall have three distinct positions namely services, test and fully withdrawn positions. In test position, it shall be possible to operate the circuit breaker without energizing the power circuits. Separate limit switches each having a minimum of four (4) NO contacts shall be provided for both service and test position of the circuit breaker. These contactors shall be rated for 10 Amps 240 volts AC.~~

Operating Mechanism

- ~~a) — The EDO type ACB shall be power operated by a motor charged spring operated mechanism & MDO type shall be manual type spring operated mechanism.~~
- ~~b) — The operating mechanism shall have anti-pumping features under every method of closing. The operating mechanism shall normally be operated by Local/Remote electrical control, when the breaker is in service position. Shunt trip coils shall perform electrical tripping.~~
- ~~c) — The main poles of the breaker shall operate simultaneously. There shall not be any objectionable rebound of the moving contact in the fixed contacts.~~
- ~~d) — The mechanism shall be such that any failure of auxiliary spring shall not prevent tripping. When the breaker is in closed position, failure of any auxiliary spring shall not cause damage to the CB or danger the operation.~~
- ~~e) — A mechanical indicator shall be provided on the breaker operating mechanism to indicate open and closed position of the breaker. This shall be visible to a man standing in front of the cubical with the door closed.~~
- ~~f) — It shall be possible to operate the breaker mechanically. This shall be possible only after opening the cubical door. Provision shall be made for local electrical control also when the breaker is in the test position by a control switch on the cubical doors.~~
- ~~g) — All working parts of the mechanism shall be of corrosion resistance material. All split pins, bolts, nuts and other parts shall be properly pinned and locked to prevent loosening with repeated operation of the breakers.~~
- ~~h) — Auxiliary switch containing 6 NO +6 NC potential free contacts rated for 10 Amp 240 V AC (Inductive breaking).~~

Spring Charged Mechanism

- a) ~~Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.~~
- b) ~~The breaker operation shall be independent of the motor, which shall be used only for tensioning/compressing of the spring.~~
- c) ~~The closing operation shall automatically charge the tripping spring. The closing, opening shall get charged immediately after a closing operation is performed.~~
- d) ~~Motor used shall be preferably universal type operated on AC supply. The Motor shall operate satisfactory at all values "between" 85% to 110% of rated voltage.~~

Mechanical/Electrical Interlocking

- a) ~~Mechanical interlock arrangement shall be provided between two incomer breakers. Interlocking arrangement shall be robust, heavy duty type and sturdy in construction.~~
- b) ~~Interlocking between two incomer breakers shall be provided in such a way that in normal condition bus coupler shall be in "OFF" position so that both the transformer can be kept charged and the total load can be divided equally between two circuits.~~
- c) ~~During fault, maintenance or any other abnormal condition while one of the transformers is not in working mode, the bus coupler shall be in "ON" position so that total load can be supplied by the remaining transformer circuit.~~
- d) ~~Interlock shall be Mechanical and Electrical type. In case if one of the interlocks fails the other way can be used for interlocking purpose.~~

Moulded Case Circuit Breakers (MCCB)

- a) ~~The MCCBs shall conform to IEC 947 & the latest applicable standards.~~
- b) ~~All MCCBs shall be of fixed type unless otherwise specified in the specifications elsewhere.~~
- c) ~~MCCBs shall be of four pole/triple pole with neutral construction arranged for simultaneous four/ three pole manual closing and opening and for automatic instantaneous tripping on short circuit.~~
- d) ~~All the incomer & bus coupler MCCBs for Main LT PMCC panels shall be FP type with Microprocessor based O/L +S/C + inbuilt E/F release & all outgoings MCCBs shall be TPN with thermal magnetic based O/L +S/C + E/F releases.~~

- e) ~~All MCCB's shall Schneider/Siemens/ABB /L&T/Mitsubishi/C&S OR Reputed & Standard makes from the approved make list.~~
- f) ~~For achieving the Earth Fault protection in thermal magnetic (TM) based MCCBs, external CBCT, Earth Fault relay & shunt trip provision shall be considered as part of complete TM based MCCB.~~
- g) ~~The ON, OFF and TRIP positions of the MCCB shall be clearly indicated by using LED indications.~~
- h) ~~MCCBs shall be with $I_{cs} = I_{cu} = 100\%$~~
- i) ~~MCCB shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stresses caused by the peak short circuit current of value associated with the switch gear rating.~~
- j) ~~All the MCCBs shall be of current limiting type and shall provide a cut off in 4-8 milli seconds for prospective currents during faults.~~
- k) ~~All the MCCBs shall be provided with rotary operating handle with door interlock.~~
- l) ~~MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.~~
- m) ~~All MCCBs shall be provided with additional 2 NO + 2 NC contacts, exclusively for Purchaser's use.~~
- n) ~~All the switchgear selection for motor feeders shall be Type 2 co-ordinated.~~

~~Entire LV system shall be fuse less type & fuses shall be used only for VT/Control Transformer primary side. MCBs shall be provided on secondary of PT/Control transformer~~

Miniature Circuit Breaker (MCB)

- a) ~~MCB shall be hand operated, air break, quick make & quick break type.~~
- b) ~~Operating mechanisms shall be mechanically trip free from the operating knob to prevent the contacts being held closed under overload or short circuit conditions.~~
- c) ~~Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the characteristics of the connected load. Where this is not specified, it shall be Type C.~~

- d) ~~The short circuit rating shall be not less than that of the system to which they are connected.~~

Direct On Line Starters

~~Direct on line motor starter shall have following components/features~~

- a) ~~Direct on line starters shall be suitable for Class AC 3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.~~
- b) ~~DOL starter shall have MCCB/MPCB, Overload Relay with SPP, Contactor etc.~~
- c) ~~Type 2 Co-ordination shall be ensured.~~

Automatic Star-Delta Starters

~~Automatic star-delta motor starters shall have following components/features:~~

- a) ~~Three sets of contactors one for the line, one for the star point and one for the delta, and a timer to automatically change the connections from star to delta.~~
- b) ~~Star Delta Starters shall consist of MCCB/MPCB, Overload Relay with SPP, Contactors, electronic timer etc.~~
- c) ~~Star delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized after time delay, timer contact de-energizing the star contactor, and delta contactor closing.~~
- d) ~~Star delta starters shall be suitable for AC 3 utilization category as per IS: 13947 (Part 4), unless otherwise mentioned in tender.~~
- e) ~~Type 2 Co-ordination shall be ensured.~~

Reversing Starters

~~Motor Reversing starter shall have following components/features.~~

- a) ~~Forward and reverse contactors, electrically interlocked with each other.~~
- b) ~~Reversing starters shall be suitable for Class AC 4 duty as specified in applicable standards, unless otherwise mentioned in tender.~~

Auto Transformer Starter (ATS)

~~Auto Transformer starter shall have following components/features.~~

- a) ~~Auto transformer shall be air cooled type having three (3) tapings of 50%, 65% and 80%. The same should be wound with Copper wire. The size of the wire should be determined to suit the associated motor rating. The tapping requirement indicated is minimum required & Contractor to ensure proper tapping selection based on motor starting requirement.~~

- b) ~~Stamping of reputed make and winding wire with 'B' class insulation should be used. This should also be suitable for minimum 6 starts per hour. Core shall be of CRGO material.~~
- c) ~~Maximum temperature rise should not be more than 115°C Kordnoffer circuit (Closed Transition type) should be adopted in ATS panel. There shall be an acrylic/Hylem sheet over & below the transformer. To absorb humming, rubber sheet shall be provided below the auto transformer.~~
- d) ~~Auto transformer shall be vacuum impregnated.~~
- e) ~~Testing of transformers should withstand full load starting current for six starts per hour, each kick of 15 seconds duration as per relevant IS.~~
- f) ~~ATS shall be provided with thermal overload protector in each coil of transformer from overheating. Thermal overload protector rating shall be 900°C with 10% tolerance.~~
- g) ~~ATS shall consist of MCCB/MPCB, Overload Relay and Contactors etc.~~
- h) ~~Ratings of MPCB, overload relay & contactor for auto transformer starter panels up to 50 HP are tabulated below.~~

Sr. No.	Type of Panel	MPCB rating Line-A	Overload relay rating Line	Contactor rating		
				Main	Step	Star
1	ATS 21 to 30 HP	37 — 50	30 — 50	63 / 70	32	22 / 25
2	ATS 31 to 35 HP	48 — 65	45 — 70	70	38 / 40	32
3	ATS 36 to 45 HP	56 — 80	55 — 90	80 / 110	38 / 40	32
4	ATS 46 to 50 HP	60 — 100	60 — 110	95 / 110	63 / 70	38 / 40

- i) ~~Ratings of MCCB, overload relay & contactor for auto transformer starter panels above 50 HP are tabulated below.~~

Sr. No.	Type of Panel	MCCB rating in Amps	Overload relay rating Line	Contactor Rating		
				Main	Step	Star
1	ATS 51 to 60 HP	120	60 — 100	120	63 / 70	38 / 40
2	ATS 61 to 70 HP	160	80 — 120	160 / 200	63 / 70	38 / 40
3	ATS 71 to 80 HP	160	90 — 150	160 / 200	100	50

Soft Starters

Fully automatic microprocessor based soft starters with built-in bypass contactor for pump control application shall be considered for the motors $\geq 75\text{KW}$. The features/requirements of the starters shall be as per following but not limited to:

- a) — The soft starter shall be designed, built and tested according to the latest editions of applicable IEC standards/IEC 947-4-UL, CE.
- b) — Input Voltage: 3Phase, $415\text{V} \pm 10\%$
- c) — Input Frequency: $50\text{ Hz} \pm 5\%$
- d) — Control Voltage: $100 - 240\text{ V AC}$
- e) — Ambient Conditions:
 - i. — Temperature: 50°C (Operating range: 5 to 70°C)
 - ii. — Relative Humidity of 5% to 95%
- f) — Control Method: Torque Control/Reduced Voltage/Ramp
- g) — Motor Protection: Thermal Overload Protection
- h) — Starter Protection: S/C, Phase imbalance, Phase failure, Phase reversal, O/V, U/V, Locked rotor, excessive starts per hour for application, Phase loss input/output, Motor output loss.
- i) — EMC standard: IEC 61000-4-2 level 3, IEC 61000-4-3 level 3
- j) — Built-in communication port for RS 485
- k) — Type 2 Co-ordination shall be ensured.
- l) — The soft starter shall be complete with the following acceleration and deceleration settings & display requirements as a minimum
 - i. — Starting Torque: Initial torque shall be adjustable from $0 - 100\%$ of maximum locked rotor torque.
 - ii. — Ramp Time: The time between starting torque and maximum torque shall be adjustable between 1 to 60 seconds. The time between maximum torque & stop shall be adjustable between 2 to 120 seconds
 - iii. — The current limit feature shall have the following characteristics
 - — The maximum allowed current during start shall be adjustable from 150% to 500% of soft starter maximum current rating.
 - — Starting torque shall be fixed at 40% when utilizing the current limit function.

- ~~iv. Voltage Ramp start & Full voltage DOL start shall be possible.~~
- ~~v. For stop function Linear torque control, Quadratic Torque Control, Voltage ramp control, soft break etc. functions shall be provided.~~
- ~~vi. The soft starter shall be provided with a functional ground to remove and/ or minimize electrical noise injected on the soft starter control board.~~
- ~~vii. Normally open output relays shall be provided for faults and status indications.~~
- ~~viii. Normally closed contacts for fault relays shall be provided as an option.~~
- ~~ix. The soft starter shall be provided with a 2-position dip switch to select between the normal in-line connection (3-lead motor) and inside the delta (6-lead or 12-lead delta wound motors).~~
- ~~x. The soft starter shall be controlled completely through solid state design algorithms. No moving electromechanical contacts shall be allowed.~~
- ~~xi. All adjustments shall be made from the front of the soft starter through keyboard (soft keys)~~
- ~~xii. The Soft starter shall have in built/remote display with following display parameters.
Three Phase Currents/Three Phase Voltages/Shaft Power in KW/HP (selectable)/ Motor thermal capacity/Motor Energy consumption (kWh)/Power factor/Run time in hours~~
- ~~xiii. The Soft starter shall have following fault indications
Line failure / Phase imbalance / Over temperature — Motor / Over temperature — Soft Starter / Shorted Thyristor / Open Thyristor / Locked Rotor / Motor output loss / Overload — Shaft Torque / Underload — Shaft Torque / Over voltage / Under voltage / Excessive Starts / Phase reversal.~~
- ~~xiv. Shaft Power measurement without the use of external electro-mechanical sensors.~~
- ~~xv. Shaft overload and under load protection shall be available through the controller, even in a by-pass configuration.~~
- ~~xvi. When fault conditions are detected, the controller shall inhibit starting or shut down SCR-pulse firing.~~
- ~~xvii. The standard feature pump control shall be implemented to provide closed loop control of a motor to match the specific torque requirements of~~

~~centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomenon commonly referred to as “water hammer”.~~

~~xviii. The soft starter shall be designed for three-phase control with two anti-parallel SCRs in each phase. SCR-Diode combination shall not be acceptable.~~

- ~~• The PCB shall provide digital microprocessor control and supervision of all controller operation, including SCR pulse firing control.~~
- ~~• The PCB power supply shall be self-tuning to accept control power input from 100 to 240 or 380 to 500 V AC, 50/60 Hz.~~
- ~~• The SCR firing circuitry shall incorporate an RC snubber network to prevent false SCR firing.~~
- ~~• When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.~~

~~xix. SCRs shall have the following minimum repetitive peak inverse voltage ratings:~~

- ~~• 200 to 525V: 1600 V~~
- ~~• 200 to 690V: 1800V~~

~~m) Soft Starter shall be as per approved GWSSB vendor list make.~~

Contactors

~~The power contactors used in switchboard shall have following features.~~

- ~~a) The contactors shall conform to IS: 13947 & the latest applicable standards.~~
- ~~b) The power contactors shall be of, air break, single throw, triple pole, electromagnetic type.~~
- ~~c) The insulation class of contactor's coil should be B or higher.~~
- ~~d) Operating coils of all contactors shall be suitable for operation on 110/ 240 V, single phase, 50 Hz, AC supply.~~
- ~~e) Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.~~
- ~~f) Contactors shall not drop out at voltages down to 70 % of coil rated voltage.~~
- ~~g) All the switchgear selection for motor feeders shall be Type 2 coordinated.~~
- ~~h) Motor starters shall be complete with auxiliary relays, timers and necessary indications.~~

Relays

- ~~a) Main protective relays shall be **Microprocessorbased** type. They shall be suitable for semi-flush mounting with only flanges projecting on the front with connections from the rear.~~

- ~~b) All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.~~
- ~~c) All protective relays shall be in draw out cases with built in test facilities.~~
- ~~d) Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage~~
- ~~e) Test block and switches shall be located just below each relay for testing unless otherwise specified. All auxiliary relay and timers shall be supplied in non draw out cases.~~
- ~~f) All protective relays shall be provided with at least two pair of potential free output contacts, exclusively for Purchaser's use.~~
- ~~g) Relay cases shall have adequate number of terminals for making potential free connections, to the relay coils and spare contacts. Paralleling of contacts if any shall be done at the terminals on the casing of the relay.~~
- ~~h) Each relay shall have provision for easy isolation of trip circuit for the purpose of testing and maintenance.~~
- ~~i) All relays shall withstand out a test voltage of 2 KV, 50 Hz RMS voltages for one minute.~~
- ~~j) Auxiliary seal in units provided on the protective relay shall be shunt reinforcement type.~~
- ~~k) 250 kW & above rated motors shall be breaker controlled with motor protection relay Siemens OR equivalent from approved make list.~~

Thermal Overload Relays

- ~~a) Starters shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.~~
- ~~b) Thermal overload relays shall be hand reset type.~~
- ~~c) 'Stop' push button of the starter and hand reset device shall be separate from each other.~~
- ~~d) Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least 1 'NO' and 1 'NC' or one changeover contact.~~

Timers

~~Electronics timer for change over in star delta and ATS panel should be provided.~~

Switch and Contactor Ratings

~~Switch and contactor rating for various motor starter modules shall be selected by the Contractor based on the specifications. Contractor shall also select appropriate ratings & ranges for thermal overload relays. These details shall be subject to the Purchaser's approval.~~

Single Phasing Preventers

- ~~a) Single phasing preventer relay shall be provided to protect motors against single phasing.~~
- ~~b) It should operate satisfactory from 320/ 480V. Timing range of delay start 0 – 45 seconds.~~
- ~~c) Toggle switch for Auto SPP bypass should be provided on front of unit.~~
- ~~d) The relay shall not operate for supply voltage unbalance of $\pm 5\%$. After sensing single phasing, the relay shall operate with a time delay of 2 to 3 seconds.~~
- ~~e) The relay shall not operate for a 3 phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.~~
- ~~f) The relay shall be suitable for application to protect reversible and non-reversible motors.~~
- ~~g) The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and RPM of the motor.~~
- ~~h) The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.~~

Power & Control Wiring Connections

- ~~a) Terminals for both incoming and outgoing cable connections shall be suitable for 1.1 KV grade Al/ Cu conductor XLPE armoured cable and shall be suitable for connections of solder less sockets for the cable size.~~
- ~~b) Main PMCC incomer feeder shall be suitable for cable termination/bus duct connections using Aluminium Bus bars.~~
- ~~c) Both control and power wiring shall be suitable for Bus Duct/Cable termination as per guidelines mentioned in transformer specifications.~~

- ~~d) Both control and power terminals shall be properly shrouded. Power terminals shall be of stud type.~~
- ~~e) 20 % spare terminals shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire is connected to per terminal.~~
- ~~f) Suitable barriers of enclosures shall preferably separate terminals strips for power and control from each other.~~
- ~~g) Wiring inside the modules for power, control, protection and instruments etc. shall be done with use of 1.1 KV grades, multi-stranded Cu, PVC FRLS wiring.~~
- ~~h) Power wiring inside the starter module shall be rated for full current rating of respective contactor but not less than 4.0 sq. mm & 2.5 sq. mm copper wire shall be used for current transformer circuits.~~
- ~~i) Other control wiring shall be done with 1.5 sq. mm copper conductor wires.~~
- ~~j) Wires for connection to the door shall be flexible. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.~~
- ~~k) There shall be control transformer for control power supply (110/ 240V AC) and separate control bus.~~
- ~~l) Particular care shall be taken to ensure that the layout of wirings is neat and orderly. Identification ferrules shall be fitted to all the wirings terminations for ease of identification and to facilitate checking and testing.~~
- ~~m) Washers shall be used for all Copper and Aluminium connections.~~
- ~~n) Final wiring diagram of power and control circuit with ferrules nos. shall be submitted along with the panel as one of the documents against the contract.~~

Terminals

- ~~a) The outgoing terminals and neutral shall be brought to a cable alley suitably located and accessible from the panel front.~~
- ~~b) The current transformer for instruments metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming or outgoing cables to internal components of the distribution board is permitted; only one conductor may be connected in one terminal.~~

Wire Ways

~~The horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.~~

Indicating Instruments

- ~~a) All analogue indicating meters shall be 96 x 96 mm size taut band with 240° Scale. All indicating meters shall be provided as per enclosed electrical Single Line Diagram.~~
- ~~b) Ammeters for motor feeders shall have suppressed scale up to 6 times beyond full load.~~
- ~~c) Dials shall be parallax free and white with black numbers and letterings & pointer shall be of knife edge type. Such instruments shall be provided with zero adjustor accessible from the front.~~
- ~~d) Instruments shall have an accuracy class 1.0 or better.~~
- ~~e) Instrument dials shall be white with black numbers and lettering.~~
- ~~f) Ammeter and current coils of wattmeter's and ammeters shall continuously withstand 120 % of rated current and 10 times the rated current for 0.5 second without loss of accuracy.~~
- ~~g) Voltmeters and potential coils of voltmeters shall withstand 120% rated voltage continuously and twice the rated voltage for 0.5 seconds without loss of accuracy.~~

Metering Instruments

- ~~a) Multifunction meters shall be provided for incomers, main pump motor feeders and outgoing feeders of 250A and above. Size of the MFM shall be 96 x 96 sq. mm & provided with following metering features:
 - ~~i. Current, Voltage, Energy (kWh), MD (kW, kVA), PF & Hz etc.~~
 - ~~ii. MFM shall be L & T, Siemens, Rishabh, ABB, Elmeasure, Selec OR any Standard & reputed makes.~~
 - ~~iii. MFM shall be with accuracy class 1.0 or better & having RS 485 communication port.~~~~
- ~~b) Multifunction meters shall be suitable for operation from the secondary of CTs and VTs. They shall be provided with a separate 3 phases, 4 wires type test terminal blocks for testing of meters without disturbing CT and VT secondary connections.~~
- ~~c) Current coils of meters shall have a continuous overload capacity of 120 % for both accuracy as well as thermal limits. The coil shall withstand at least 10 times rated current for 0.5 second without loss of accuracy.~~

Current Transformers

- ~~a) Current transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.~~

- ~~b) — Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second for breaker feeders.~~
- ~~c) — Unless otherwise specified, the minimum performance requirement of current transformers is as follows
 - ~~i. — Measuring CTs: 15 VA, accuracy class 1.0 or better.~~
 - ~~ii. — Protective CTs: 15 VA, accuracy class 5P10.~~~~
- ~~d) — The abovementioned burdens are minimum required & it will be Contractor's responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer. Contractor has to provide sufficiency calculations for the same.~~
- ~~e) — Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block~~
- ~~f) — CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current~~
- ~~g) — Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.~~
- ~~h) — Identification labels giving type, ratio, output and serial numbers shall be provided.~~

~~Voltage Transformers~~

- ~~a) — Voltage transformers shall be of cast resin type. Insulation Class shall be Class 'E' or better.~~
- ~~b) — Unless otherwise specified, the minimum performance requirements of Voltage transformers are as follows:
 - ~~i. — Measuring VTs — 50 VA per phase and accuracy class 1.0~~
 - ~~ii. — Protective VTs — 50 VA per phase and accuracy class 3P.~~
 - ~~iii. — Dual purpose VTs — 100 VA and dual accuracy class 1.0/3P for metering and protection respectively. VA is per phase.~~
 - ~~iv. — The above mentioned burdens are minimum required & Contractor has to provide sufficiency calculations for the same.~~~~
- ~~c) — All secondary windings of voltage transformers including open delta windings shall be rated for 110 V / $\sqrt{3}$, 110V/ 3 per phase.~~
- ~~d) — Voltage transformer shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows.
 - ~~i. — 1.5 for 30 seconds in case of effectively earthed system.~~~~

- ii. ~~1.9 for 8 hours in case of non-effectively earthed system.~~
- e) ~~Voltage transformers shall be complete with suitable rated primary, fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. All the secondary circuits of the VT shall be protected by MCBs.~~
- f) ~~It shall be possible to replace voltage transformers without having to de-energize the main bus bars.~~
- g) ~~The terminals of VT secondary and tertiary windings, which are required to be connected to earth, shall be earthed by an isolating link without a fuse.~~
- h) ~~Identification labels giving type, ratio, output and serial numbers shall be provided.~~

Push Buttons

- a) ~~Push buttons shall have two normally open and two normally closed contacts unless otherwise specified. The contacts shall be able to make and carry 5A at 110V DC and shall be capable of breaking 1A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.~~
- b) ~~Emergency stop' push buttons shall be of Mushroom type, lockable in the pushed position and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.~~
- c) ~~The Internal wiring and terminal blocks shall meet the relevant requirements.~~

Auxiliary Transformer

~~Any auxiliary voltage required for any of the component inside the switchgear shall be derived from the main supply by providing adequately rated auxiliary transformer mounted inside.~~

Indicating Lamps

~~Indicating lamps shall be~~

- a) ~~Clustered LED type and of low watt consumption.~~
- b) ~~Provided with series resistors.~~
- c) ~~Provided with translucent lamp covers of colours 'Red', 'Green' and Amber' etc. as required.~~

- ~~d) — Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 110 V AC or at the specified AC/DC system voltage as applicable.~~

Control & Selector Switches

~~Control and selector switches shall be~~

- ~~a) — Rotary type with enclosed contacts.~~
- ~~b) — Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 230V AC and 1A (inductive break) 220VDC.~~
- ~~c) — Provided with escutcheon plates clearly marked to show the positions.~~
- ~~d) — Control switches shall be spring return to normal type & provided with pistol grip type handles.~~
- ~~e) — Selector switches shall be maintained contact stay put type. Switches in ammeter circuits shall be of break type contact. Selector switches shall be provided with oval handles.~~

Space Heaters

- ~~a) — Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk.~~
- ~~b) — Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1 phase, 50 Hz, AC system.~~
- ~~c) — Each space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a control thermostat to cut off the heaters at 35^o C.~~
- ~~d) — Space heater indicated in the breaker modules represents the space heater for each vertical section of the switchboard. Where breakers are mounted in two tier formation, then only one space heater with associated MCB and thermostat is adequate for the vertical section~~

Cubicle Lighting/Receptacle

- ~~a) — Each control cabinet, marshalling box etc. shall be provided with interior lighting by means of 11 W LED luminaries with door operated ON/OFF switch.~~
- ~~b) — A 240 V, 1 Phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with MCB.~~

~~Local Push Button Stations~~

~~Constructional Features~~

~~The constructional features of the local push button stations shall be as follows~~

- ~~a) — Metal enclosed, weatherproof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium or sheet metal of 2 mm thickness.~~
- ~~b) — Dust and vermin proof.~~
- ~~c) — Provide a degree of protection of not less than IP55.~~

~~Pump Selector Switch~~

~~It requires in the usually in the pattern of (1 + 1) pumps / (2 + 1) or (3 + 2) Pumps i. e. One/Two/ Three pumps working & one/two standby i. e. at any given time only one/ two/ three pumps can be selected for simultaneous operation out of total 02/03/05 installed pumps in case of all pumping stations/pumping sections covered in this tender. Suitable capacity reputed make pump selector switch shall be incorporated between two pump feeders. The selector switch shall be confirming to relevant IS. Pump selector switch shall be provided in configuration (e. g. 1 W + 1SB; 2 W+ 1SB; 3 W + 2 SB...) as per the requirement of the pumping systems.~~

~~Pump Running Hour Meter~~

~~Panel mounting Microprocessor based pump running hour meter is required for all the pumps installed in pumping station.~~

~~Earth Leakage Relay~~

~~For the protection against the rise of damaging/dangerous and possible lethal electric shocks, automatic disconnection of supply device i. e. ELR should be incorporated in MCC panel suitably designed as per relevant IS/BSS in accordance with Indian electricity rules 1985 & statutory requirements of power utility i. e. UGVCL. Separate earth leakage breaker also shall be provided in the starters. The relay shall be voltage/current operated. The Minimum range should be 320 to 480 volts with suitable time delay. ELR should be of adjustable from minimum 0.5 to 2.5 amperes with CBCT with time delay.~~

~~Routine and Acceptance Tests~~ ~~to be conducted by the manufacturer at their own risk and cost in presence of GWSSB's representative during inspection & testing at manufacturer's works.~~

~~Following Routine tests as per IS: 13947 and IEC: 60947 standards & other specified relevant IS standards shall be performed by the manufacturer and witnessed by GWSSB's representative on LV Switchgear panel complete with the accessories.~~

- ~~i. — Dielectric test on main circuit~~
- ~~ii. — Test on auxiliary and control circuit~~
- ~~iii. — Measurement of insulation resistance of the main circuit~~
- ~~iv. — Tightness of main circuit~~
- ~~v. — Design and visual check~~
- ~~vi. — Dimensional check and BOM verification~~
- ~~vii. — High Voltage test on power & control circuit~~
- ~~viii. — Functional & mechanical operation test of all components~~
- ~~ix. — Measurement of thickness of sheet steel & paint~~
- ~~x. — Verification of wiring as per approved schematic~~
- ~~a) — Following Type Tests reports as per IS: 13947 and IEC: 60947 to be submitted for the same rating & type of LV Switchgear panel conducted in past for review of GWSSB at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years. LV type test panel certificate for temperature rise and short circuit shall be with switchgear which shall confirm the design reliability of the panels as per IEC test standards.~~
 - ~~i. — Dielectric test on main and auxiliary circuit~~
 - ~~ii. — Temperature rise test~~
 - ~~iii. — Making and Breaking test of switching elements~~
 - ~~iv. — Degree of protection test~~
 - ~~v. — Short circuit withstand test~~
 - ~~vi. — Electromagnetic compatibility test~~
- ~~b) — Certified copies of all type and routine test certificates and Calibration Certificates of measurement instruments which are used during inspection shall be submitted for the GWSSB's review/approval before dispatch of the switchgear.~~

Test Certificates

- ~~a) — Testing of switchgear shall be carried out at factory or at site as per standard in presence of GWSSB's representative.~~
- ~~b) — The test results shall be recorded on prescribed forms. The certificates for the test carried out at factory or at site shall be submitted in duplicate to the GWSSB's Representative for approval. Components and equipment that are not fully interchangeable are liable for rejection. Contractor shall replace all such non interchangeable equipment at his cost.~~

Drawings/Documents

~~After award of contract, Contactor has to submit drawings/documents for GWSSB's approval as mentioned below but not limited to:~~

- ~~a) — General arrangement diagram showing dimensions of enclosure, length, widths and depth of enclosure and bill of quantity indicating the rating, make of each components and quantity.~~
- ~~b) — Complete assembly drawings of the switchboard/distribution board/MCC showing plan, elevation and typical sectional views and location of cable boxes and control cable terminal blocks for external wiring connections, etc.~~
- ~~c) — Foundation plan showing the location of channel sills, foundation, anchor bolts and anchors, floor plans and openings.~~
- ~~d) — Schematic power and control wiring diagrams with bus bar rating with material, instrument & control transformers, switchgear rating, control interlocks, relays, instruments, space heaters details etc.~~
- ~~d) — Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.~~
- ~~e) — Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6 mm.~~
- ~~f) — Provided with two earthing terminals suitable for earthing wire/strip.~~
- ~~g) — Provided with removable undrilled gland plate and cable glands for two nos. 5C x 2.5 mm² Cu conductor, XLPE insulated, armoured cable. Cable entry shall be from bottom.~~
- ~~h) — Earthing shall be provided by 8 SWG GI wire and connected to earthing system.~~

~~DETAILS & REQUIREMENTS FOR LV (415 V) PMCC/MCC PANELS (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

CUBICAL CONTROL PANEL BOARDS

Supply of fully automatic air break type panel up to 7.5 H.P. D.O.L. Star Delta from 8 – 20 H.P. above 20 H.P. auto transformer Control Panels for Submersible Pumps suitable for operation on

415 (+ 10% – 15%) Voltage, 3 Phase, 50 \pm 3% Hz A.C. Supply, Control Panels shall be comprising of MCB/MCCB, Overload relays, Contactors and Accessories. The details of equipment / accessories for each type of panels are given in enclosed data sheet.

1) ENCLOSURES:

The control panel shall be dust and vermin proof as per IP-41 and fabricated out of minimum 1.5 mm CR sheets for all Panels. Control Panel shall be wall mounting type for DOL / Star Delta and for ATS wall mounting cum pedestal type. All items inside the panel shall be mounted on steel base plate. All metal parts shall be thoroughly cleaned, degreased and made free from rust. Control panels shall be powder coated. The color shade of panel shall be RAL 7032 for entire panel and component mounting plates should be Orange only. Size of the enclosure should be as mentioned in the drawing attached.

All bolts, nuts, screws, washers shall be Galvanized Zinc / Cadmium plated and passivity, and full protection from dust rubber lining should be provided. There shall be cable entry for suitable size at the bottom of the control panel for outgoing cable to submersible motor. There should be one suitable entry on bottom of Control Panel for incoming cable. Layout on the door will be as per drawing (attached). For Closing the Door Two Half Turn Door Locks (Top and Bottom) operated by a Screw Driver type key should be provided. One Key is provided by the supplier with each Control Panel.

The cable entries for incoming and outgoing cable shall be provided with rubber grommets, at bottom of panel.

2) WIRING AND TERMINALS:

Power Supply to Control Panel and Internal Control Panel wiring shall be done with

P.V.C. insulated copper conductor / Strip having 660/1100 V grade insulation Control wiring shall be done with 1.0 mm² copper conductors and shall be terminated with adequately sized compression type lugs for connections to the equipment terminals and the terminal strips. Each wire shall be identified at both ends by PVC ferrules. Not more than 2 wires to be terminated at one terminal and proper type and size at terminals should be used keeping in view the components for which they are used, so, that sufficient surface contact can be achieved. Screws and Bolts should be used as per corresponding size and hole. That should be done to the satisfaction of inspection authority. Incoming and outgoing connections to be made at terminals only Clip on type terminals shall be used for wiring up to 10mm² and for conductors larger than 10 mm² bolt type terminals shall be provided. Terminal may also be permissible on epoxy insulator with copper strip and Hardware of proper size. The size of incoming cable should be provided as per table I here under:

TABLE-I

Sr No	Type of Control Panel	Size of incoming Conductor Terminal	Terminal strip for outgoing Conductor		
1	D.O.L. Up to 3 H.P.PANEL	1 x 3 x 2.5 sq.mm	1 No.	-	2.5 sq.mm
2	D.O.L. Up to 5 H.P.PANEL	1 x 3 x 2.5 sq.mm	1 No.	-	2.5 sq.mm
3	D.O.L. Up to 7.5 H.P.PANEL	1 x 3 x 4.0 sq.mm	1 No.	-	4.0 sq.mm
4	S.D. 8 to 10 H.P.PANEL	1 x 3 x 6.0 sq.mm	2 Nos.	-	4.0 sq.mm
5	S.D. 11 to 15 H.P.PANEL	1 x 3 x 6.0 sq.mm	2 Nos.	-	4.0 sq.mm
6	S.D. 16 to 20 H.P.PANEL	1 x 3 x 10.0 sq.mm	2 Nos.	-	6.0 sq.mm
7	ATS 21 to 30 H.P.PANEL	1 x 3 x 16.0 sq.mm	1 No.	-	16.0 sq.mm
8	ATS 31 to 35 H.P.PANEL	1 x 3 x 16.0 sq.mm	1 No.	-	16.0 sq.mm
9	ATS 36 to 45 H.P.PANEL	1 x 3 x 25.0 sq.mm	1 No.	-	25.0 sq.mm
10	ATS 46 to 50 H.P.PANEL	1 x 3 x 25.0 sq.mm	1 No.	-	25.0 sq.mm
11	ATS 51 to 60 H.P.PANEL	1 x 3 x 35.0 sq.mm	1 No.	-	35.0 sq.mm
12	ATS 61 to 70 H.P.PANEL	1 x 3 x 35.0 sq.mm	1 No.	-	35.0 sq.mm
13	ATS 71 to 80 H.P.PANEL	2 x 3 x 25.0 sq.mm	1 No.	-	50.0 sq.mm
14	ATS 81 to 90 H.P.PANEL	2 x 3 x 25.0 sq.mm	1 No.	-	50.0 sq.mm
15	ATS 91 to 100 H.P.PANEL	2 x 3 x 25.0 sq.mm	1 No.	-	70.0 sq.mm
16	ATS 101 to 110 H.P.PANEL	2 x 3 x 35.0 sq.mm	1 No.	-	70.0 sq.mm
17	ATS 111 to 120 H.P.PANEL	2 x 3 x 35.0 sq.mm	1 No.	-	70.0 sq.mm
18	ATS 121 to 130 H.P.PANEL	3 x 3 x 35.0 sq.mm	1 No.	-	95.0 sq.mm
19	ATS 131 to 140 H.P.PANEL	3 x 3 x 35.0 sq.mm	1 No.	-	95.0 sq.mm
20	ATS 141 to 150 H.P.PANEL	3 x 3 x 35.0 sq.mm	1 No.	-	95.0 sq.mm
21	ATS 151 to 160 H.P.PANEL	3 x 3 x 35.0 sq.mm	1 No.	-	Above 95 sq.mm.

3) — EARTHING :

Provision shall be provided for connecting the earth. All non-current carrying metallic parts of the equipment shall be earthed Two "L" shaped earth bus of aluminum (19 mm x 3 mm) will be connected between base plate and the body of the panel. Also necessary provision of earthing on door shall be made to connect main Earthing.

4) — NAME PLATE :

Labels shall be provided for each equipment mounted on the panel and all labels shall be engraved in Gujarati Language on 3 ply laminated sheets or anodized aluminum. These shall be fastened to the panels by screws and not by Adhesive. All mounted equipment shall have identification with paint inside the panels. Instruction for operation of panel shall be engraved in Gujarati language on 3 ply laminate sheet or anodized aluminum. These should be fastened to the front side of panel door by screws and not by Adhesive.

5) — ACCESSIBILITY :

Checking and removal of components shall be possible without disturbing adjacent equipment. All auxiliary equipment's shall be easily accessible incoming supply terminals shall be shrouded with plastic covers to prevent accidental contact.

6) INCOMING:

MCCB for ATS and MCB for DOL / Star Delta

MCCB:

- 1) Fixed thermal magnetic type.
 - 2) Breaking capacity (ICU) should be minimum 10 KA up to 200 A and Minimum 35KA for 225 A and above (ICU = 50% of Ics).
 - 3) All Accessories should be field fit table type.
 - 4) Rated Insulation voltage should be minimum 600 V.
 - 5) Certified pollution degree for environment for MCCB should be as per IEC 60947 MCB:
- 1) Should be suitable for Isolation function as specified in IEC 60898 / IS: 8828.
 - 2) Should have IP 20 protection with positive contact indication.
 - 3) Should be of "C" type tripping class suitable for motor application.
 - 4) Energy limitation class should be III.
 - 5) Average suitable life should greater than 20,000 for 32 A and 10,000 for more than 32 A rating.
 - 6) Breaking capacity should be minimum 10KA.

7) MCCB / MCB

MCCB / MCB for main circuit should be TP and Neutral should be separate. It should be mounted inside the panel on base plate and the operating trigger shall be front of the panel in such a way that only trigger is seen fitted in a Hooper type box as shown in drawings. A separate MCCB / MCB for capacitors should be mounted as suitable place inside the enclosure. The current rating shall be as per Table II.

TABLE II

Sr. No.	Type of Control Panel Board	FOR MAIN CIRCUIT	FOR CAPACITOR		Range of CT
		Capacity of MCB / MCCB	Capacity of MCB / MCCB (TP 10 KA)	Capacitor KVAR	
1	D.O.L. Up to 3 H.P. Panel	16 AMP MCB	-	0	10/5 AMP
2	D.O.L. Up to 5 H.P. Panel	20 AMP MCB	-	0	15/5 AMP
3	D.O.L. Up to 7.5 H.P. Panel	25 AMP MCB	6 AMP MCB	3	20/5 AMP
4	S.D. 8 to 10 H.P. Panel	32 AMP MCB	6 AMP MCB	3	30/5 AMP
5	S.D. 11 to 15 H.P. Panel	50 AMP MCB	10 AMP MCB	4	50/5 AMP
6	S.D. 16 to 20 H.P. Panel	63 AMP MCB	10 AMP MCB	5	60/5 AMP
7	ATS 21 to 30 H.P. Panel	75/80 AMP MCCB	16 AMP MCB	7	75/5 AMP
8	ATS 31 to 35 H.P. Panel	100 AMP MCCB	16 AMP MCB	8	100/5 AMP
9	ATS 36 to 45 H.P. Panel	125 AMP MCCB	20 AMP MCB	10	100/5 AMP
10	ATS 46 to 50 H.P. Panel	150/160 AMP MCCB	25 AMP MCB	11	150/5 AMP
11	ATS 51 to 60 H.P. Panel	200 AMP MCCB	32 AMP MCB	13	150/5 AMP
12	ATS 61 to 70 H.P. Panel	200 AMP MCCB	32 AMP MCB	15	200/5 AMP
13	ATS 71 to 80 H.P. Panel	225/250 AMP MCCB	40 AMP MCB	17	250/5 AMP

14	ATS 81 to 90 H.P. Panel	300/320 AMP MCCB	40 AMP MCB	19	250/5 AMP
15	ATS 91 to 100 H.P. Panel	300/320 AMP MCCB	50 AMP MCB	21	300/5 AMP
16	ATS 101 to 110 H.P. Panel	300/320 AMP MCCB	50 AMP MCB	23	300/5 AMP
17	ATS 111 to 120 H.P. Panel	400 AMP MCCB	50 AMP MCB	25	400/5 AMP
18	ATS 121 to 130 H.P. Panel	400 AMP MCCB	63 AMP MCB	27	400/5 AMP
19	ATS 131 to 140 H.P. Panel	400 AMP MCCB	63 AMP MCB	29	400/5 AMP
20	ATS 141 to 150 H.P. Panel	400 AMP MCCB	63 AMP MCB	31	500/5 AMP
21	ATS 151 to 160 H.P. Panel	500 AMP MCCB	63 AMP MCB	33	500/5 AMP

8) ~~CONTACTORS:~~

~~The contactors shall be air break type having AC-3 duty rating. The contactor shall be suitable for operation on 415+10% -15% voltage Current as per Table-III All contactors should be suitable to perform at ambient temperature - 20° C to 45° C. The insulation class of coil is B or higher. Minimum life of operating cycle as under in million~~

~~1) Mechanical - a) 15 up to 32 A, b) 10-33 A to 80 A and c) 5-81 A to 400 A~~

~~2) Electrical - a) 1 up to 70 A, b) 0.75 - 71 A to 150 A and c) 0.5-151 A to 400A~~

9) ~~OVERLOAD RELAYS: (IN CASE OF DOL / STAR DELTA / ATS)~~

~~Overload relays shall be three element positive acting ambient temperature compressed type with in built single phasing prevention mechanism and adjustable setting range to ensure protection against overload and single phasing. Bimetal relays shall be manually and auto reset type. Should have 1 No + 1 NC or 1C/O potential free auxiliary contact. Ratings shall be as per Table-III. Overload relays should be same make as per contactor as far as possible.~~

TABLE—III
CONTACTORS & MCCB / OVERLOAD RELAYS

Sr. No.	Type of Control Panel board	Rating			
		Main Contactor	Delta/ Step Contactor	Star Contactor	Relay Range in Amp (Approx.)
1	2	3	4	5	6
1	D.O.L. Up to 3 H.P. PANEL	16	-	-	3-5
2	D.O.L. Up to 5 H.P. PANEL	16	-	-	6-10
3	D.O.L. Up to 7.5 H.P. PANEL	22/25	-	-	10-16
4	S.D. 8 to 10 H.P. PANEL	16	16	16	6-10
5	S.D. 11 to 15 H.P. PANEL	22/25	22/25	22/25	10-16
6	S.D. 16 to 20 H.P. PANEL	30/32	30/32	30/32	13-21
7	ATS 21 to 30 H.P. PANEL	63/70	30/32	22/25	30-50
8	ATS 31 to 35 H.P. PANEL	63/70	38/40	30/32	45-70
9	ATS 36 to 45 H.P. PANEL	80/110	38/40	30/32	55-90
10	ATS 46 to 50 H.P. PANEL	95/110	63/70	38/40	60-100

11	ATS 51 to 60 H.P.PANEL	120/130	63/70	38/40	60-100
12	ATS 61 to 70 H.P.PANEL	160/200	63/70	38/40	80-120
13	ATS 71 to 80 H.P.PANEL	160/200	95/100	50	90-150
14	ATS 81 to 90 H.P.PANEL	200	95/100	50	135-225
15	ATS 91 to 100 H.P.PANEL	200	120/125	50	135-225
16	ATS 101 to 110 H.P.PANEL	225	120/125	65/70	135-225
17	ATS 111 to 120 H.P.PANEL	250	140	65/70	135-225
18	ATS 121 to 130 H.P.PANEL	300	150	80/100	135-225
19	ATS 131 to 140 H.P.PANEL	300	150	95/100	180-300
20	ATS 141 to 150 H.P.PANEL	300	160/170	110	180-300
21	ATS 151 to 160 H.P.PANEL	400	160/170	120/125	180-300

Note:

Overload relay should be provided considering

For D.O.L.:- 1.6 times of maximum H.P.

For Star Delta.:- 0.96 times of Maximum H.P.

For ATS up to 80 H.P.:- 1.5 times of Maximum H.P. For

ATS above 80 H.P.:- 1.4 times of Maximum H.P.

It should be within calculation range having margin at upper side for future. It should be manually or auto-reset type.

Temperature compensation -20 to +55 Degree C

~~10) CONTROL SUPPLY:~~

~~415 (+10% -15%) Voltage, 3 Phases, 50 + 3% Hz A.C. Supply~~

~~Door push button should be provided for control circuit. Such a way motor supply should be cut off when door was opened.~~

~~415 / 230 V Transformer shall be provided for Supply to MFM.~~

~~11) AUTO TRANSFORMER:~~

~~Auto transformers shall be air cooled type having 3 tapping of 60%, 70% and 80%. The same should be wound with copper wire. The size of the wire should be determined as per the H.P. of the motor. Stampings of reputed make and winding wire with 'E' Class insulation should be used. This should also be suitable for 6 starts per hour. Maximum temperature rise should not be more than 115^o C as per ISS Kordnoffer Circuits as per ISS should be adopted in ATS Panel. ATS shall be provided with Thermal Overheat Protector (TOP) in each coil of Transformer in such a way to cut the supply of control circuit to save the Transformer from overheating. Thermal Overheat Protector (TOP) rating shall be 90^o Centigrade. But add 10% tolerance i.e. 100^o Centigrade +/- 10% shall be an Acrylic / Hylem sheet over the transformer. Also to absorb humming Rubber sheet shall be provided below Auto Transformer.~~

~~11) ATS~~

- ~~i) Auto transformer shall be vacuum impregnated.~~
- ~~ii) Testing of transformers should withstand full load starting current (6 x 1.5 x H.P. x Tapping²) for six starts per hour. Each kick of 15 seconds duration as per relevant IS.~~
- ~~iii) (%) Percentage regulation of voltage should be within 10%.~~
- ~~iv) Excitation current at no load at rated voltage should be less than 10% of rated current~~
- ~~v) Lamination should be preferably CRGO (Cold Rolled Grain Oriented) alternative CRNGO.~~

~~12) CONTROL FUSES:~~

~~Re-wire able Control Fuse shall be provided for DOL, Star Delta, and ATS Panels 16A 415 Volts. 3 Nos~~

~~13) TIMER:~~

~~Star Delta - Electronic Star Delta change over time 0 to 30 Sec. ATS Thermal / Electro-pneumatics / Electronic timer for change over in start to run should be provided. Control wiring may be change as per type of timer and contactors.~~

~~14) MULTIFUNCTION METER:~~

~~Digital type CT Operated Multifunction meter, 3 lines display i.e. showing any three parameters at a time, of class 1% accuracy shall be provided showing A, V, Hz, Pf, KW, KWH etc. Range of Three no.s CT shall be as per Table II.~~

~~15) INDICATING LAMPS:~~

~~Light Emitting Diode red color lamp should be used at 230 V and size of lamp holder should be 22.5 mm.~~

For DOL / STAR DELTA	For ATS
ON	OFF
Over load Trip	Start

SPP	Run
	Over load Trip
	SPP

16) ~~PUSH BUTTONS (22.5 MM DIA)~~

Push button colors shall be as follows:

Stop	Red
Start	Green
Timer Falls (ATS)	Yellow
Overload Reset (ATS)	Black

17) ~~SINGLE PHASING PREVENTOR:~~

~~Single phasing preventer with auto switch should be operating on negative phasing sequence components principals and voltage sensing type only. It should be operate satisfactory from 320 / 480 V. Cut off Voltage should be 320 V and 480 V. Timing range of delay start 0 to 45 Sec. Toggle switch for Auto SPP By pass should provided on the front of the unit. There must be an indication when 3 phases are balanced. When one fuse blows, indication light would go off. The wiring diagrams of SPP should be provided on the unit (SPP).~~

18) ~~INCOMING CABLE:~~

~~The length of cable for panels shall be provided with 3 meters suitable size (as per table-~~

~~1) Flat PVC Copper Submersible Cable of 660/1100 V Grade duly crimped with lugs of both ends. And an additional wire of 2.5 Sq.mm (Black) Single Core shall be provided with 3 phase incoming cable from neutral point to GEB supply. The cable shall be IS Marked and GWSSB Approved vendor.~~

19) ~~CAPACITOR:~~

~~APP 415/440 Volts A.C. GEB approved capacitor with GEB test report should be provided with necessary connections. GEB Test Certificate shall have to provide in duplicate in each respective panel. Capacitor should be inside or outside the panel. Capacity of Capacitor shall be as tabulated as per Table II. (Different unit of Capacitor is acceptable but total KVAR should be same as per Table II).~~

20) ~~TEST AND INSPECTION:~~

~~1) Tests shall be carried out at manufacturer's works under his care and expenses.~~

~~2) Following tests as per applicable standard code shall be conducted during inspection.~~

~~a) H.V. I.R. All panels 2.0 KV for power test Circuit for 1 Min.~~

~~—1.0 KV FOR CONTROL CIRCUIT~~

~~b) Meager All panels test as per relevant IS~~

~~c) Functional test (All panels)~~

~~d) Temperature rise test for autotransformer only one from each category out of lot of any number of panels offered for inspection.~~

~~3) The test report of the concern equipments / components from the concern vendor will have to be provided to inspecting agency vendor of the equipment.~~

21) — EQUIPMENT MAKES:

Unless approved in writing equipment/components of following make approved by CPRI / EARDA Tested shall only be acceptable.

MCB / MCCB	L & T SIEMENS, ELCON, STANDARD, C & S, GE, HAVELLS, SCHNEIDER, HPL, INDO-ASIAN, BCH and GWSSB Approved Vendors Make.
Contactors	L&T, SIEMENS, YULE, JSL, C&S, GE, BCH, SCHNEIDER, HAVELLS, PECO, INDO-ASIAN and GWSSB Approved Vendors Make.
Overload Relays	L&T, SIEMENS, SCHNEIDER, GE, YULE, JSL, C&S, BCH, HAVELLS, T/M, GS, PECO, INDO-ASIAN and GWSSB Approved Vendors Make.
Timers	L&T, JSL, ELLICO, C&S, BCH, GELCO, INDO-ASIAN and GWSSB Approved Vendors Make.
Push Buttons (22.5 mm)	L&T, SIEMENS, TEKNIC, VAISHNO, C&S, MATHURA and GWSSB Approved Vendors Make.
CT Coil	Approved by CPRI / ERDA Tested
Door Push Button	REPUTED and GWSSB Approved Vendors Make.
Digital Meters	AE, IMP, MECO, RISHABH (L&T), TRINITY, EL- MASURE, HPL, INDOTECH, NIPPEN, SELEC, GELCO, ELLICO and GWSSB Approved Vendors Make.
Terminals	TOSHA, ELMEX, TECHNOPLAST, PI, CONNECT WELL, AIRON, VIRAL and GWSSB Approved Vendors Make.
Single Phase Preventer (Auto Switch)	MINILEC, GELCO, ELLICO, AMBILIN OR Any other make approved by CPRI / ERDA Tested as per GWSSB Specification for each Rating and GWSSB Approved Vendors Make.
Incoming Cable	GWSSB Approved with IS Marked.
Indicating Lamps (LED)	AIRON, ESSEN, IEC, B.C.H., VAISHNO, CONCORD, TEKNIC, ELCOM, MATHURA and GWSSB Approved Vendors Make.
Rewire able Fuse	WILLY, KEW, SUPER, PEW and GWSSB Approved Vendors Make.
Auto Transformer	SUN, ELEMBICA, SUECO, ELTECH OR Any other make approved by CPRI/ERDA Tested as per GWSSB Specification for each Rating and GWSSB Approved Vendors Make.
Capacitor	G.E.B. Approved make and GWSSB Approved Vendors Make.

22) — I.S. SPECIFICATIONS:

Control Panel and equipment shall conform to following OR relevant I.S. specifications.

a)	IS : 13947 / Part-I	General requirement of switchgear and control gear voltage not exceeding 1000 Volts.
	IS : 13947 Part-II	Degree of protection provided for switchboard.
	IS : 13947 Part-IV	Contractor AC Voltage not exceeding 1000 Volts.
	IS : 13947 (Part-I & IV)	Motor starter for voltage not exceeding 1000 Volts.

b)	IS : 2705	Specifications for Current Transformer.
c)	IS : 5124-1964	Code of practice for installation and maintenance of induction motor starter AC voltage not to exceeding 1000 Volts.
d)		Multi function meter.

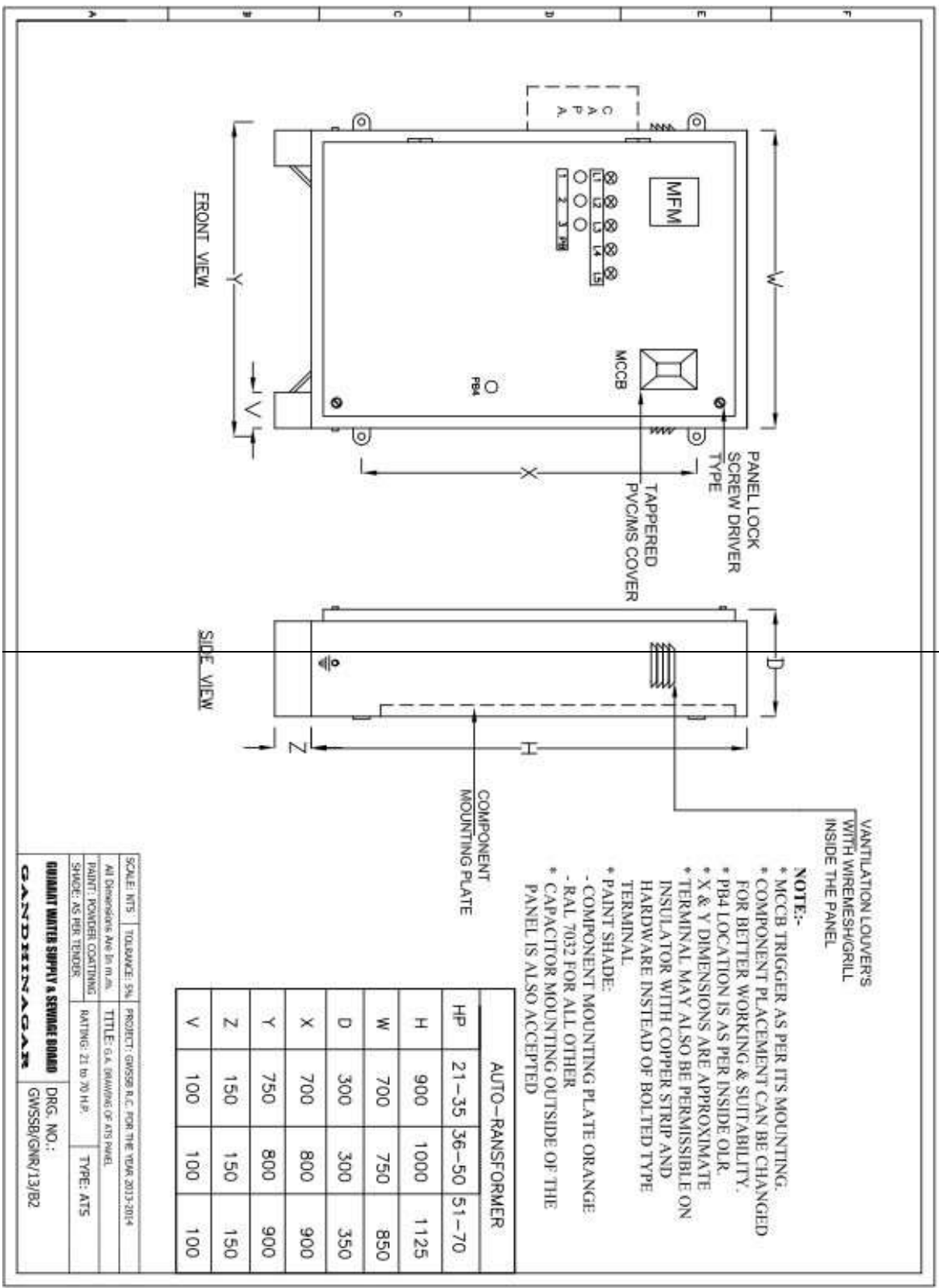
23) Suppliers shall have to supply the Control Panel Boards as per the Approved Wiring Diagrams.

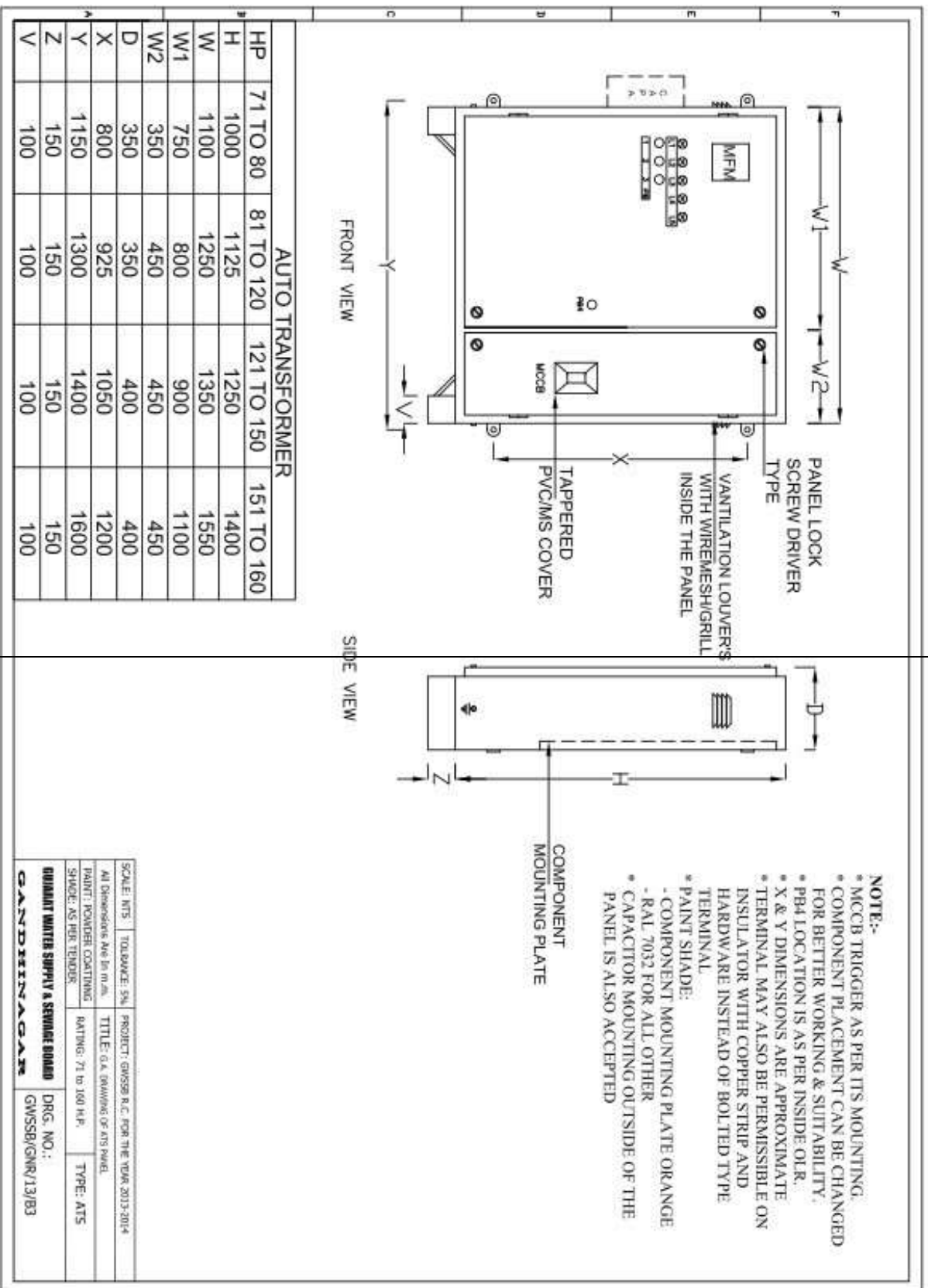
24) The Monogram of "GWSSB" should be screen printed on the panel.

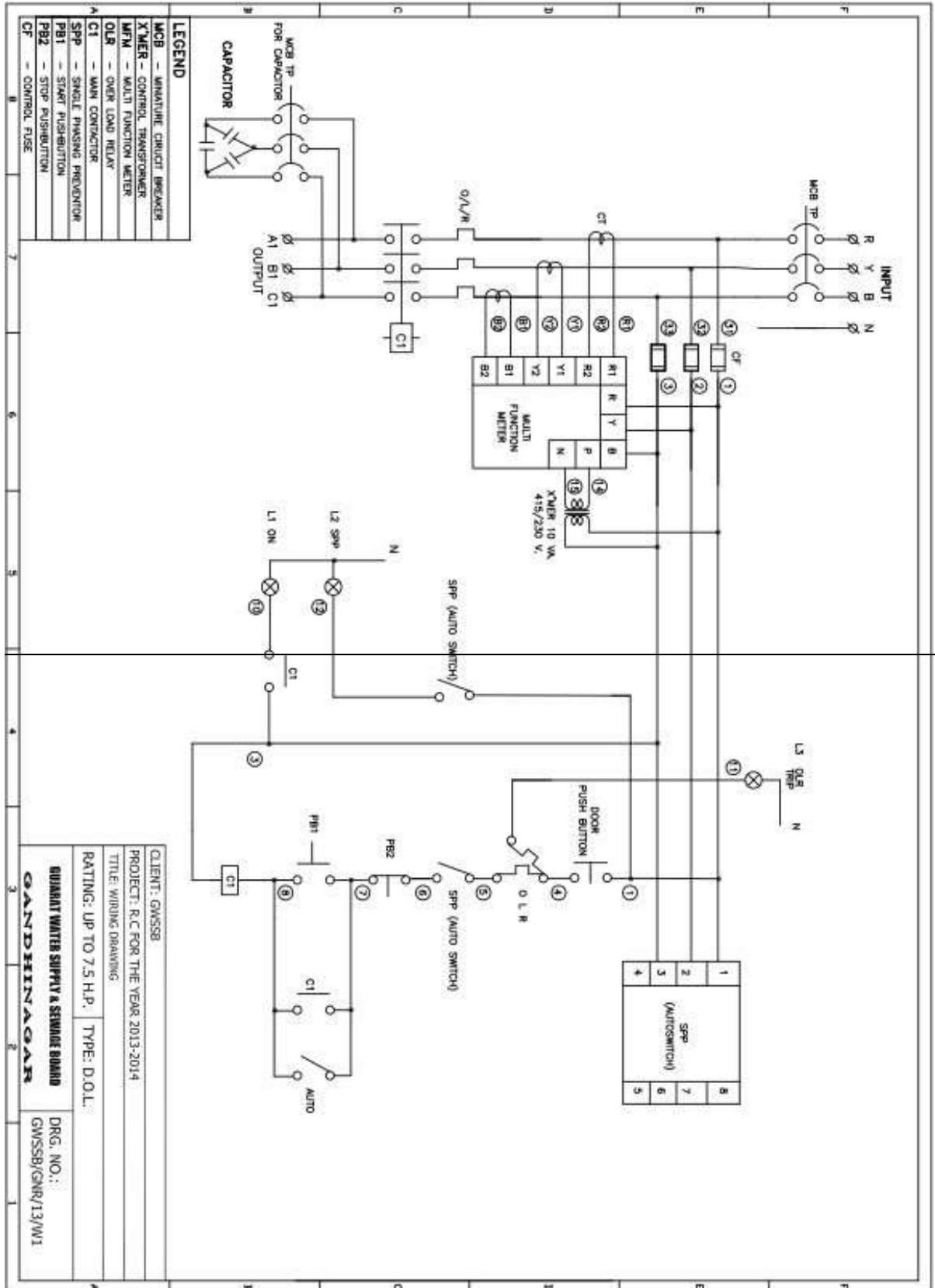
DATA SHEET FOR D.O.L. / STAR DELTA & ATS CONTROL PANEL

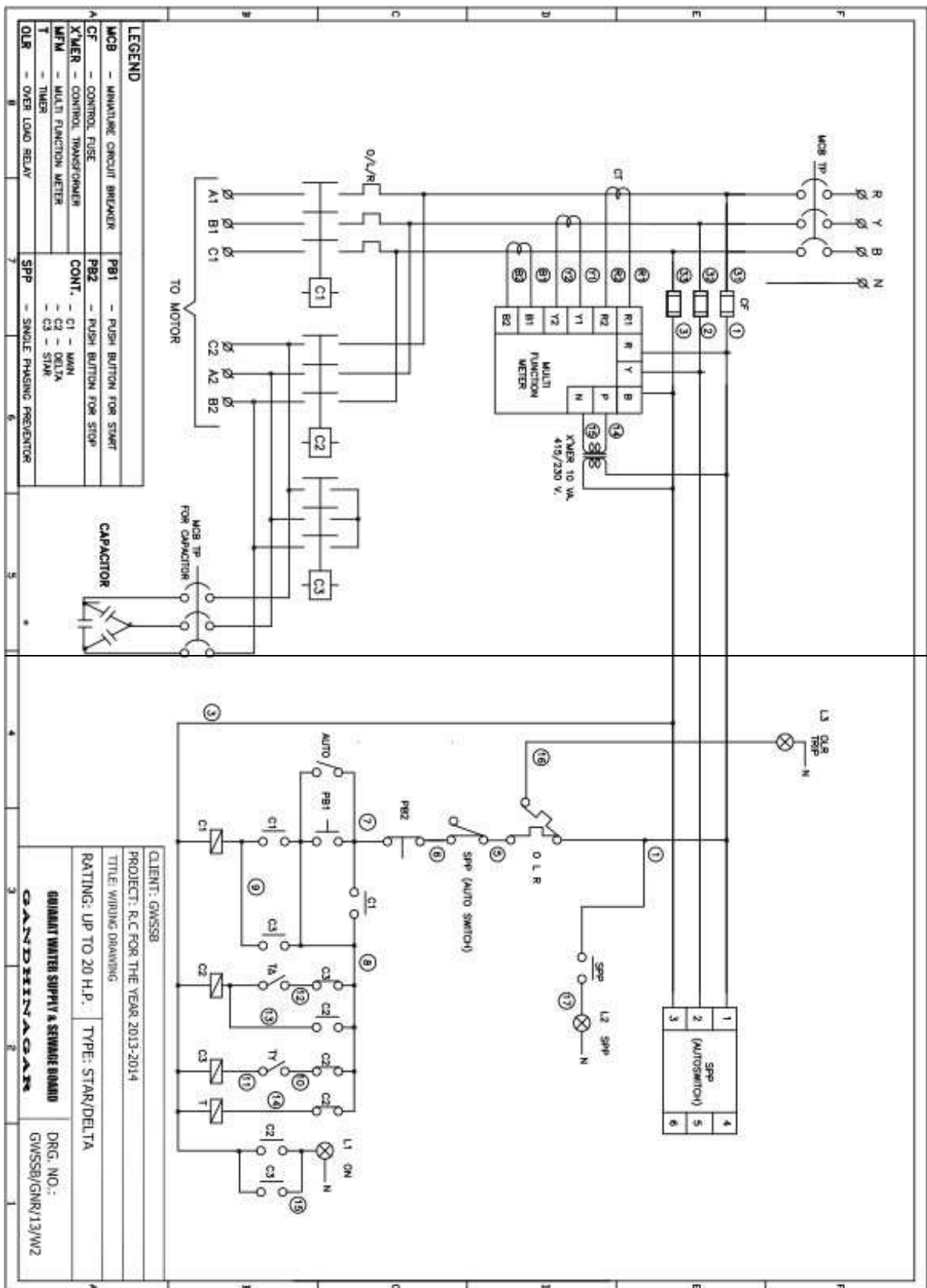
Sr No	Description	D.O.L. Qty.	S.D. Qty.	A.T.S. Qty.
1	MCB (For Motor)	1	1	
	MCCB			1
2	Contactor	1	3	3
3	Overload Relay	1	1	1
4	Push Buttons			
	Motor Start	1	1	1
	Motor Stop	1	1	1
	Timer Bypass			1
	Overload Relay Reset			1
5	Indicating Lamps			
	Motor on	1	1	1
	Motor Run			1
	Motor Off			1
	Overload Trip	1	1	1
	SPP	1	1	1
6	Digital Multi Function Meter	1	1	1
7	CT for Multi Function Meter	3	3	3
8	Single phasing Preventer (Auto Switch)	1	1	1
9	Capacitor	1	1	1
10	MCB / MCCB for Capacitor	1	1	1
11	Timer		1	1
12	Control Fuse	3	3	3
13	Auto Transformer			1

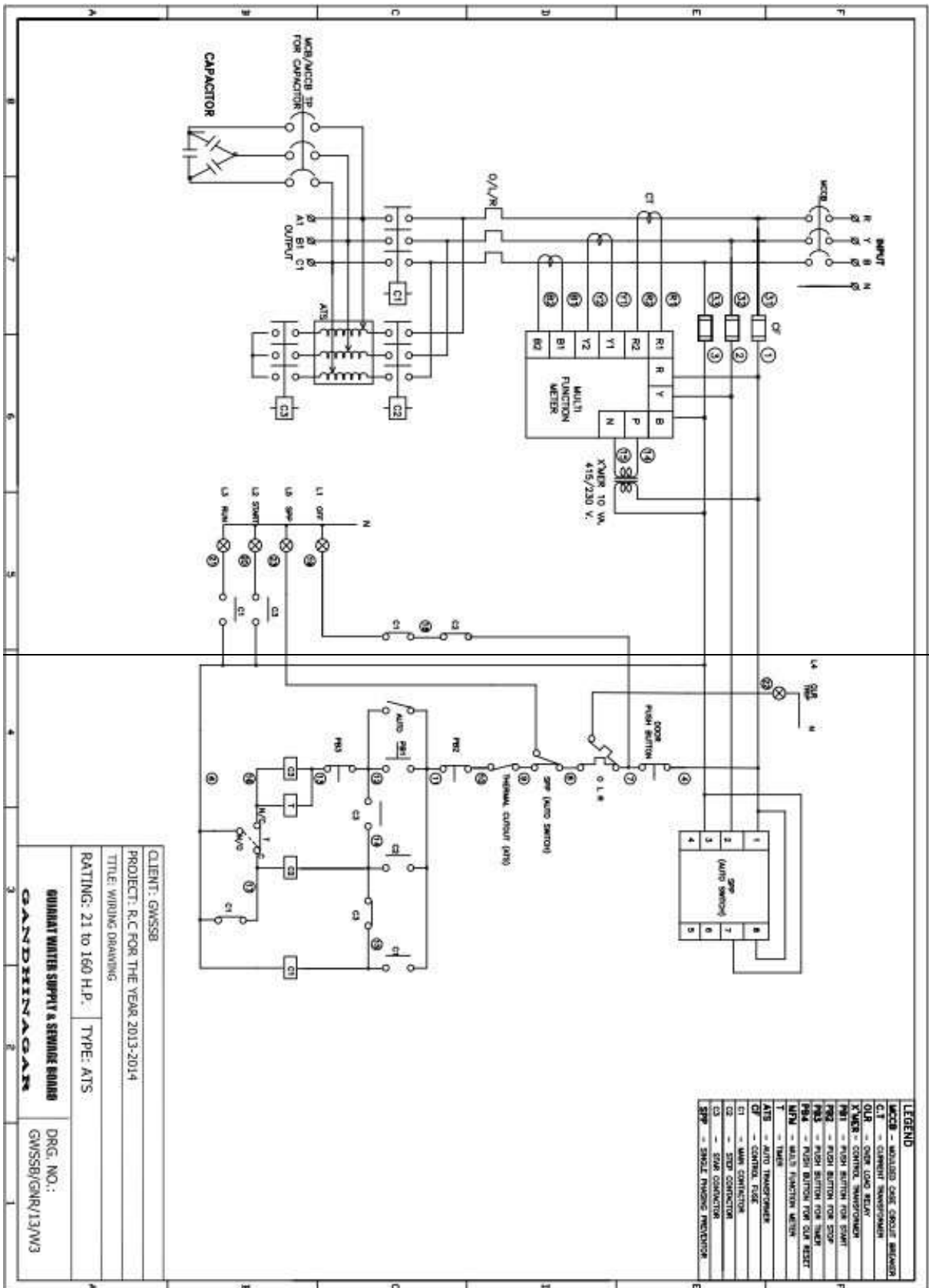
NOTE: The use of contactors and overload relays in the Control Panel shall be of one make as far as possible.











APFC PANEL WITH CAPACITOR BANKS (If applicable)

Scope

~~This specification covers design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/manufacturer's works to erection site including transit insurance, unloading, storage at site, assembly, erection, testing, installation, commissioning and performance demonstration of the following equipment with associated accessories. It is two provided on two sections i. e. two numbers of equal & half capacity as described in data sheet in combined enclosure with PMCC panel i.e. PMCC cum APFC panels at various Pumping Stations.~~

Capacitor Banks

- a) ~~The type of capacitors shall be All Polypropylene type double layer conforming to IS: 13585 (1994) & having following specifications:~~

Supply	3 Phase, 3 wire
Rated voltage	415 V
Rated frequency	50 Hz
Permissible over voltage	1.1 Vn
Permissible over current	1.5 In
Temperature category	50°C

- b) ~~The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability.~~
- c) ~~The capacitors shall have Low Dielectric Loss of ≤ 0.5 W/KVAR.~~
- d) ~~Each capacitor bank shall be provided with the 7% detuned filter.~~
- e) ~~* kVAR is net reactive compensation required to maintain 0.99 PF at 415 V Bus i.e. excluding compensation required for detuned filters.~~
- f) ~~Bushing should have high mechanical strength & method of fixing should be proper so that no leakage occurs.~~
- g) ~~Auto/Manual switch shall be provided in the APFC panel. For manual switching, every capacitor bank feeder shall be provided with ON & OFF push buttons along with the ON & OFF indications.~~

- ~~h) Minimum current rating under site conditions, of circuit breakers, contactors and cables shall be at least 150% of rated capacitor current, to take care of harmonics.~~
- ~~i) Contactor for switching of capacitor banks shall have AC 6b utilization category according to IEC 60947-4-1 & sized accordingly.~~
- ~~j) All the components shall be suitable for capacitor duty application.~~
- ~~k) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not. Capacitor shall be designed to improve the power factor to 0.99 lagging.~~
- ~~l) It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, Al/Cu bus bars, Al/Cu connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.~~
- ~~m) The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units. The assembly of the banks shall be such that it provides sufficient ventilation for each unit.~~
- ~~n) Each capacitor case and the cubicle shall be earthed to a separate earth bus.~~
- ~~o) Capacitor shall conform to IS: 2834.~~
- ~~p) The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10 % above the rated voltage, excluding transients.~~
- ~~q) Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection, in accordance with the provisions of the latest edition of IS:2834.~~
- ~~r) Individual capacitor protection shall be provided with required rating of MCB of required curve characteristic. Fuses are not acceptable.~~

Control Cubicles

- ~~a) Capacitor and capacitor control shall be housed in a metal enclosed cubicle. Capacitor shall be housed in the lower compartment and capacitor control unit at the top compartment, the two compartments being segregated. Control cabinets shall be free~~

standing floor mounted type and shall meet the requirements of Metering, Protection & related provisions for APFC panel as tabulated below.

Panel Section	Breaker Type	Protection	Metering	Indications	Other
Incomer	MCCB (TPN, Fixed Type)	TM based O/L, S/C release, APFC Relay, E/F Relay with CBCT & Shunt Trip	Analogue + Digital A, V	R, Y, B, On, Off, Trip	ETPB, A/M SS, Annunciator
Outgoing	MCCB (TP, Fixed Type)	TM based O/L, S/C release	A, AS	On, Off, Trip	Start, Stop Push Buttons

- b) ~~APFC panel shall have AI bus bars sized for appropriate SC rating for 1 sec & to carry continuous rated current.~~
- c) ~~All CTs/VTs shall be cast resin type.~~
- d) ~~All the MCCB's shall be current limiting type. Necessary auxiliary contact block required is included in Contractor scope.~~
- e) ~~One contact of power factor correction relay shall be provided for annunciation "POWER FACTOR LOW". The relay shall switch on/off capacitor banks for loads from 5% to 100%. The annunciation window shall be with test, accept and reset push button & hooter.~~
- f) ~~Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.99 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.~~
- g) ~~The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/removal of capacitor or other components and maintenance considerations.~~

~~Contractor shall submit General Arrangement drawings of capacitor and capacitor control panel, with description of power factor control panel with its components.~~

- ~~h) For control circuit 415/240/110V AC control transformer shall be considered. VA burden to be decided by the Contractor. Minimum clearance between live parts shall be phase to phase 25.4 mm & phase to neutral 20mm.~~
- ~~i) Bus bars shall be sleeved with coloured heat shrinkable sleeves. All the Bus bar supports shall be SMC type only.~~
- ~~j) Degree of protection shall be IP 52 for the enclosure, epoxy painted, powder coated with colour shade RAL 7032 for exterior & interior with minimum thickness 80 micron.~~
- ~~k) All necessary auxiliary contactors are included in scope.~~
- ~~l) Contractor shall note that verification of double layer construction shall be done on any one of the capacitor banks during inspection by opening the capacitor bank at no extra cost.~~
- ~~m) The cubicle shall be fabricated out of 2.0 mm thick cold rolled sheet steel & shall comprise of:
 - ~~i. Isolating MCCB~~
 - ~~ii. Contactors with overload element~~
 - ~~iii. Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit.~~
 - ~~iv. Auto Manual selector switch~~
 - ~~v. Microprocessor based Automatic Power Factor Correction (APFC) Relay of minimum 12 stages with RS 485 Port & Scada Comapatility.~~
 - ~~vi. Push button for opening and closing the power circuit~~
 - ~~vii. Red and Green lamps for capacitors ON/OFF indication~~
 - ~~viii. Protective relays to protect the healthy capacitor units when one unit fails in a series connection~~
 - ~~ix. Space heater and cubicle lighting & receptacles.~~~~

~~Principle of Operation~~

- ~~On deviations from set power factor, the power factor controller shall release command~~
- ~~Signal to switch on/switch off capacitor bank stages and maintain the set powerfactor.~~

~~———— APFC Relay~~

~~———— APFC relay shall have following standard features.~~

- ~~a) The Automatic Power Factor Correction relay shall be of Microprocessor based type and shall automatically switch ON/OFF the capacitor banks to attain the value of “PF” close to the set value.~~
- ~~b) Switching shall follow first in first out (FIFO) method to ensure uniform use of all capacitor banks. At least eight steps or as decided by EIC shall be provided for switching.~~
- ~~c) To measure/monitor power factor and VAR continuously. Status of switching step shall be displayed through LED.~~
- ~~d) Following adjustment shall be available in APFC Relay.~~
 - ~~i. Power factor~~
 - ~~ii. Dead band capacitive region with respect to set power factor (PF).~~
 - ~~iii. Inductive region with respect to set PF~~
 - ~~iv. Operating time for programmable switching steps.~~
 - ~~v. Auto/Manual selector switch.~~
 - ~~vi. Manual step control.~~
- ~~e) All control knobs, LEDs for display and selector switches shall be mounted on the front face of panel.~~
- ~~f) It should be fully programmable. There should be a choice for customer to select operating sequence up to 4 to 5 which will have maximum number of steps of capacitors equal to fourteen (14). The sequence shall be arithmetic 1, 2, 3.....13, 14.~~
- ~~g) Operating time selection of time interval designation between switching stages shall be possible using time selector switches. The device shall take care that any stage which has just been switched out will only be reconnected by the pulse counter, after 60 seconds has elapsed so that it has safely discharged. This is a requirement for 415 V capacitors.~~
- ~~h) Loss of voltage element: This would prevent abnormal switching surges on loss of supply as well as it would control the switching ON/OFF surges.~~
- ~~i) Dead band features: Relay response sensitivity adjustable using dead band so that hunting is prevented.~~

j) ~~Auto/Manual control: This would help testing and commissioning at site as well as ease in operation when either mode fails during service time.~~

k) ~~**Performance Tests**~~

a) ~~Contractor shall carry out all routine tests as specified in relevant IS/IEC standards on all major components and furnish copies of test reports for GWSSB's approval. Wherever required, Contractor shall conduct the necessary type tests in the presence of GWSSB's representative.~~

b) ~~Contractor shall also carry out all routine and functional tests as specified in the relevant IS on the assembled switchgear panels in the presence of the GWSSB's representative at works before dispatch and furnish copies of test reports for approval. If required stage inspection will be carried out by the GWSSB.~~

c) ~~During inspection, Contractor shall furnish copies of routine test report for all bought out items for GWSSB's approval.~~

d) ~~Primary Injection Test for various currents & time settings shall be provided in routine test.~~

e) ~~All the components shall be tested for their entire operating range & certification for the same shall be provided at the time of inspection.~~

Maintenance Requirements

a) ~~As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Contractor shall supply one complete set of such tools along with the equipment.~~

b) ~~Contractor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to carry out maintenance work.~~

Drawings/Documents Required

a) ~~Dimensioned general arrangement drawings of capacitor and capacitor control panel.~~

b) ~~Justification for number of steps for switching.~~

c) ~~Fully dimensional general arrangement drawings of capacitor and capacitor control panel with elevation side view, sectional view and foundation details.~~

d) ~~Complete schematic and wiring diagrams for capacitor control panel.~~

~~DETAILS & REQUIREMENTS FOR L V (415 V) APFC PANEL WITH CAPACITOR BANKS (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section. Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

CABLES and CABLING SYSTEM

Scope

~~It shall be inclusive of supply, installation, testing & commissioning of power, control and instrumentation cables, cable terminations, cable accessories, stripping of cable insulation, supplying and fixing of Aluminium lugs for aluminium cables & tinned plated copper lugs for copper cables and crimping the same to the conductor, supply and fixing of double compression cable glands including all labour supply and consumable material required for jointing/ termination. The rate shall also include the laying of cable in ground/ in cable trays /cleating to structure etc.~~

Applicable Standards

~~The cables shall conform to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.~~

PVC insulated cables (for voltage up to 1100 V)	IS: 694
HRPVC & PVC insulated cables heavy duty	IS: 1554
Cross linked polyethylene insulated PVC sheathed cables	IS: 7098
Low frequency cables and wires with PVC insulation and sheath	IEC: 189-1 & IEC 189-2
PVC insulation and sheath of electric cables	IS: 5831
Polyethylene insulation and sheath for electric cables	IS: 6474
Conductors for insulated electric cables	IS: 8130
Methods of test for cables	IS: 10810
Specification for drums of electric cables	IS: 10418
Specification for PVC insulated cables for electricity supply	BS: 6346
Specification for PVC insulation and sheath of electric cables	BS: 6746

Constructional Features

- a) ~~HV power cables shall conform to 11 KV Earthed grade (E), 3 core, stranded, Aluminium conductor, screened by extruded semi-conducting compound, cross-linked poly ethylene (XLPE) insulated, cores screened with non-magnetic metallic tape laid up with inner and outer extruded PVC sheath compound Type ST2 and galvanized~~

~~steel strip armouring. The cables shall generally conform to IS 7098-1985 with relevant parts thereof.~~

- ~~b) Armouring shall conform to latest version of IS: 3975.~~
- ~~c) LV Power cables shall be 1.1 KV grade, 4/3.5/3 Core, multi-stranded, Al/Cu conductor, XLPE insulated, extruded inner & outer PVC sheath compound type ST2 and galvanized wire (up to 6 sq. mm)/steel strip (>6 sq. mm) armoured cables. All single phase, Lighting cables, UPS cables shall have 100% Neutral.~~
- ~~d) All the control cables shall be 1.1 KV grade, no. of cores (as per requirement/application with minimum 2 spare cores for 7C & above), multi-stranded, Copper conductor, XLPE insulated, extruded inner PVC & outer PVC FRLS sheath compound type ST2 and galvanized steel round wire armoured.~~
- ~~e) All control cables shall be with following specific requirements.~~
 - ~~i. Copper conductor stranded class 2~~
 - ~~ii. XLPE Insulated~~
 - ~~iii. Provided with inner extruded PVC and outer PVC FRLS sheath of extruded black PVC compound.~~
 - ~~iv. Galvanized steel armouring in the form of GI round wire.~~
 - ~~v. Core identification shall be by printed numerals.~~
 - ~~vi. The insulation over the individual conductor core will be colour coded.~~
 - ~~vii. Minimum 2 spare cores for above 7C.~~
- ~~f) The DC power supply cable shall be two core, multi-stranded copper conductor, armoured cables with inner extruded PVC & outer PVC FRLS sheath. All control wiring shall be PVC FRLS insulated.~~
- ~~g) All the power, control & instrumentation cables used in the hazardous area shall be flame proof type suitable for the intended application.~~
- ~~h) Earthing cable shall be Single core multi-stranded Cu, 1.1 KV grade, XLPE insulated, un-armoured green coloured outer sheath with yellow strips/band cable to be laid in trays, underground, trenches etc. as applicable.~~
- ~~i) Submersible Cables (If Required)~~

~~Multi core flexible Cu conductor XLPE insulated & PVC sheathed heavy duty cable suitable for submersible application (in case of submerged pumps) shall be manufactured as per governing standards. High purity electrolytic grade, annealed Cu~~

~~conductor shall be used. Cables shall be extruded inner & outer PVC sheathed. PVC compound shall be dielectric grade & shall be impervious to water, oils & grease etc. Similarly, double PVC sheathing shall also be done as per IS: 5831/1984. Flexible inner sheath & high abrasion resistant flexible outer sheath is required for these cables. Double PVC sheathing shall be done so as to withstand abrasion & prevent ingress of water along the interstices of the cable. Core identification shall be by printed numerals. Conductors shall be as per IS 8130. Cable shall be constructed as per relevant IS/IEC standards.~~

Cable Colours

- ~~a) All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.~~
- ~~b) The colour coding should be as follows~~
 - ~~i. 3 phase Red, Yellow and Blue~~
 - ~~ii. single phase or DC supply Red and Black~~
 - ~~iii. earth Green/Green with Yellow coloured band~~
 - ~~iv. control Grey (DC)~~

Cable Conductors

- ~~a) Cables up to 4.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi stranded conductor with galvanized steel round wire/flat strip armoured.~~
- ~~b) Single core cable shall have non-magnetic material armouring.~~
- ~~c) Lighting final distribution circuits shall be of a minimum cross section of 1.5 mm².~~
- ~~d) Small control cables shall be of a minimum cross section of 1.5 mm².~~
- ~~e) Internal wiring of control panels shall be of a minimum cross section of 1.5 mm² flexible and multi stranded.~~
- ~~f) Instrumentation and control cabling shall be of a minimum cross section 1.5 mm² for external use and 1.0 mm² for internal use.~~
- ~~g) Cable sizing shall be done as per design criteria specified in specifications.~~

Cable Numbering

~~All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Necessary loop at both ends shall be provided for future~~

~~use and cables of different categories shall be tagged with the following subscripts and three digit number.~~

~~HV power _____ HV P _ _ _~~

~~LV power _____ P _ _ _~~

~~Control _____ C _ _ _~~

~~Instrumentation _____ I _ _ _~~

~~Protection _____ PR _ _ _~~

~~Telecommunication _____ T _ _ _~~

~~Cable Terminations~~

~~a) Cable Lugs~~

- ~~i. Cable lugs shall be of tinned copper, solder less crimping type for Cu cables & Al lugs for the Al cables.~~
- ~~ii. The current rating of the lugs shall be same as that of the respective cable conductors.~~
- ~~iii. Bi metal strip/Bi metallic lug shall be used whenever two different metals are to be connected together.~~
- ~~iv. Double holes extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.~~
- ~~v. Anticorrosion/anti-oxidation compounds shall be used for crimping lugs. This shall especially be ensured for Al cable terminations & bimetallic terminations shall be used wherever required.~~
- ~~vi. If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.~~

~~b) Cable Glands~~

- ~~i. Glands shall generally be of the double compression hexagonal type brass glands. Earth continuity of brass glands shall be assured.~~
- ~~ii. Double compression type cable glands shall be used. Cable glands shall be brass casting, machine finished and Nickel plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.~~

- ~~iii. For single core cables, gland shall be with brass ring.~~
- ~~iv. Glands for single core cables shall be constructed from non magnetic materials.~~
- ~~v. Cable glands shall be with metric threads.~~
- ~~vi. Where holes for cable entries are not provided it shall be the responsibility of the Contractor to mark out and drill such holes. Burrs and swarf shall be removed, care being taken to ensure that swarf and filings etc. do not enter the equipment.~~
- ~~vii. For non-hazardous areas cable glands in situations where moisture may be present shall be double seal weatherproof type, gland shrouds shall be used and entry shall be sealed.~~
- ~~viii. For dry indoor situations, standard industrial glands with shrouds are acceptable.~~
- ~~ix. For hazardous areas, glands conforming to IEEE standard shall be used with double seal and shroud.~~

~~c) Trefoil Clamps for Single Core Cables~~

- ~~i. All the single core cables shall be laid in trefoil formation only.~~
- ~~ii. The grouping & sequencing of three single core cables arranged in trefoil formation shall be done in such a way to ensure balanced current distribution.~~
- ~~iii. Trefoil clamp of suitable size & having non-magnetic material shall be used.~~
- ~~iv. The Trefoil groups shall be held in trefoil clamps at an interval not exceeding 3.0 meters.~~
- ~~v. In addition to trefoil clamps as mentioned above, the trefoil groups of cables shall be additionally tied by means of 3.0 mm dia. nylon cord clamp at an interval not exceeding 750 mm.~~

- ~~d) Wherever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to Cu strip shall be provided.~~

Instrumentation Cables

- ~~a) This specification covers the requirements for instrument signal cables, thermocouple extension cables, RTD cables and power/control cables.~~
 - ~~i. Single pair shielded signal/alarm cables shall be used between field instruments/ switches and junction boxes/local control panels.~~
 - ~~ii. Single pair shielded thermocouple extension cables shall be used between~~

~~thermocouple head and junction boxes/transmitters/local control panel mounted instruments.~~

- ~~iii. Single triad shielded signal cables shall be used between RTD head and junction boxes/ transmitters/local control panel mounted instruments.~~
- ~~iv. For field bus compatible instrument single pair shielded cable shall be used between instrument to junction box/local panel and to control room.~~
- ~~v. Foundation Field bus shall be Type A cable. Construction of same shall be as per IEC 61158-2. Trunk cable shall be used of 1 Pair, 5 Pair, and 12 Pair.~~
- ~~vi. Separate Multi-pair/multi-triad cables shall be used between junction boxes/local control panel and control room as per following applications.~~
 - ~~• 4-20 mA signals (for conventional HART Transmitters)~~
 - ~~• Foundation Field signals~~
 - ~~• Thermocouple signals~~
 - ~~• Resistance Temperature Detectors (RTD) signals~~
 - ~~• Switch contacts/Proximity switch contacts~~
 - ~~• Gas detectors~~
- ~~vii. Instrument power cables shall be used between power supply distribution boards and power consumers such as control panels, DCS/PLC cabinets, any instruments requiring power supply, etc.~~
- ~~viii. Instrument control cables shall be used for valves, feedback of feeders etc.~~
- ~~ix. The cable design shall generally follow BS 5308 Part 1 for various cables listed in clause e as above.~~
- ~~x. Thermocouple cables design shall comply with ANSI MC 96.1.~~
- ~~xi. The power and control cables shall be generally as per BS 6346. For these cables, equivalent IEC/IS specifications are also acceptable.~~
- ~~xii. The insulation grade shall be 1100 V AC for all cables.~~
- ~~xiii. The primary insulation shall be cross-linked Polyethylene with temperature rating 70^oC conforming to BS 5308/ IS: 7098.~~
- ~~xiv. Inner and outer sheath/jacket shall be made of extruded fire retardant, low smoke, low halogen, low toxic, polymeric compound having physical properties as per IS:5831 Type ST2.~~

- ~~xv. All cables shall be armoured and suitable for operation when installed as follows~~
- ~~• Directly buried in the ground~~
 - ~~• Fastened to cable ladder rack or tray in the open air~~
 - ~~• In underground ducts~~
 - ~~• In overhead closed cable ducts~~
- ~~xvi. Running length of the cable shall be printed at least at every 5metre interval.~~
- ~~xvii. For Multi pair/multi triad cables, pair identification shall be provided with numbers at interval of not more than 250 mm as per Contractor's standard.~~
- ~~xviii. Contractor shall ensure a minimum of 20% of quantity of each type of cables supplied as spare including any special cable and in each Multi pair cable 20% pairs shall be kept as spare.~~
- ~~xix. A pair of communication wire shall be provided for Multi pair/ multi triad cables.~~
- ~~xx. Each wire shall be 0.5 mm² of plain annealed single or multi-strand copper conductor with 0.4 mm thick 70°C XLPE insulation.~~
- ~~xxi. All cables shall be fire retardant and low smoke.~~

b) Design and Testing Standards

i. Instrument signal, RTD and thermocouple cables

Sr. No.	Description	Particulars
1	Conductors	BS 6360/IS: 8130 for instrument signal and RTD cables and ANSI MC 96.1/IEC 60584-3 for thermocouple cables.
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS: 5308/IS: 7098.
3	Armour	Round wire armour galvanized steel as per IS: 1554 Part 1
4	Inner & Outer Sheath PVC	Extruded Fire Retardant, Low Smoke, Low Halogen, Low Toxic, PVC having physical properties as per IS: 5831 Type ST2. Flammability and chemical properties shall be as follows <ul style="list-style-type: none"> • Oxygen Index: 30 (minimum) at room temp as

Sr. No.	Description	Particulars
		<p>perASTM-D-2863-77</p> <ul style="list-style-type: none"> •Temperature Index: 250⁰-C (minimum) at Oxygen Index of 21 as per ASTM-D-2863. •Light Transmission: 70% (minimum) as per IEC1034. •Flammability test: As per IEC-332 Part 1 & Part 3 Cat. A •Corrosivity of combustion gases: pH index> 4.3, Electrolytic conductivity < 100 micro S/cm as per IEC-754-2 •Toxicity index: Maximum 05 Gases to be extracted – HCL, HBr, HF, CO, CO2, NO, SO2, HCN as per NES-713. HCL shall be first gas to be extracted <p>Inner Sheath and outer sheath thickness: Minimuminner sheath thickness and outer sheath thickness shall be as per IS: 1554(P-1)1988 (should not be less than 0.5 mm).</p> <p>Outer Sheath Colour: Blue</p> <p>Inner Sheath Colour: Black</p>
5	Testing of the instrument Signal and RTD cables	BS: 5308
6	Testing/Calibration of Thermocouple cables.	ANSI MC96.1/IEC-60584-2
7	Dimensions	BS: 5308

ii. ~~Instrument power and control cables~~

Sr. No.	Description	Particulars
1	Conductors	IS: 8130/BS-6360
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS: 5308 / IS:

Sr. No.	Description	Particulars
		7098.
3	Armour	Round wire armour galvanized steel as per IS: 1554 Part 1
4	Inner & Outer Sheath PVC	<p>Extruded Fire Retardant, Low Smoke, Low Halogen, Low Toxic, PVC having physical properties as per IS 5831 Type ST2. Flammability and chemical properties shall be as follows:</p> <ul style="list-style-type: none"> • Oxygen Index: 30 (minimum) at room Temp as per ASTM D 2863-77 • Temperature Index: 250° C (minimum) at Oxygen Index of 21 as per ASTM D 2863. • Light Transmission: 70% (minimum) as per IEC 1034. • Flammability test: As per IEC 332 Part 1 & Part 3 Cat. A • Corrosivity of combustion gases: pH index > 4.3, Electrolytic conductivity < 100 micro S/cm as per IEC 754-2 • Toxicity index: Maximum 05 Gases to be extracted – HCL, HBr, HF, CO, CO2, NO, SO2, HCN as per NES-713. HCL shall be first gas to be extracted. <p>Inner Sheath and outer sheath thickness: Minimum Inner sheath thickness and outer sheath thickness shall be as per IS: 1554(P-1)1988, should not be less than 0.5 mm.</p> <p>Power Cables: Black</p> <p>Control Cables: Blue with black bands (4 bands at 90° apart)</p>
5	Testing of the power and control cables.	IS: 1554 Part I, BS 6469 / BS 6346

Cable Construction

e) ~~The various mechanical/electrical parameters indicated here are indicative and the Contractor shall be responsible to select/design the cables as per applicable standards.~~

i. ~~**Instrument Signal Cables (4 – 20 mA or Switch Contacts)**~~

Sr. No.	Description	Particulars
1	Conductor (Single / Multi Pair)	7 stranded/0.53 mm dia. (1.5 mm²) stranded annealed tinned copper conductors of electrolytic grade copper.
2	Insulation	Cross linked Polyethylene (XLPE) as per BS 5308/IS: 7098.
3	Inner & outer sheath	PVC, fire retardant, low smoke, low halogen, low toxic, polymeric compound.
4	Pairs	Two insulated conductors shall be uniformly twisted together to form a pair at least 10 twists per metre.
5	Maximum Resistance	DC Shall not exceed 12.3 ohms/ km at 20°C for cables with 1.5 mm conductor.
6	Mutual capacitance	BS 5308 Part 1
7	L/R ratio of adjacent cores/pairs	BS 5308 Part 1
8	Shield	Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair and 0.075 mm in case of multi pair cable.
9	Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm²) multi-stranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield.

Sr. No.	Description	Particulars
		The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76dB.
10	Colour coding	Individual pair core insulation: Blue & Black Inner jacket: Black Outer jacket: Blue for intrinsically safe application and blue with black bands (4 bands at 90° apart) for non-IS applications.

i. ~~RTD Cables~~

Sr. No.	Description	Particulars
1	Conductor (Single/ Multi Triad)	7 stranded/0.53 mm dia. (1.5 mm²) annealed tinned copper conductors of electrolytic grade copper.
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS 5308/IS: 7098
3	Inner & outer sheath	PVC, fire retardant, low smoke, low halogen, low toxic, polymeric compound.
4	Triads	Three insulated conductors shall be uniformly twisted together to form a Triad at least 10 twists per metre.
5	Maximum DC resistance	Shall not exceed 12.3 ohms/km at 20°C for cables with 1.5 mm² conductor
6	Mutual capacitance	BS 5308 Part 1
7	L/R ratio of adjacent triads	BS 5308 Part 1
8	Shield	Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single triad and 0.075 mm in case of multi-triad cable.

Sr. No.	Description	Particulars
9	Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm² multi-stranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield. The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76dB.
10	Colour coding	Core insulation: Red, Yellow and Blue Inner jacket: Black Outer jacket: Blue for intrinsically safe application and blue with black bands (4 bands at 90° apart).

ii. ~~Thermocouple Cables~~

Sr. No.	Description	Particulars
1	Conductor Single pair cable	16 AWG or 1.5 mm² solid conductors Conductor Materials: K type T/C – Nickel/ Chromium, Nickel/ Aluminium (KX), Class 1.0
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS 5308/IS: 7098, Colour code: Nickel/ Chromium: Green Nickel/ Aluminium: White
3	Pairs	Two insulated conductors shall be uniformly twisted together to form a pair at least 10 twists per metre. The lay length of adjacent pairs/ triads in case of Multi-pair cables shall not be equal, to reduce cross-talk.
4	Mutual capacitance	BS: 5308 Part 1
5	L/R ratio of adjacent triads	BS: 5308 Part 1
6	Core inductance	Shall not exceed 4 mH/km. However, for J-type thermocouple inductance could be 8 mH/km.

Sr. No.	Description	Particulars
7	Shield	Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair and 0.075 mm in case of multi pair cable.
8	Drain wire	Drain wire shall be provided for individual pair and overall shield with 0.5 mm ² multi-stranded bare tinned annealed copper conductor continuously in contact with aluminium side of shield. The drain wire resistance including shield shall not exceed 30 ohm/km. Electrostatic noise rejection ratio shall be over 76dB.
9	Colour coding	Outer sheath colour – Green Inner sheath colour – Black

All thermocouple extension cable shall be matched and calibrated in accordance with IEC 60584-2/ ANSI MC 96.1.

ii. Instrument Control Cables

Sr. No.	Description	Particulars
1	Conductor 2 Core/Multi-core type	7 stranded/0.53 mm dia. (1.5 mm ²) annealed tinned copper conductors of electrolytic grade copper.
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS 5308/IS 7098
3	Inner & Outer Sheath	PVC, fire retardant, low smoke, low halogen, low toxic, polymeric compound.
4	Maximum DC Resistance	Shall not exceed 12.3 ohms/km at 20°C for cables with 1.5 mm ² conductor

Sr. No.	Description	Particulars
5	Core Identification	IS: 1554/ BS 6746

iii. ~~Instrument Power Cables~~

Sr. No.	Description	Particulars
1	Conductor	7 stranded/0.67 mm dia. (2.5 mm²) annealed tinned copper conductors of electrolytic grade copper. The size of the conductor specified here is minimum however, the exact size of the conductor shall be selected based on the length of cable and power consumption. For higher conductor sizes, Aluminium can be considered.
2	Insulation	Cross-linked Polyethylene (XLPE) as per BS 5308/IS 7098
3	Core Identification	IS-1554/BS 6746
4	Colour coding	Outer sheath colour — Black Neutral wire insulation colour — Black Phase wire insulation colour — Red Ground wire insulation colour — Green

iv. ~~Ethernet Cables~~

- ~~EIA/ TIA 568 A Category 5, 4 pair 0.5 mm² (24 AWG) solid conductors, with plastic foil wrapping.~~
- ~~Overall screen to consist of aluminium bonded polyester tape and tinned copper wire.~~
- ~~Overall sheath shall be light grey PVC.~~

v. ~~Fibre Optic Cables~~

- ~~62.5/125 micron multimode, graded index, glass silica fibre core, mechanical protection provided by round galvanized steel armour with polyester laminated tape layered over inner sheath.~~
- ~~Outer sheath shall be orange.~~
- ~~HDPE conduit shall be orange colour.~~

- ~~vi. Any other special cables such as co-axial cable or cables with glass insulation, required for instruments shall also be supplied as per requirements.~~
- ~~vii. Contractor shall ensure that these cables are armoured type and shall meet all other requirements specified above, as applicable.~~

Cable Drums

- ~~a) Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.~~
- ~~b) Before winding the cables on drums, Contractor shall obtain GWSSB's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.~~
- ~~c) Contractor has to ensure reference of an arrow and suitable accompanying wording which shall be stencilled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit. Cable ends shall be sealed by non-hygroscopic sealing caps.~~
- ~~d) It shall be the Contractor's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.~~
- ~~e) Contractor shall obtain GWSSB's approval for the drum lengths.~~
- ~~f) The following information shall be given on the drums as a minimum:
 - ~~i. Drum identification number~~
 - ~~ii. Voltage grade~~
 - ~~iii. Type of cable.~~
 - ~~iv. Number of cores and cross-sectional area~~
 - ~~v. Cable quantity~~
 - ~~vi. Purchaser's order number and item number~~
 - ~~vii. Total weight of cable and drum~~~~

Tests Before and After Laying of Cables at Site

~~Following Routine & acceptance tests on each drum as per IS: 10810, IS: 7098 standard &~~

~~other specified relevant standards shall be performed by the manufacturer and witnessed by GWSSB's representative.~~

- a) ~~For 1.1 KV Power & Control cables~~
 - i. ~~Dimensional & visual check~~
 - ii. ~~Conductor resistance test~~
 - iii. ~~Insulation Resistance Test~~
 - iv. ~~High voltage test~~
- b) ~~For 11 KV power cables~~
 - i. ~~Design and visual check~~
 - ii. ~~Conductor resistance test~~
 - iii. ~~Very low frequency AC HV test (instead of DC test)~~
 - iv. ~~Insulation resistance including P.I. at rated voltage~~
 - v. ~~Capacitance and tan delta~~
 - vi. ~~AC leakage current~~
 - vii. ~~Partial discharge measurement~~
- c) ~~All HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 6.0 in IS: 1255 (Code of practice for Installation & Maintenance of Power Cables up to and including 33 KV).~~
- d) ~~Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the Megger for cables of different voltage grades shall be as indicated below.~~

Voltage Grade	Megger rating
1.1 KV	500V
11 KV	1000V
33 KV	2500V

- e) ~~Following tests in the presence of GWSSB's representative shall be carried out at site before commissioning of cables.~~
 - i. ~~Insulation Resistance test between phases and phase to Neutral and phase to earth.~~
 - ii. ~~Continuity test of all the phases, neutral and earth continuity conductor.~~

- iii. ~~Sheathing continuity test.~~
- iv. ~~Earth resistance test of all the phases and neutral.~~

f) ~~Instrument Cable Testing~~

~~Contractor shall submit routine and Acceptance test certificates, in original at the time of delivery of cables.~~

- i. ~~Type Test: Certificate from independent test house for the following tests shall be furnished by the Contractor for the FRLS low halogen sheathed cable.~~

- ~~Flammability Test as per IEC 60332, Part III, Cat A.~~
- ~~Electrostatic noise Rejection test.~~
- ~~Oxygen Index, Temperature rating, light transmission, pH Index, electrical conductivity and toxicity index for the cable~~

- ii. ~~Routine Test and Acceptance test: Each of the following tests to be carried out by Contractor during various stages of manufacturing. Purchaser shall review the related documentations. In addition, the following test shall be carried out for checking properties of low halogen FRLS sheathing material.~~

- ~~Light Emission test as per IEC 1034. Acceptance norms shall be minimum 70%.~~
- ~~Determination of the degree of acidity of gases evolved during combustion as per IEC 754-2 (pH value to be minimum 4.3 and conductivity to be maximum 100 micro-Siemens/cms.~~
- ~~Toxicity Index as per NES 713. Value shall not exceed 5~~
- ~~Tear Resistance as per BS 7655 Section 6.1~~
- ~~Abrasion test method as per BS 6724 Annexure E~~

- iii. ~~All above tests shall be carried in presence of GWSSB's representative. Immediately after completion of the electrical test the ends of the cable shall be sealed to prevent ingress of moisture with suitable rubber/PVC caps.~~

iv. ~~Identification Marks on Instrument Signal Cables~~

~~Outer Embossing: Following embossing should be in bold fonts at outer sheath at every five (5) meters intervals.~~

- ~~Type of Cable i.e. Signal Cable~~
- ~~No of Pairs i.e. 1, 6, 12 etc.~~

- ~~Core Size i.e. 1.5 sq. mm etc.~~
- ~~Sequential meter marking shall be embossed at every one (1) meter interval~~
- ~~Individual pairs Embossing and identification~~
~~Core no shall be printed on each core for identification at regular interval of 250 mm or so.~~
- ~~The pair numbers shall be available on individual pair by method of polyester number tape also.~~

v. ~~Identification marks on Instrument Control Cables~~

~~Following embossing should be in bold fonts at outer sheath at every 5 meters intervals.~~

- ~~Type of Cable i.e. Control Cable~~
- ~~No of Cores i.e. 2, 4, 10, 12, 24 etc.~~
- ~~Core Size i.e. 1.5 sq. mm~~
- ~~Sequential meter marking shall be embossed at every one (1) meter interval~~

vi. ~~Identification marks on Instrument Thermocouple Cables~~

~~Outer Embossing~~

~~Following embossing should be in bold fonts at outer sheath at every five (5) meters intervals.~~

- ~~Type of Cable i.e. T/C Cable~~
- ~~No of Pairs~~
- ~~Core Size i.e. 16 AWG~~
- ~~Temperature Range~~
- ~~Sequential meter marking shall be embossed at every 1 meter interval.~~
- ~~Individual pairs Embossing and identification: Each core of pair shall be numbered for identification at regular interval of 250 mm or so.~~

g) **Cable Gland**

- i. ~~Cable glands required for glanding all cables at both ends shall be supplied by Contractor.~~
- ii. ~~A minimum of 20% of cable glands shall be supplied as spare.~~
- iii. ~~Cable glands shall be of SS 316 and double compression type suitable for~~

~~armoured cables.~~

- ~~iv. All cable glands shall be weatherproof to IP 66. Flameproof glands wherever required shall be supplied with Ex (d) certification suitable for Gas Groups IIA / IIB / IIC.~~
- ~~v. All cable glands shall be with LSF shrouds.~~
- ~~vi. For all field items and junction box end, NPT threaded cable glands shall be used and for control room/control panel end, cable glands shall be ET threaded types.~~

~~h) Junction Boxes~~

- ~~i. In order to make the most economic use of cable tray and trench capacity, multicore /multi pair cabling shall be utilised in order to connect instrumentation groups by using suitably located junction boxes.~~
- ~~ii. The junction boxes shall have weather protection suitable for the area in which they are to be installed and for the type of circuit.~~
- ~~iii. They shall be readily accessible for maintenance and clearly labelled.~~
- ~~iv. Junction box shall be constructed of die cast aluminium and provide degree of protection IP 65.~~
- ~~v. Wires and terminals for the digital and analogue signals shall be segregated within junction boxes.~~

Drawings/ Documents Required

- ~~a) As a part of the Bid, Contractor shall furnish the following
 - ~~i. General information~~
 - ~~ii. Principal technical data~~~~
- ~~b) After award of contract it shall be the responsibility of Contractor to work out a detailed layout for the complete plant cabling system. The layout drawing shall be furnished for the approval of GWSSB's representative before commencement of installation including cable trays, cable racks/trenches, accessories, tray supports, conduits etc.~~
- ~~c) Contractor to submit following drawings/details after award of contract
 - ~~i. Cable Sizing calculations~~
 - ~~ii. Details of Installation of cables in trenches, on cable trays, directly buried etc at all locations inside the plant.~~
 - ~~iii. Cable routing lay out inside and outside the plant with route marker provided~~~~

~~at 30 meters intervals.~~

~~iv. Bill of quantities of cables, lugs and glands.~~

~~v. HV Cable termination and mounting kits layout drawing.~~

~~d) Following Type Tests reports as per relevant standard to be submitted for the same rating & type of Cables conducted in past for review of GWSSB's representative by the Contractor at the time of inspection & testing of equipment. Type test reports should be valid and not be older than the 5 years. —————~~

~~i. Annealing test~~

~~ii. Tensile test~~

~~iii. Wrapping test~~

~~iv. Test for thickness of insulation & sheath~~

~~v. Physical test for insulation & sheath~~

~~vi. Tensile strength and elongation at break of insulation and sheath~~

~~vii. Loss of mass test~~

~~viii. Ageing in air oven~~

~~ix. Shrinkage test~~

~~x. Heat shock test~~

~~xi. Insulation resistance test~~

~~xii. High voltage test~~

~~xiii. Flammability test~~

~~DETAILS & REQUIREMENTS FOR CABLES (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

CABLE CARRIER SYSTEM

Cable Trays & Accessories

General

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories.

Applicable Standards

Sr. No.	Description	Standards
1	Steel for general structural purposes	IS: 2062
2	Dimensions for hot rolled steel beam, column channel and angle sections	IS: 808
3	Code of practice for use of metal arc welding for general construction in mild steel	IS:816
4	Hot deep galvanizing of iron & steel	IS: 2629
5	Methods of testing uniformity of coating of zinc coated articles	IS: 2633
6	Hot dip zinc coatings on structural steel and other allied products	IS: 4759

- a) Cable trays shall be of Galvanised Steel/Fibre Reinforced Plastic and of ladder/perforated/ solid type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as detailed in the relevant drawings. All hardware (i.e. bolts, nuts, screws, washers etc.) shall be hot dip galvanized.
- b) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) MS sheets.
- c) The cable trays shall be supplied in standard lengths of 2500 mm and clear inside widths of trays shall be as follows:
 - i. Perforated type trays: 150, 300, 450 and 600 mm
 - ii. Ladder type trays: 300, 450, 600 and 750 mm

- ~~d) Cable trays, accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint for indoor use.~~
- ~~e) For outdoor use, cable trays, accessories and covers shall be either galvanized or made of aluminium as specifically mentioned in the layout drawings.~~
- ~~f) For use in corrosive atmospheres both indoors and outdoors, the cable trays, accessories and covers shall be as per above serial no. (e).~~
- ~~g) The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise noted.~~
- ~~h) All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.~~

Galvanizing

~~Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below.~~

~~a) Fabricated Steel~~

Thickness less than 2 mm but not less than 1.2 mm	340 gms/sq mm
Thickness less than 5 mm but not less than 2 mm	460 gms/sq mm
Thickness 5 mm and over	610 gms/sq mm

~~b) Fasteners~~

Up to nominal size M 10	270 gms/sq mm
Over M 10	300 gms/sq mm

~~Galvanizing shall be carried out only after drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and Aluminium paint.~~

EARTHING & LIGHTNING PROTECTION SYSTEM

Scope

- a) ~~The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrodes, earthing strips installation and approval to the satisfaction of electrical inspector under this tender specification.~~
- b) ~~Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.~~

Applicable Standards

~~The earthing and lightning protection system shall conform to the CEA guidelines and the latest applicable standards indicated below.~~

Code of Practice for Earthing	IS: 3043
Code of Practice for the Protection of Building and allied structure against Lightning	IS: 2309
Hot dip galvanizing	IS: 2629, 2633, 4759
Structural steel	IS: 2062 & 808
Welding	IS: 816

Earthing & Lightning system

- a) ~~The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided for complete plant i.e. pumping stations, switchyard and all electrical equipment as per the latest edition including all official amendments and revisions of IS: 3043 and CEA guidelines.~~
- b) ~~All materials and fittings used in the earthing installation shall conform to the relevant Indian Standards or shall be approved by the EIC & CEIG.~~
- c) ~~Contractor has to carry out soil resistivity test at, at least 4 locations for which locations shall be provided by GWSSB's representative. Testing is to be done at each site.~~

- ~~d) Soil resistivity shall be carried out by Wenner four electrode method as described in IS: 3043. Contractor has to carry out the test in presence of GWSSB's representative & test shall be carried out keeping electrode spacing as 1, 2, 4, 6, 8, 10, 15, 25 M (each, along all 8 directions) as per normal practice and report has to be submitted. Polar curves shall be used for measurement of mean soil resistivity, which shall be used in finding earthing resistance at a particular location. Mean soil resistivity values shall be approved by GWSSB's representative.~~
- ~~e) The Contractor shall base his earthing calculations on actual measurement carried out by him in the presence of GWSSB's representative.~~
- ~~f) Copper Strip/Galvanized Iron flat or wire shall be used as earthing conductor as per specifications/actual requirements & data sheets.~~
- ~~g) The conductor sizes & types shall be as per specified in the technical specifications. Contractor to note that, the sizes indicated are minimum required & earthing conductor sizes shall be approved by the GWSSB's representative on the basis of adequacy calculations with justifications submitted by Contractor.~~
- ~~h) The underground joints in the system shall be properly welded or brazed and the bolted type connection shall be made with structures/equipment. Petroleum jelly shall be applied to contact surface of the bolted joints, which will be covered with bituminous compounds and tapes.~~
- ~~i) Earthing conductor shall be protected against mechanical damages considering the installation conditions.~~
- ~~j) The earthing system shall comprise one or more earth electrodes, earthing grid or a combination of these in order to obtain the required earth electrode resistance of less than one (1) Ohms/or as per IEEE Std 80-2000.~~
- ~~k) For equipment earthing, two earthing leads will be used if rated voltage of the equipment is 125 volts & above and one earthing lead will be provided for equipment rated below 125 volts.~~
- ~~l) The earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm below FGL.~~

- m) ~~Earth pit of minimum bore dia. 150 mm size with earthing electrode consisting pipe in pipe technology (Outer dia. of 50 mm & inner dia. of 25 mm with length of minimum 2.0meters with back filling compound of minimum 25 Kg for each) as per IS: 3043 for all HV/LV equipment viz. Two Pole Structure, Transformer Body Etc; RMU, VCB HV Switchgear Panel, PMCC/MCC panels, LVDB, CPB, LDB, Motors as required @ All Pumping Stations along with grid of necessary length of double GI strip/flat (double flat size: 25 x 6 mm to suit maximum short circuit current & design criteria) bolted/jointed/connected to the required point of DP with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete.~~
- n) ~~Maintenance free UL listed earthing system made of copper bonded rod of minimum 3.0 meters approximate length (17.2 mm dia. with minimum copper bonding of 0.25 mm suitable for 25 KA fault current with 95 % pure carbon based earth enhancement material of 30 Kg for each with pit cover) as per relevant IS for LA of two pole structure and each transformer neutral as required @ All Pumping Stations along with grid of Copper strip of minimum 25 mm x 6 mm size bolted/jointed/connected complete to the transformer neutral with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete.~~
- o) ~~Maintenance free UL listed earthing system made of copper bonded rod of minimum 3.0 meters approximate length (17.2 mm dia. with minimum copper bonding of 0.25 mm suitable for 25 KA fault current with 95 % pure carbon based earth enhancement material of 30 Kg for each with pit cover) as per relevant IS for PLC based instrumentation panels 01 set along with grid of copper strip of minimum 25 mm x 6 mm size.~~
- p) ~~Earth pit of minimum bore dia. 150 mm size with earthing electrode consisting pipe in pipe technology (Outer dia. of 50 mm & inner dia. of 25 mm with length of minimum 1.0meter with back filling compound of minimum 15 Kg for each) as per IS: 3043 for all LV equipment viz. induction motors & PMCC/MCC Panels totally minimum 03 sets @ All pumping stations along with grid of necessary length of double GI strip/flat (double flat size: 25 x 6 mm to suit maximum short circuit current & design criteria) bolted/jointed/connected to the required point of DP with end socket as per direction~~

~~and duly tested by earth tester conforming to IS as per drawing and specifications complete.~~

- ~~q) All grounding (earthing) pits are to be interconnected with suitably sized earthing grids of GI and copper strips.~~
- ~~r) Where multiple rods are to be used, they shall be separated by a distance of minimum 2000 mm.~~
- ~~s) Each earth electrode shall be welded at the top to a mild steel plate to which the earthing strips shall be connected. These connections shall each be housed in individual inspection chamber set which shall project 100 mm above the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked 'Electrical Earth'.~~
- ~~t) All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the GWSSB's representative.~~
- ~~u) All civil works, such as excavation, boring, provision of back filling compounds in adequate quantity, backfilling for the installation of the earth electrodes and the earth pit/ inspection pit shall be in the scope of Contractor.~~
- ~~v) After the earth installation has been completed the Contractor shall demonstrate to the GWSSB's representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.~~
- ~~w) Main equipotential Bonding Conductor~~

~~Main equipotential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the works.~~
- ~~x) Circuit Protective Conductors~~

~~An independent circuit protective conductor shall be provided for each circuit and may comprise one or any of the following as appropriate.~~

 - ~~i. a separate core within a multicore cable.~~
 - ~~ii. A separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor.~~
 - ~~iii. The metal sheath of an armoured cable. The sheath shall be bonded to the metal work of the apparatus and to the apparatus earth bar, if any.~~

- ~~iv. The copper sheath of a mineral insulated copper sheathed cable~~
- ~~v. An independent earthing conductor GS run adjacent to the circuit it protects.~~
- ~~vi. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.~~
- ~~vii. The armouring of the supply cable shall not form the sole means of earthing a switchboard or large electrical load.~~

y) Instrumentation Earth

- ~~i. An instrumentation earth bus shall be provided in each control panel. This shall comprise a Copper strip/flat of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the control panel electrical power earth.~~
- ~~ii. If due to the physical size of a control panel more than one instrument earth bar is required the additional bar shall be connected again with a single earth connection to the same point as before on the control panel electrical earth bar. In this fashion all instrument earths shall be connected radial from the same earth point.~~
- ~~iii. All signal cable screens (analogue and digital) shall be terminated on to the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated.~~
- ~~iv. Surge Protector Devices (SPDs) associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer's recommendations.~~
- ~~v. Separate electronic earthing system with dedicated earth pit shall be provided by the bidder for I&C equipment.~~

Important Instructions for Earthing

- ~~a) Each pole of lightning arrestors shall be earthed with separate earth pit.~~
- ~~b) Two earth conductor shall connect outdoor CT secondary winding to earth grid.~~
- ~~c) The switchyard fencing shall be earthed at every alternate block and the switchyard gate shall be earthed with flexible GI flat/wire.~~
- ~~d) All the earthing material with laying etc. shall be included in the scope.~~

- e) ~~The entire plant will have an earth grid laid in trenches/trays/buried in the ground outside. The main earthing grid shall be embedded at a minimum depth of 600 mm below FGL which shall be connected to earth electrodes.~~
- f) ~~All interconnections of the earthing grid conductors will have welded type joints except at electrodes with disconnecting facility and at equipment with bolted connections. All indoor earthing grids will be suitably interconnected to the external earthing grid.~~
- g) ~~Each steel/RCC column of the building will be interconnected to the floor earthing grid. Steel columns, steel strips/conduits, cable trays etc. will not be used as earth continuity conductors.~~
- h) ~~Disconnecting type facility shall be provided between Earthing grid & each earth electrode.~~
- i) ~~All connection between the conductors shall be welded/brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.~~
- j) ~~The down conductors shall be fixed with embedded brass posts (on concrete columns) with nuts & bolts used for fixing the saddle/clamp (direct drilling of down comer and fixing with screw shall not be acceptable).~~
- k) ~~Cleats for 'earthing and lightning protection systems' shall be of GI.~~
- l) ~~The lightning protective conductor shall not be connected with the earthing above ground however both the systems shall be interconnected below ground.~~
- m) ~~The earth pits may require boring & drilling in the soil & the same shall be considered in Contractor's scope.~~
- n) ~~Earth electrode with disconnecting facility shall be provided so that the resistance of the independent earth electrode may be measured.~~
- o) ~~Internal earth bus of each panel shall be connected to both ends to the earthing system by means of earthing conductor.~~

- ~~p) — Metallic frames of all current carrying equipment, structures supporting and adjacent to current carrying conductors, lightning protection system conductors, metallic structures, metallic stairs, hand rails, fences shall be connected to a single earthing system. Neutral points of various systems shall be connected to the dedicated treated earth pits and these earth pits shall be interconnected to each other below ground.~~
- ~~q) — All connections in the equipment earth conductors buried in ground (or otherwise) shall be cad welded/brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. All bimetallic connection shall be treated with suitable compound to prevent moisture ingress. For Bimetallic bolted connection, bimetallic washers shall be used. All bolted joints shall have minimum two bolts to ensure proper surface contact. Termination of stranded conductors at earth inserts shall be with ring type/lugs.~~
- ~~r) — Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/structure.~~
- ~~s) — Suitable earth risers approved by the EIC shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.~~
- ~~t) — Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.~~
- ~~u) — All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval of not more than 10 meters by 25 x 3 mm GI flat.~~

Earthing Pits

- ~~i. — Adequate number of earthing pits shall be provided in conjunction with earthing grid for the earthing system. The minimum spacing between two adjacent earthing pits shall not be less than 2000 mm and shall be kept 1500 mm away from footings of the structure.~~
- ~~ii. — Earthing pits shall be located in ground, which has a reasonable chance of remaining moist.~~

- ~~iii. A galvanized iron strip of adequate size (as per calculations) shall be provided from plate electrode to about ground level to facilitate jointing with earth conductors. Each earth electrode ending at the pit shall be connected to suitable linking strips to connect and disconnect the earthing suitably.~~
- ~~iv. Earthing chamber shall be of RCC/brick chamber of 600 mm x 600 mm, with removable 6 mm thick MS chequered plates. The covers shall have holes for handling. Earthing pits (chambers) shall be painted Green and the earth pit number shall be marked on it.~~
- ~~v. Earthing cables crossing other metallic structures such as conduits pipelines etc shall be minimum 300 mm away from such structures.~~
- ~~vi. Earthing conductors shall be protected against mechanical damage.~~
- ~~vii. All earth lead connections shall be as short and direct as possible and shall be without kink.~~
- ~~viii. The main earth loop in plant area shall be generally routed along cables. When equipment is located away from main earth loops, suitable sub loops shall be run up to them for deriving connections for individual equipment. The entire earthing system shall fully comply with the CEA guidelines and requirements.~~
- ~~ix. The Contractor shall have to carry out any changes as desired by the Electrical Inspector or the EIC, in order to make installation conforming to the CEA guidelines 2010 and IS 3043.~~

Lightning Protection

- ~~a) The lightning protection system need will be established by calculating the risk factor value of each building, structure etc. as per procedure given in IS/ IEC 62305 2010 and if found necessary the same shall be provided by the Contractor.~~
- ~~b) For Lightning protection of Civil Structures including RCC Buildings, fixing of 25x6 mm GI earth strip to roof as per IS/IEC Std. saddle clamp, down comer connector etc. as required with all hardware shall be in Contractor's scope.~~

Galvanizing

- ~~a) Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below~~

<u>Fabricated Steel</u>	
i. Thickness less than 2 mm, but not less than 1.2 mm	340 gms/sq.m
ii. Thickness less than 5 mm, but not less than 2 mm	460 gms/sq.m
iii. Thickness 5 mm and over	610 gm/sq.m
<u>Fasteners</u>	
i. Up to nominal size M10	270 gms/sq.m
ii. Over M10	300 gms/sq.m

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- b) Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.
- c) Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

Drawings/Documents Required

The Contractor should prepare Layout drawings, after award of contract and before commencement of work for Purchaser's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculations.

DETAILS & REQUIREMENTS FOR EARTHING & LIGHTNING PROTECTION SYSTEM (DATA SHEETS)

Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.

Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.

LIGHTING, RECEPTACLE & VENTILATION SYSTEM

Scope

- a) ~~The scope of the Contractor shall include design, supply and installation of all equipment necessary for a complete lighting and receptacle system. The lighting system includes Lighting fixtures (indoor/outdoor), lamps, lighting panels (LP), switchboards, Receptacles, JB's, cables/wires for lighting/receptacles, conduits etc. The supply of street light/flood light poles as per IS: 2713 is also included in the Contractor's scope.~~
- b) ~~The various types of lighting fixtures with lamps shall be installed based on the mounting arrangement shown in the typical drawings enclosed with the specification. Installation scope shall include all material to mount the fixtures in proposed manner.~~
- c) ~~The various types of lighting fixtures as specified in this specification shall be assembled, installed, tested & commissioned by the Contractor.~~
- d) ~~The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria.~~
- e) ~~Lighting system installation shall be as per the tender specifications.~~
- f) ~~It shall be the responsibility of the Contractor to work out complete detailed requirement of lighting and receptacle system for the whole plant and staff quarters including area lighting as per specification and accordingly procure and install them.~~

Emergency Lighting

~~Emergency lighting shall be designed such that at all junctions, exit passages & strategic locations, Lux level shall be maintained above 10 Lux. Emergency light fitting shall be 240 V self-contained 2 x 10 W fluorescent tube with built in Ni-Cd battery having charging facility and six hours back-up time. The emergency light fittings shall be provided at strategic locations of each house/area. Emergency fixtures shall come in service when AC supply fails. Pump room and Electrical room shall be considered for Emergency lighting.~~

Applicable Standards

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

a) Lighting Fixtures & Accessories

Electrical lighting fittings general and safety requirements	:	IS: 1913/ BS: 4533
Code of practice for industrial lighting	:	IS: 6665
Code of Practice for Interior Illumination	:	IS: 3646
Code of Practice for Lighting of Public Thoroughfares	:	IS: 1944
Calculation of co-efficient of utilization	:	IS: 3646 (Part III)
Industrial lighting fittings with metal Reflectors	:	IS: 1777
Decorative lighting fittings	:	IS: 5077
Dust proof electric lighting fittings	:	IS: 4012
Dust tight electric lighting fittings	:	IS: 4013
Flood lights	:	IS: 10322/BS: 4533
Luminaries for street lighting	:	IS: 10322 Part 5
Water tight electric lighting fittings	:	IS: 3553/ BS: 4533, 5225(I)
Bayonet lamp holders	:	IS: 61184 / IEC: 61
Edison screw lamp holders	:	IS: 10276/BSEN 60238
Bi-Pin lamp holders for tubular Fluorescent lamps	:	IS: 3323
Starters for fluorescent lamp	:	IS: 2215/BSEN 60155
Holders for starters for tubular Fluorescent Lamps	:	IS: 3324/BSEN 60400
Ballast for use in fluorescent lighting	:	IS: 1534 (Part 1)/
Fittings	:	BSEN 60920 & 60921
Transistorized ballast for fluorescent Lamps	:	IS: 7027
Ballast for HP mercury vapour lamp	:	IS: 6616

Capacitors for use in fluorescent, _____ IS: 1569/BSEN 61048

HPMV & LP sodium vapour discharge _____ & 61049 / IEC: 586

Circuits

Vitreous enamel reflector for tungsten _____ : _____ IS: 8017

Filament lamp

Tubular fluorescent lamps _____ : _____ IS: 2418 (Part 1) / BSEN 60081/IEC:
81

High pressure mercury vapour lamps _____ : _____ IS: 9900/BS: 3677/ IEC: 188

Tungsten filament general electric lamps _____ : _____ IS: 418/IEC: 432

Cast acrylic sheets for use in Luminaries _____ : _____ IS: 7569

Screw less terminal and electrical _____ : _____ IS: 10322

Connections for lighting fittings

High pressure sodium vapour lamps _____ : _____ IS: 9974

Emergency lighting units _____ : _____ IS: 9583

Ignition proof enclosures, dust tight for _____ : _____ IS: 11005

Electrical Equipment

Luminaries _____ : _____ IS: 10322(Part I to V)

b) Lighting System Equipment

General Requirements

The Lighting system includes following items:

- a) Lighting fixtures complete with Lamps and accessories
- b) Lighting system equipment
- c) Light control switches, receptacle units with control switch units, lighting wires, conduits, earth wires and other similar items necessary to complete lighting system.
- d) Lighting fixture supports, street lighting poles and flood light towers/poles.
- e) Lighting main distribution board, lighting panels.
- f) Multi core cables for street, boundary and flood lighting.

Lighting Layout

- a) It shall be the responsibility of the Contractor to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the relevant standards

b) ~~The types of fixtures to be used in various areas are also indicated in the above-mentioned drawing. The Contractor shall be responsible for measuring the levels of illumination and uniformity after installation and establish compliance with the specification.~~

c) ~~The lighting system will comprise the following.~~

~~Normal AC Lighting: Normal lighting in all indoor and outdoor areas will be operated on 230V, 1Phase, 50 Hz AC supply.~~

~~Arrangement for busbars, main : IS: 5578/ 11353/ BS: 159~~

~~Connections and auxiliary wiring and marking~~

~~Enclosed distribution fuse boards and : IS: 2675/BSEN 60439~~

~~Cutouts for voltages not exceeding 1000 V~~

~~General requirements for switchgear : IS: 13947~~

~~and control gear for voltages not~~

~~Exceeding 1000 V~~

~~Code of practice installation and : IS: 10118/BS: 6423~~

~~Maintenance of switchgear BS 6626, BS 6867~~

~~Factory built assemblies of switchgear : IS: 8623/BS 5486/ IEC: 439~~

~~and control gear for voltages up to and~~

~~including 1000 V AC and 1200 V DC~~

~~Miniature air break circuit breakers for : IS: 8828/BSEN 60898~~

~~AC circuits~~

~~HRC cartridge fuse links up to 650 V : IS: 9224/BS: 88/IEC: 269~~

~~'D' Type fuses : IS: 8187~~

~~Current transformers : IS: 2705/BS: 7626/IEC: 185~~

~~Voltage transformers : IS: 3156/BS: 7625/IEC: 186~~

~~Direct acting electrical indicating instruments: IS: 1248/BS: 89/IEC: 51~~

~~AC electricity meters : IS: 722/BS 5685~~

~~Electrical relays for power system protection: IS: 3231/BS: 142/IEC: 255~~

~~Switches for domestic and similar purposes : IS: 3854/BS: 3676~~

~~Three pin plugs and socket outlets : IS: 1293/BS: 546~~

~~Boxes for enclosure of electrical accessories : IS: 5133(1)~~

~~Rigid steel conduits for electrical wiring : IS: 9537/BS: 31~~

~~Accessories for rigid steel conduits for : IS: 3837/BS-31~~

~~Electrical wiring~~

~~Flexible steel conduits for electrical wiring : IS: 3480~~

~~Rigid non-metallic conduits for electrical : IS: 9537/BS: 4607(2)~~

~~Installations~~

~~Fittings for rigid non-metallic conduits : IS: 3419/BS: 4607(2)~~

~~PVC insulated cables for working : IS: 694~~

~~Voltages up to and including 1100 V~~

~~Tubular steel poles : IS: 2713~~

~~Specification for copper rods and bars : IS: 613~~

~~for electrical purposes~~

~~Code of practice for phosphate iron & steel : IS: 6005/BS: 3189~~

~~Fittings for rigid steel conduits for : IS: 2667~~

~~Electrical wiring~~

~~National Building Code of India (NBC) : NBC 2005~~

Other Design considerations for Lighting

- ~~a) Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from lighting panels. Lighting panel shall comprise of Four pole MCB + RCCB (100 mA) for incomer and SP MCB's for each outgoing single-phase circuit.~~
- ~~b) The wiring for lighting circuits in indoor areas will be done by wires run in PVC/GI conduits. For outdoor lighting, wiring will be done by using armoured cables.~~
- ~~c) Lighting cable from Main lighting DB (MLDB) to lighting panels shall be Cu/Al conductor, XLPE insulated, 1.1KV grade, laid in cable trays otherwise cleated along the wall/column/beam.~~
- ~~d) For lighting fixtures (Pump room) 1100V grade, 4C x 2.5 sq. mm PVC insulated, multi-stranded copper conductor armoured/unarmoured cables shall be used.~~
- ~~e) For lighting fixtures (For Office, electrical room, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded Copper conductor wires of area not less than 1.5 sq. mm laid in min. 20 mm dia. PVC/GI conduit (above false ceiling, if provided) shall be used.~~

- ~~f) For 5/15A decorative sockets (For Office, toilets etc. areas) 1100V grade, FRLS PVC, multi-stranded copper conductor wires of area not less than 2.5/4.0 sq. mm. Cu laid in minimum 20 mm dia. PVC/GI conduit shall be used.~~
- ~~g) Wiring shall be concealed in wall below false ceiling with concealed switch board. Minor civil work like chasing wall, cut outs for conduit, switch board, Lighting Panel in wall, entries for tray, conduits etc. is in scope.~~
- ~~h) Lighting cable from MLDB to Lighting Panels and Lighting Panels to street light fixtures, shall be Al conductor, XLPE insulated, armoured, 1.1 KV grade, laid in cable trays otherwise cleated along the wall/ column/beam and buried in the ground.~~
- ~~i) The point wiring for lighting/receptacle/exhaust fan/wall mounted fan/ceiling fan shall include conduits, conduit accessories, FRLS PVC insulated multi-stranded Copper conductor wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, accessories, anchor fasteners etc. It shall include wiring from lighting panel to switchboard and receptacles & switchboard to lighting fixtures. Sheet metal switchboard embedded in wall shall be considered for receptacles and lighting switchboards on wall shall be considered for lighting.~~
- ~~j) For power sockets in wall/furniture, PVC switch box of approved make with switch plate & accessories and 16 Amp piano modular switches and 5/15A sockets etc. as applicable shall be considered. For all types of point wiring the receptacles with switches shall be included in the point wiring rate.~~
- ~~k) Lighting switchboard consisting of (*) no. of 6A piano switch without indicator, 1 no. 6A piano switch with indicator, 1 no. white coloured cover plate for (*) module (4/6/8/12 module), 1 no. 2/3 pin shuttered socket of 5/ 15A and metal flush box.~~
- ~~l) Decorative socket switchboard consisting of (*) no. of 16A piano switch with indicator, (*) no. 2/3 pin shuttered socket of 5/ 15A and metal flush box, 1 no. white coloured cover plate for (*) module (4/ 6/ 8/ 12 module).~~
- ~~m) Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.~~
- ~~n) Lighting Control Philosophy as per mentioned below shall be observed. From each switch~~
 - ~~i. Max. 2 (3 in case unavoidable) LED luminaries (2x36W)~~
 - ~~ii. Max. 4 (5 in case unavoidable) LED/down lighters luminaries (2x18W)~~

- ~~o) All MH fixtures, High bay T5 fixtures, Street Light fixtures shall be controlled directly from respective Lighting Panels, through MCB.~~
- ~~p) Each lighting panel/Receptacle DB shall have minimum 2 spare circuits of 10/ 16A SPN outgoing feeders. A circuit consists of R, Y, and B Phase each.~~
- ~~q) Lighting for staircase shall be controlled with flushed modular switch. The conduit for main staircase shall be concealed. Lighting for all staircases shall be with 2way switch~~
- ~~r) Contractor shall note that any chasing in walls or cutouts or openings such as fixing of LPs, DBs, switchboards, concealing conduit in wall etc. in walls required shall be made before plastering of brickwork wherever applicable and installation rates quoted shall be inclusive of chasing, cutting & making the plaster as per standard practice.~~
- ~~s) Lighting for street light fixtures/flood light fixtures and metal halide fixtures shall be carried out with cables. The supply of cables, junction boxes, street light poles & structural steel required for mounting fixtures/LPs etc. are in the scope of Contractor. The cable wiring shall include supply & installation of cable required from LP to the junction box mounted on street lighting pole/near indoor fixture and also between junction box mounted inside pole/near indoor fixture to control gear box and same for flood lighting, supply and installation of all termination accessories such as lugs, cable glands etc. DBO Contractor's scope shall also include excavation, preparation of soil bedding, supply and installation of protection cover, back-filling, supply and installation of cable route markers etc.~~
- ~~t) Point Wiring for lighting/raw power receptacle/emergency lighting

 - ~~i. Point wiring covers the wiring between the circuits of the lighting panel to switchboard and then from switchboard to lighting fixtures connected to that circuit of the lighting panel.~~
 - ~~ii. For receptacle circuits point wiring shall cover wiring between the circuits of the lighting panel to receptacles connected to that circuit of the lighting panel.~~
 - ~~iii. The scope of the Contractor shall include the supply, erection, testing and commissioning of the above LPs/ DB boards for supply of power to the various sockets required for computers, raw power points etc. The point wiring rate from these DBs shall include supply of wires, conduits, cleats/ clamps etc. as may be required and shall be in the scope of the Contractor.~~
 - ~~iv. The conduit point wiring rate for exhaust fan shall include conduits/ casing~~~~

~~capping, conduit/ casing capping accessories, Switch boards, PVC insulated wires and earthing wires, pull boxes, ceiling rose, clamps, cleats, hardware, sheet metal switchboards fabricated out of 16 SWG sheet steel housing 5 Amp piano switches. It shall include wiring from Exhaust Fan/RDB to switchboard & switchboard to exhaust fan as applicable. Neutral for individual circuit shall be run separate from DB to individual receptacles.~~

- ~~v. All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Contractor under the scope of this contract.~~
- ~~vi. Required no. of 1phase & 3phase, industrial receptacles with respective 2P/4P ELCB (30mA) & 3/ 5 pin plug shall be provided for maintenance purpose.~~
- ~~vii. Receptacle & its ELCB shall be mounted in prefabricated CRCA box of 16 SWG, epoxy painted with shade 631 of IS: 5. Earthing studs shall be provided for connecting external earthing with receptacle box.~~
- ~~viii. The configuration of industrial receptacle units shall be as per following combination.~~
 - ~~• 240V, 1phase, 50Hz, 3pin, 15A Industrial receptacles with RCBO (30 mA).~~
 - ~~• 415V, 3phase, 50Hz, 32/63A Industrial receptacles with respective RCBO (30 mA).~~

~~u) Lighting Fixtures and Accessories~~

~~i. General~~

Normal supply voltage, phase and frequency	240 V, 1 Phase, 2 Wire, 50 Hz
Variation in Supply	
Voltage (AC & DC)	± 10 %
Frequency	± 5 %
Combined voltage & frequency	± 10 %
Design ambient air temperature	50°C

- ~~ii. The luminaries shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.~~
- ~~iii. Connections between different components shall be made in such a way that~~

~~they will not work loose by small vibration.~~

- ~~iv. For each type of luminaries, the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.~~
- ~~v. All luminaries shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of $\pm 10\%$, $\pm 5\%$ and $\pm 10\%$ respectively.~~
- ~~vi. The luminaries and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.~~
- ~~vii. LED luminaries shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters, re-wireable fuse and fuse base. These shall be mounted as far as possible in the luminaries housing only. If these cannot be accommodated integral with the luminaries then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weather proof box.~~
- ~~viii. LED luminaries with more than one lamp shall be provided with capacitors connected in lead lag circuit for correction of stroboscopic effect.~~
- ~~ix. Each luminaire shall have a terminal block suitable for loop-in, loop-out and T-off connection by 230/415 V, 1 core, FRLS PVC insulated Copper conductor wires up to 4 sq. mm in size. In outdoor areas the termination at the luminaries shall be suitable for 1100 V, PVC insulated, Cu/Al conductor, armoured cables of sizes up to 6/16 sq. mm conductor. Terminals shall be of stud or clamp type. The internal wiring should be completed by means of stranded Copper wire of minimum 1 sq. mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.~~
- ~~x. Mounting facility and conduit knock-outs for the luminaries shall be provided.~~

~~v)~~ **Earthing**

- ~~i. Each luminary shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.~~

- ~~ii. Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.~~
- ~~iii. All metal or metal enclosed parts of the luminaries/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.~~

w) ~~Painting/Finish~~

- ~~i. All surfaces of the luminaries/control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.~~
- ~~ii. When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non porous and free from blemishes, blisters and fading.~~
- ~~iii. The luminaire housing shall be stove enamelled/epoxy stove enamelled-vitreous enamelled or anodised as indicated under various types of fittings.~~
- ~~iv. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90° over ½" dia. mandrel.~~
- ~~v. The finish of the luminaries shall be such that no bright spots are produced either by direct light source or by reflection.~~
- ~~vi. External control gear box provided for housing accessories shall be painted or galvanised.~~

LED Luminaries

- ~~a) The luminaries shall be provided with CRCA sheet steel mounting rail/baton with reflector of minimum 20 SWG thicknesses and complete with all control accessories mounted on it. The finish shall be vitreous enamelled.~~
- ~~b) Luminaries mounted recessed in false ceiling shall be with reflector housing and spring loaded fixing arrangement for the diffuser/louver frame. It shall be possible to have access to the lamp and other accessories from below.~~
- ~~c) Luminaries shall be suitable for the number of lamps of specified wattage, direct mounting on ceiling/wall/ column/pendent mounting.~~
- ~~d) The distribution of light shall be such that at least 80% of the total luminous flux from the luminaries shall be in the lower hemisphere.~~

- ~~e) The luminous output of the luminaries with reflector shall not be less than 75% irrespective of type of reflector used.~~

High, Medium and Low Bay Luminaries: LED T5 lamps

- ~~a) Luminaries selection on the basis of height shall be generally selected considering following height criteria~~
- ~~i. High Bay for mounting heights above 9 meters~~
 - ~~ii. Medium Bay for mounting heights from 6 m to 9m~~
 - ~~iii. Low Bay for mounting heights below 6 meters~~
- ~~b) High and medium bay luminaries shall be with cast aluminium/stove enamelled housing, anodized aluminium mirror polished reflector, canopy with eye bolt for suspension, cooling fins. Glass cover shall be provided. The luminaries shall be suitable for metal halide lamp up to 400 W. The control gear accessories shall be mounted integral with the luminaries.~~
- ~~c) Low bay luminaries may be with sheet steel/cast aluminium enclosure, wide angle distribution type polished reflector, acrylic cover and wire guard complete with neoprene gaskets, mounting bracket etc. The luminaries shall be suitable for metal halide lamp up to 125 watts. The control gear accessories shall be mounted integral with the luminaries.~~
- ~~d) All luminaries used with metal halide lamps shall be of enclosed type.~~

Well glass luminaries

~~Well glass luminaries shall be robust construction, cast aluminium/vitreous enamelled housing, clear heat and shock resistant glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire guard with vitreous enamelled finish shall be provided. Additional heavy gauge vitreous enamel reflector shall be provided. The luminaries shall be suitable for incandescent lamp up to 200 watts, mercury vapour up to 250 watts for suspension mounting by conduit pipe, hook or strap.~~

~~Luminaries shall be with degree of protection IP 54 generally used indoor.~~

Flood Light Luminaries

General purpose flood light luminaries

- a) ~~Flood light luminaries shall be of weather proof construction with cast aluminium housing, anodised aluminium mirror polished reflector, heat resistant, toughened glass cover and necessary neoprene gaskets to prevent ingress of dust.~~
- b) ~~The housing shall be supported on a cast iron base and capable of being swivelled in both horizontal and vertical directions and locked in any desired position.~~
- c) ~~For focussing purposes, knobs, shall be provided along with sector plate indicating the angle in degrees between 0 and 90° in vertical direction.~~
- d) ~~The Luminaries shall be suitable for single and dual Metal Halide (MH) lamps of 150W/250 W/400 W etc. as required. The same shall be mounted in a separate sheet metal enclosed/ cast aluminium weather proof control gear box.~~
- e) ~~The luminaries shall be provided with cable gland on the canopy in down ward direction for cable connection.~~
- f) ~~It shall be possible to adjust the lamp position to achieve wide beam, medium beam or narrow beam.~~
- g) ~~It shall be possible to replace the lamp from the canopy without opening the front glass.~~

Outdoor/Street Lighting Luminaire

a) ~~Fluorescent Luminaire~~

- i. ~~Street lighting fluorescent luminaries shall be outdoor weather proof type for illumination of secondary roads, walkways, peripheral lighting of buildings etc.~~
- ii. ~~The luminaries shall be of semi cut off or non cut off type, with CRCA sheet steel housing, vitreous enamelled, plain or corrugated clear acrylic cover, complete with integral mounted control gear, neoprene gaskets, side pipe entry or top suspension type.~~
- iii. ~~The luminaries shall be suitable for 1 x 36 watts or 2 x 36 watts fluorescent tubes and for mounting heights up to 4.5 metres.~~

b) ~~Metal Halide luminaire~~

- i. ~~Street light MH luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.~~
- ii. ~~The luminaries shall be of semi cut off with cast aluminium housing, acrylic or~~

~~prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.~~

- ~~iii. The luminaries shall be suitable up to 150/250 watts MH lamps and for mounting heights from 4 metres to 12 metres.~~

~~c) Post Top Lantern~~

- ~~i. Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.~~
- ~~ii. The luminaries shall have cast aluminium spigot finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.~~
- ~~iii. The luminaire shall be suitable up to 125 W mercury vapour lamp or 70W sodium vapour lamp.~~

~~d) Bollard Luminaries~~

- ~~i. Bollard luminaries shall be outdoor, weather proof type for illumination of lawns, gardens, pathways etc.~~
- ~~ii. The luminaries shall be of FRP housing, clear acrylic cover, louvers for directing light downwards and bottom cable entry.~~
- ~~iii. The luminaries shall be suitable for 9/11/18 W LED.~~

Substation Lantern

~~Substation lantern shall be generally outdoor weather proof type for illumination of switch yard equipment.~~

~~The luminary shall have cast aluminium housing finished with corrosion proof paint, spigot for mounting on pole, prismatic glass refractor dome to give distribution of light in horizontal plane, anodised aluminium reflector to give light distribution at an angle 20 to 40 degrees, above the horizontal plane, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.~~

~~The luminaries shall be suitable up to 200 watts incandescent lamp, 125 W mercury vapour lamp or 70 W sodium vapour lamp.~~

Mercury Vapour and Sodium Vapour luminaries

~~Street light mercury/sodium vapour luminaries shall be out door weather proof type for illumination of main roads, traffic islands etc.~~

~~The luminary shall be of semi cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.~~

~~The luminaries shall be suitable up to 400 watts mercury or sodium vapour lamps and for mounting heights from 4 metres to 12 metres.~~

Portable Emergency Light Luminary

~~Emergency light of installite luminary shall be indoor type for providing emergency light during failure of normal AC supply.~~

~~The luminary shall be with CRCA sheet steel enclosure, complete with metallised mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminary.~~

~~The luminary shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminary shall pick up automatically and on restoration of AC supply the luminary shall switch off automatically.~~

~~The luminary shall be suitable for LED lamp up to 20 W.~~

High Mast Flood Light/Flood Light Towers

- ~~a) High mast shall be outdoor weather proof type for illumination of main roads and area lighting, wherever found necessary. One set per head works is to be provided.~~
- ~~b) The high mast shall be continually tapered, polygon cross section and telescopically jointed steel fabricated construction. The mast shall be hot dip galvanised internally and externally. Weather proof door shall be provided near the base to permit access to winch, cables, plug, socket etc. The mast shall be designed for wind speeds depending upon wind pressure and direction as per relevant Indian Standards. Foundation bolts shall be included in the scope of supply.~~
- ~~c) The moving platform shall be of steel construction hot dip galvanised and designed to hold the number of flood light luminaires specified. The control gear boxes shall be cast aluminium weather proof type mounted on the moving platform. The moving platform shall be raised or lowered with the help of winch, pulley system and stainless steel wire ropes. The winch shall be suitable for hand operation or alternate by electric power.~~

- ~~d) The mast shall be suitable for mounting numbers of luminaires as required. The standard mast heights are generally from 16 to 30 meters.~~

Emergency Light Luminaries

- ~~a) Emergency light fitting shall be 240 V self-contained 2 x 11 W fluorescent tube with built in Ni Cd battery having charging facility and six hours back up time. The emergency light fittings shall be provided at strategic locations of each house/area.~~
- ~~b) Emergency fixtures shall come in service when AC supply fails.~~
- ~~c) Pump room and Electrical room shall be considered for Emergency lighting.~~
- ~~d) In addition to above emergency fixtures, every pump station shall be provided with two nos. of portable emergency luminary, which shall be with CRCA sheet steel enclosure, complete with metalized mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminaries.~~
- ~~e) The luminaries shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal AC supply the luminary shall start automatically and on restoration of AC supply the luminary shall switch off automatically.~~
- ~~f) The luminaries shall be suitable for up to 11/15 W LED.~~

Accessories for Luminaries

a) Reflectors

- ~~i. The reflectors shall be made of CRCA sheet steel/aluminium/silvered glass/chromium plated sheet copper as indicated for above mentioned luminaries.~~
- ~~ii. The thickness of steel/aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finish. Aluminium used for reflectors shall be anodized/epoxy stove enamelled/mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.~~
- ~~iii. Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient so as to ensure the overall light output specified by the Contractor.~~
- ~~iv. Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They~~

~~shall be securely fixed to the housing by means of positive fastening device of captive type.~~

b) ~~Lamp/ Starter Holders~~

- ~~i. Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.~~
- ~~ii. Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp is in working position.~~
- ~~iii. Lamp holders for mercury vapour and sodium vapour lamps shall be of Edison Screw (ES) type.~~
- ~~iv. The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.~~

c) ~~Ballasts~~

- ~~i. The electronic ballasts shall be designed to have a long service life and low power loss. The ballasts shall be of the inductive, heavy duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage within the range of variation in supply voltage of $\pm 10\%$ of 240 V. End connections and taps shall be brought out to a suitable terminal block rigidly fixed to the ballast enclosure. Ballasts shall be free from hum and such of those which produce hum shall be replaced by Contractor free of cost.~~
- ~~ii. Ballasts shall be mounted using self locking, anti vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non-combustible enclosures.~~
- ~~iii. All the luminaries other than Flood Light Fixtures shall have integral control gear.~~

- ~~iv. All type of fluorescent light fittings shall be provided with high frequency electronic ballast of proven design with less than 10% THD, fully wired up to the connector block. The electronic ballast shall be suitable for operation with input voltage variation between 180- 260V to give a constant light output.~~
- ~~v. All gas discharge/MH type lamps shall be provided with control gear, with Copper wound and polyester filled low loss ballast, igniter and PF correction capacitor.~~
- ~~vi. Contractor to provide comprehensive technical details of the luminaries and the lamps being offered. The details must be sufficient to take in to consideration maximizing of energy efficiency and minimizing overall shop power consumption.~~
- ~~vii. In Crane bays, lighting fixtures shall be mounted with the minimum 500 mm clearances above overhead crane clearance level as asked by Crane Manufacturer.~~
- ~~viii. All the outdoor purpose luminaries, including Street light luminaries shall be with ingress protection of IP 65 minimum.~~
- ~~ix. All the Mid Bay & Highbay fixtures, street light fixtures shall be provided with the toughened Glass covers.~~
- ~~x. In case of Hazardous areas, if any Flame proof luminaries (complete with suitable lamp & accessories) in line with the requirements of IS: 5572 shall be provided by the Contractor.~~

~~d) Starters~~

- ~~i. Starters shall have bimetal electrodes and high mechanical strength.~~
- ~~ii. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool.~~
- ~~iii. Starters shall have brass contacts and radio interference capacitors.~~

~~e) Capacitors~~

- ~~i. The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.~~
- ~~ii. The capacitors shall be suitable for operation at specified supply voltage conditions and shall have a value of capacitance so as to correct the power~~

~~factor of their corresponding lamps circuit to the extent of 0.95 lag or better.~~

~~iii. The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.~~

~~f) — Lamps~~

~~Lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/ electrodes shall not break under such circumstances.~~

Drawings/Documents Required

~~a) As part of proposal, the Contractor shall furnish relevant descriptive and illustrative literature & drawings/data for the respective lighting fixtures & accessories with manufacturer's catalogue numbers.~~

~~b) It shall be the responsibility of the Contractor that, on award of contract to work out a detailed lighting layout for the complete plant in order to provide the levels of illumination as indicated under design criteria and shall be furnished for the approval of the GWSSB's representative before commencement of installation.~~

~~c) Detailed room wise lighting layout with type of fixture details, mounting detail arrangement and circuit diagram showing phase wise load distribution and interconnection between switches, fixtures, lighting panel, receptacles etc.~~

~~d) Conduit layout showing room wise routing of wires from lighting panel to lighting fixtures covering primary & secondary point wiring, receptacles etc.~~

~~e) Internal road lighting and area lighting layout with type of mounting details and fixture details.~~

~~f) Street Light pole details with Foundation details~~

~~g) General arrangement of lighting panel & lighting distribution board showing plan, elevation and typical section views.~~

Lighting System Equipment

~~h) — Main Distribution Boards and Lighting Panels~~

~~i. Main Lighting distribution board (MLDB) shall have MCCB as incomer & outgoing feeder with Microprocessor based/thermal magnetic release for O/L+S/C+E/F~~

~~protections.~~

- ~~ii. This MLDB shall feed to different Lighting Panels/Lighting DBs for further distribution.~~
- ~~iii. Where ever MLDB is not applicable, lighting feeder of appropriate rating shall be derived from the local distribution board. This feeder will feed to local LP catering to lighting requirements of that particular area.~~

i) ~~Constructional Features~~

- ~~i. Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP 52 for indoor. Outdoor panels shall in addition be completely weather proof with a sloping canopy for protection against rain and providing a degree of protection of IP 55. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2.0 mm thick.~~
- ~~ii. The lighting panel for outdoor lighting shall have a programmable timer for automatic control of lighting along with contactor, MCB, auto/manual selector switch.~~
- ~~iii. All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets.~~
- ~~iv. A slotted metallic sheet shall be provided inside. Only the MCBs operating knobs shall project out of the metallic sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with four pole MCB + RCCB.~~
- ~~v. All accessible live connections/metals shall be shrouded and it shall be possible to change individual MCBs from the front of the boards/panels without danger of contact with live metal.~~
- ~~vi. For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.~~
- ~~vii. Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be~~

~~provided. Cable glands shall be screwed on type and made of brass.~~

~~viii. Two earthing terminals shall be provided to suit the earthing conductor.~~

~~ix. All sheet steel parts shall undergo rust proofing process which should include 7 tank processing. The steel works shall then be painted with two coats of Zinc-chromate primer and two coats of final epoxy based finish paint of colour 631 as per IS-5.~~

j) — Busbars

~~i. Busbars shall be of copper conductor of hard drawn (HD) and high conductivity.~~

~~ii. Busbars shall be provided with at least the minimum clearances in air as per applicable standards.~~

~~iii. Busbars shall be adequately sized for the continuous current rating such that the maximum temperature of the bus bars, bus bar risers/droppers and contacts does not exceed 85^o C under site reference temperature.~~

~~iv. The bus bars, bus bar connections and bus bar support shall have sufficient strength to withstand thermal and electro-mechanical stresses of the MCB's let through/cut-off current associated with the specified short-circuit level of the system.~~

~~v. Busbar supports shall be SMC type. Separate supports shall be provided for each phase of the bus bars.~~

~~vi. The neutral bus of the main 3 phase, 4 wire distribution board shall be 100% of the phase busbars.~~

k) — Panels/Boards Component & Lighting Accessories

i. — MCB/ELCB

~~• MCBs shall be C curve type for lighting panels.~~

~~• For all the lighting panels RCCBs shall be with 100 mA sensitivity & for all receptacles RCBO sensitivity shall be 30 mA.~~

ii. — MCCB

~~MCCB requirements shall be as per specified in the LV switchgear requirements & as specified above.~~

iii. ~~Indicating Instruments and Meters~~

- ~~• Whenever required, instruments and meters shall be of the flush mounting type. They shall be suitably mounted so as to provide for easy access to CTs and small wiring.~~
- ~~• Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.~~
- ~~• Ammeter/Voltmeter selector switches having 3 positions and off, with stay-put contacts rated 10A shall be provided when specified.~~
- ~~• Potential fuses shall be provided at the tap-off point from the bus bars for the voltmeters.~~

iv. ~~Instrument Transformers~~

- ~~• Current and voltage transformers shall be of cast resin type, with insulation class B, & accuracy class 1.0 unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.~~
- ~~• Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short circuiting and grounding the CTs at the terminal blocks.~~
- ~~• Voltage transformers shall be provided with suitably rated primary and secondary fuses.~~

v. ~~Indicating Lamps~~

~~Indicating lamps shall be of the clustered LED type, low watt consumption.~~

vi. ~~Internal Wiring~~

- ~~• Panels/boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 1.1 KV grade, FRLS PVC insulated, multi-stranded Copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.~~
- ~~• Cross Ferruling i.e. engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.~~
- ~~• All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V, of reputed make of approved list,~~

~~preferably stud type for higher current ratings such that wires are connected by cable lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 20 A.~~

- ~~• Terminals for circuits with voltage exceeding 125 V shall be shrouded.~~
- ~~• Terminals shall be numbered and provided with identification strip for identification of the circuit.~~
- ~~• Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.~~

vii. ~~Labels & Diagram Plate~~

- ~~• All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also, the boards/panels shall be provided on the front with a label engraved with the designation of the board/panel.~~
- ~~• Labels shall be made of non-rusting metal, 3ply lamacoid or engraved acrylic.~~
- ~~• Inside the door of the 1 phase ways lighting panels a circuit diagram/description shall be fixed for reference and identification.~~

viii. ~~Conduits~~

- ~~• Rigid steel/non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.~~
- ~~• Steel conduits shall be seamed by welding and hot dip galvanised. They shall be supplied in standard lengths of 5 metre.~~
- ~~• Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.~~

ix. ~~Junction Boxes~~

- ~~• Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, three (3) phase receptacles etc.~~

- ~~The junction boxes shall be dust and vermin proof and shall be fabricated from 14 SWG sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.~~
- ~~The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, and HRC fuses as required.~~
- ~~The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of Copper alloy and shall be of box clamp type.~~
- ~~The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.~~

~~x. **Lighting Poles and Flood Light Pole Mounting**~~

- ~~Lighting poles for street lights and flood lights shall be of stepped tubular steel poles construction as per applicable standard. These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied.~~
- ~~Poles for mounting flood lights shall be supplied whenever required and as per typical attached drawing. Unless otherwise specified, poles shall be painted with red lead oxide primer and two coats of aluminium paint. One steel ladder shall be provided separately. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.~~
- ~~The supply of poles shall be complete with fixing bracket/necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes.~~

- ~~The required sizes of poles and the junction box shall be as indicated in the attached drawings.~~
- ~~Outdoor JB's shall be minimum IP 55 protected.~~
- ~~Cable entry for street lighting junction boxes shall be from bottom.~~
- ~~Rain water canopy shall be provided at the top for the outdoor JB's.~~
~~Terminal strip shall be provided for looping loop out of cables.~~
- ~~Street lighting JB shall consist of terminal strip (3 ways) for looping in & loop out of cables. The JB shall be provided with 6A MCB (C Curve type) for isolation of lighting fixture, as well as sufficient arrangement (earthing studs) for termination of 2 nos. earthing connections.~~

~~xi. Ceiling Fans/Wall Mounted Fans~~

- ~~Ceiling/Wall mounted fans shall be suitable for operation on 240 V, 1 phase, 50 Hz supply and shall be complete with standard mounting accessories such as suspension rods, top and bottom caps etc. for ceiling fans and easy accessibility for wall mounted fans. The fans shall be supplied with appropriate speed regulators.~~
- ~~Exhaust fans, where ever required shall also be provided. The exhaust fan with all parts shall be according to IS: 2312-1967& its latest amendment with IP 55 specification. The exhaust fan shall have epoxy powder coating with specially pre-treated components for better resistance to corrosion and acid alkali flumes. The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die cast aluminium rotor mounted on two ball bearings.~~
- ~~The fans shall generally conform to the applicable standards indicated in Tender. Details regarding blade sweep and suspension requirements shall be as per Project layout drawings & actual requirements.~~

~~DETAILS & REQUIREMENTS FOR LIGHTING, RECEPTACLE SYSTEM (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

EXHAUST FAN (If applicable)

- a) ~~The propeller type exhaust fan with all parts shall be according to IS: 2312 (1967) & its latest amendment with IP55 specification.~~
 - b) ~~The exhaust fan shall have rigid frame with rubber mounting for silent feature.~~
 - c) ~~The exhaust fan shall have epoxy powder coating with specially pre-treated components for better resistance to corrosion and acid alkali fumes.~~
 - d) ~~The exhaust fan shall have aerodynamically contoured blades handle maximum air with minimum power consumption.~~
 - e) ~~The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die-cast Aluminium rotor mounted on two ball bearings.~~
- ~~Rating & Size of exhaust fan are as following.~~

Fan Diameter	Phase	Power Input (watt)	Free Air Delivery (M ³ /H)	Speed (RPM)	Sound level
18" (450 mm) Minimum	Single	370	3900	900 (Maximum)	55—60 dB

DETAILS & REQUIREMENTS FOR EXHAUST FAN (DATA SHEETS)

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.~~

FIRE EXTINGUISHERS

~~Providing fire extinguisher CO₂ charged of reputed make as per IS: 2878 & latest revision of capacity 3.0 kg. Construction of cylinder shall be as per IS: 7285 & valve shall be brass forged & as per IS: 3224. Charge shall be CO₂ conforming to IS: 307 & filled with liquefied CO₂ gas filling ratio ≤ 0.667 . It shall be properly finished & duly painted in synthetic enamels red / fire red epoxy polyester coating. It shall be provided with wall mounting brackets.~~

PART III – INSTRUMENTATION & CONTROL EQUIPMENT

List of Measurements and Control

The water pumping system and treatment plant shall be provided with required instrumentation equipment for measurement & control functions, indicated below as a minimum, but not limited to:

- a) Flow Indicator Transmitter (electromagnetic) at common discharge header of pumps.
- b) Pressure Indicator gauge at discharge of each pump, blowers & common discharge header of pumps.

ELECTROMAGNETIC FLOW METER (If applicable)

Scope

The objective of the specification given in this section is not to specify all the details pertaining to the design, drawing and selection of equipment or product. The equipment or product supplied shall be of high standard of quality and shall comply with all currently applicable standards, regulations and safety codes. In case of differing constructional features than specified here in equal importance shall be given to adherences & fulfilment of technical parameters & accuracy. In case of difference in material (s) of construction, higher/better/superior grade of material (s) shall also be accepted after due diligence & evaluation by the EIC.

General

The flow meter shall consist of flow sensor (i. e. flow tube), flow transmitter/flow computing unit and remote flow indicator cum integrator. The electromagnetic flow meter shall be manufactured as per BS EN ISO 6817 standard measurement of conductive liquid flow in closed conduits, method using electromagnetic flow meters. The flow tube flanges and transmitter housing shall be properly earthed.

Flow tube shall have waterproof construction (IP 68) and shall be suitable for installation on underground pipe lines buried directly in the soil and also suitable for above ground pipelines.

The transmitter of the flow meter shall be SMART type microprocessor based using digital technology having facilities for configuration of engineering units, flowrange and features of

~~memory and self-diagnosis.~~

~~The transmitter shall be mounted separate from the flow tube, connected by a cable.~~

~~The flow transmitter and flow computation/evaluation unit shall be mounted in a field mounted metallic field enclosure/cabinet.~~

~~The electromagnetic flow meter shall have bi directional measurement feature and with accuracy better or equal to $\pm 0.5\%$ of measured value inclusive of linearity, repeatability, pressure effect etc.~~

~~Flow transmitter/flow computing unit should be microprocessor based having digital display with flow rate indications and integrated flow values with the configuration facility from the front face.~~

~~Material of construction of the wetted parts of flow meters shall be suitable for functioning on treated/raw and chlorinated water applications.~~

~~Flow tube shall be rugged in construction and shall be suitable for continuous operation.~~

~~Flow meters shall be suitable for the water turbidity at site during various seasons.~~

~~The flow meter shall be installed in such a way that it always remains filled with water.~~

~~To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow meter shall be provided, as required by the flow meter manufacturer.~~

~~The flow tube shall be installed at a location free from flow turbulence. In order to achieve the same, the flow tubes shall be installed in the pipe section such that straight lengths of pipe without bends or tee connection shall be minimum 5 (five) diameters on upstream and 2 (two) diameters on downstream side.~~

~~The Contractor shall finalize the exact location of flow transducers in consultation with GWSSB's EIC.~~

~~The flow meter output signals shall contain the data for flow rate and integrated flow readings.~~

~~The output signal of the flow meter will be connected to panel mounted Flow Indicator & integrator and PLC.~~

~~Full bore electromagnetic flow meters should be designed, manufactured and calibrated according to ISO standard. The flow meter shall be capable of measuring bi directional flow.~~

~~The Electromagnetic flow meters shall withstand maximum working temperature of about~~

~~60^o C and working pressure of minimum 16/10 Kg/Cm² (1.6/1.0 Mpa) as per specifications/requirement and data sheet.~~

~~General Requirements~~

~~Flow measuring system shall consist of flow sensor/transducers, flow computer & flow transmitter, digital flow indicator & integrator and any other item required to complete the system.~~

~~Flow sensors/transducers shall be rugged in construction and shall be suitable for continuous operation. The electromagnetic flow meters shall be suitable for installation on underground/above ground pipelines in pumping station/RCC chambers/open pits or buried for indication of flow rate and total consumption of water in a transmission or distribution pipe network of water supply system. Flow transducers shall have water proof construction.~~

~~To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided, as required by the flow meter manufacturer.~~

~~The exact location of flow transducers shall be finalised in consultation with Engineer's representative. However electromagnetic full bore type shall be provided on common discharge header of the pumping station.~~

~~The flow transmitter shall be suitable for field mounting and shall accept input from the flow transducer. It shall process the input signal and provide 4 – 20 mA DC output proportional to flow rate. Flow transmitters shall have LCD display to indicate instantaneous flow rate. The flow range shall be adjustable. The flow meter shall be suitable for measuring flow at velocities of water from 0.5 to 4 m/sec.~~

~~Flow measurement shall not be affected by physical properties of water viz. temperature, pressure, viscosity, density etc. within given limits. Bidder shall provide compensating electronic circuits if required.~~

~~Bidder shall construct a suitable concrete chamber (if and as required) for enclosing flow transducer to be mounted on over/under ground pipe line. A concrete cabin shall be constructed above the chamber for housing the flow transmitter. A concrete cabin shall be constructed for housing the flow transducer and the flow transmitter to be mounted on surface pipelines.~~

~~The flow transmitter shall be microprocessor based and shall have self diagnosis facility.~~

~~Measurement of outlet flow at pumping system will be by full bore type electromagnetic type flow meter.~~

~~Technical Requirements~~

~~Electromagnetic flow meter shall be a velocity sensing electromagnetic type, Microprocessor based signal converter, sealed housing, welded flanged tube meter for minimum 1.0/1.6 Mpa working pressure unless otherwise specified. The meter shall be manufactured to highest standard available for mag meters. The meter shall be equipped with minimum six digits digital totalisers, reading in units of kilolitres and shall be accurate within 0.5% of true flow. The accuracy should be inclusive of linearity, hysteresis, repeatability and pressure effect. The meter assembly shall operate within a range of 0.5 m/sec to 4 m/sec and be constructed as follows.~~

~~**Meter tube (Sensor)** shall be fabricated from stainless steel tube and use class PN 16 flat face carbon steel flanges as specified in data sheet in accordance with IS: 1538. The internal and external of the meter tube shall be blasted to near white and lined with neoprene or polyurethane. Meter tube shall have a constant nominal inside diameter offering no obstruction to the flow.~~

~~**Coil Housing** shall be fabricated from stainless steel and/or cast steel with anti corrosive epoxy painting for corrosion resistance and welded to the tube providing a completely sealed environment for all coils, electrode connections and wiring harness capable of submerged or buried operation.~~

~~**Signal Converter** shall be pulsed DC coil excitation type with auto zeroing. The signal converter shall be remotely mounted away from the meter. The converter shall indicate direction of flow and provide a flow rate indication and a total of flow volume for both forward and reverse directions.~~

~~The converter shall provide an isolated 4-20 mA output into minimum 500 Ω load and a frequency output of a maximum of 0-10 KHZ and a scaled pulse output. The Microprocessor based signal converter shall have a self diagnostic test mode and a backlit display that continuously displays 'Rate of Flow' and 'Total Volume'.~~

~~The converter shall be compatible with Microsoft Windows and other software programs with built in terminal communication capabilities of RS 485, HART or other protocols for~~

interface. The converter shall be remotely mounted up to 200 m from the sensor, and shall be supplied with all calibration complete for desired requirements.

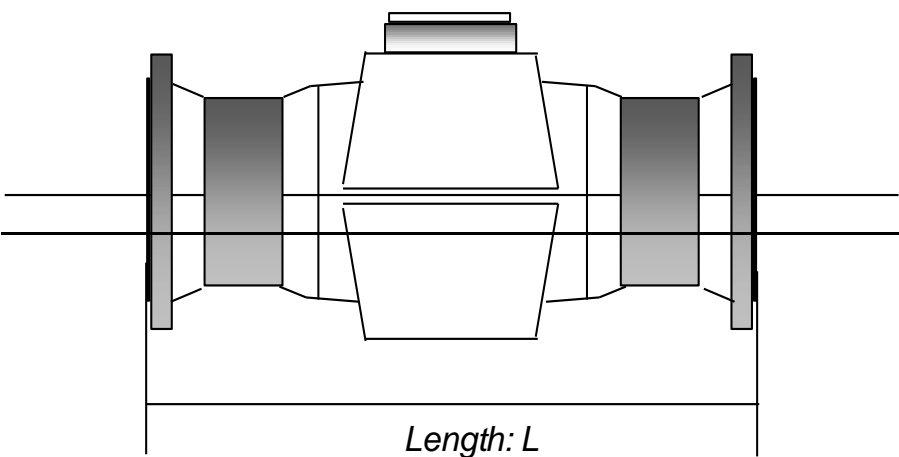
Converter shall be supplied with a programmable low flow drop out and empty pipe zero return. The signal converter housing should be die-cast aluminium with glass window. The converter cum transmitter should be fully programmable from the front fascia. The programming should be user friendly, self-prompting menu driven.

Signal Cable

The cable should be capable of transmitting low signal voltage U (milli volts, pico watts) via a double shielded cable from the primary head to the signal converter. The cable should be resistance to interference from external magnetic fields. The cable should be suitable for laying in underground and in under water installation.

Meter size & Overall Length

Meter size is designated by the nominal diameter (DN) of the flange. For each meter size designation, there is a corresponding fixed overall length and tolerance both as specified in Table. The length includes lining if it covers the flange face but excludes accessories such as gaskets, grounding and protection rings. Standard length of different reputed manufacturers' from among the vendor list is also acceptable. The length shown here is only for reference. Manufacturers' standards are to be followed in this regard.



Overall Length (only as a reference) of EM FM	
Meter Size in	Meter Overall Length (Applicable Tolerances Allowed)
DN (mm)	Length in mm

125	250
150	300
200	350
250	450
300	500
350	550
400	600
450	600
500	600
600	600
700	700
800	800
900	900
1000	1000
1200	1200

Connections

The flow meter shall be provided with flanges at both ends, the internal diameter of which shall be equal to the nominal size of the meter. The dimensions and drillings of the flanges shall be in accordance with IS: 1538.

Rubber Gasket

The flat rubber gasket shall be 3/6 mm dual thickness of SBR material and shall be suitable for making flange joints. The quality of flat rubber gasket shall be as per IS: 5382 and drilling of holes shall be as per IS: 1538.

Nuts and Bolts

Nuts and bolts shall be of best quality carbon steel, machined on the shank and under the head and nut. Nuts and bolts shall be electro-galvanized. Bolts shall be of accurate length so that only one thread shall show through the nut in the fully tightened condition. Nuts and bolts shall conform to IS: 1363 and IS: 1367.

Material Supply

All the flanged meters shall be supplied with one rubber gasket per flange and the required number of nuts and bolts as per the meter size. Matching pair of grounding rings shall be supplied with all the meter tube.

Testing & Inspection

~~Volumetric testing~~ of all meters must be performed and approved prior to shipment. The complete meter assembly and signal converter must be wet accuracy tested and calibrated as a unit near minimum, intermediate, and maximum specified flow ranges of the meter (full range of flow). The volume of water used to conduct the test must be shown on a shipping tag attached to the meter.

~~To calibrate these meters, only direct volume comparison calibration method should be used. The overall accuracy of the calibration rig should be at least three times better than the accuracy of the full bore electromagnetic flow meter. The competent authority must certify the test facility. All the meters shall be calibrated for a minimum of 5 point.~~

~~The manufacturer must have NABL approved/accredited testing facility. Complete facility of testing shall be NABL approved and not just the equipment/apparatus thereof. It should preferably have an ISO 9001 certification. The magnetic flow meter should perform within the required accuracy of measured value without being affected by change in pressure due to demand fluctuation. The length of the sensor should be strictly as per ISO up to DN 600 mm and for other sizes it should be as per the manufacturer's standard. To avoid ingress of water in the sensor housing, sensor has to be of fully welded construction. The maximum separation level (distance) between flow sensor and the signal converter/transmitter should at least 200 meters without signal boosters.~~

~~Supplier must have in house NABL approved calibration facility and should give calibration certificate for all the flow meters. The flow meter should have either earthing (grounding) electrode or grounding rings for flow meter. However for flowmeters of sizes $\geq 1000\text{mm}$, **grounding rings have to be provided compulsorily.** Calibration of each meter shall be tested at in house facility of manufacturer for the sizes for which manufacturer has this facility. The test bench of such manufacturer should be certified by a reputed company.~~

~~In case the flow water meters are to be imported by the bidder than for such flowmeters wet calibration test must be witnessed by the PMC/TPI & EIC of GWSSB. If manufacturer of imported flowmeters has no in house facility for calibration situated in India, than each flow meter shall be tested from FCRI or any NABL approved testing facility situated in India.~~

~~Supplier must have test facilities, spare parts, and personnel to maintain, instruct, train or whatever is necessary to assure that meters shall be maintained throughout the guarantee/ maintenance contract period.~~

~~Alternatively, Gravimetric method of calibration as per ISO 4185/IEC 17025 is also acceptable. Facility shall be accredited/approved by NABL.~~

Quality Control Tests

~~All water meters of the same size and class manufactured by the same firm under similar condition of production from the material of the same batch, components from the same source, shall be considered as a lot for quality control inspection. However, minimum 1 number of each size & class shall be tested. The sampling procedure and scale of sampling for visual inspection and other tests shall be as per Table 4 given in IS: 779.~~

~~The sample meters from a lot shall be inspected for workmanship to ensure that meter is free from any damage, cracks, imperfections and other defects and uniform in dimensions.~~

Acceptance Tests

~~The flow meter having satisfied for quality control requirements shall be tested for lot acceptance.~~

~~The following acceptance tests shall be conducted in accordance with IS: 779 and IS: 2373.~~

~~Pressure tightness (Hydrostatic test) and Metering Accuracy~~

~~In addition, to above tests manufacturer shall furnished a material(s) certificate(s) for meter tube, coil housing, connection flange and electrode, if required the material may be tested at approved laboratory for reconfirmation. If desired, the calibration and other test shall be witnessed by the Purchaser or their authorised representatives.~~

Packing

~~All the flow meters shall be packed in polyethylene bags. Smaller size meters shall be packed in cardboard boxes. The larger size bulk flow meter shall be packed in separate wooden crate, according to the size. Rubber gasket and nuts, bolts etc. shall be supplied in separate jute bags.~~

Battery Backup System

~~The battery backup shall be used to operate electromagnetic flow meters during power failure. The technical specification shall be as follows.~~

~~Make _____ : _____ Reputed make~~

~~Type _____ : _____ Online or line interactive~~

~~Capacity _____ : _____ 800 VA~~

Input voltage : 180 – 280 volts

Batteries : Internal

Control panel : Voltage correction, overload indicator alarm

~~DETAILS & REQUIREMENTS FOR ELECTROMAGNETIC FLOWMETER (DATA SHEETS)~~

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment~~

PRESSURE GAUGES

~~Pressure Gauges shall be bourdon tube with diaphragm seal type with dial size of minimum 150 mm in diameter and calibrated for the required range of duty heads of pumping machinery to be installed as per range required. The colour of dial shall be white. The pointer shall be adjustable & micrometer type. The indicator shall be incorporating with damper and shall have external zero setting mechanism and safety blow out mechanism. The glass shall be shatter proof. The over range protection shall be 25% above maximum pressure.~~

~~The gauge shall be supplied complete with sensing diaphragm unit, sealing liquid, a pressure indicator and an armoured capillary connecting the diaphragm to the pressure indicator. The pressure indicator shall be supported on a rigid support and the capillary shall be well supported to prevent physical damage.~~

~~Pressure gauges shall be provided on individual delivery (discharge) of each pump and on common discharge header of all pumps. The gauge shall be supplied complete with impulse tubing, two valve manifolds with drain cock/calibration valve, fittings etc. The pressure gauges shall have an accuracy of 1% full scale and weather protection class IP 65. All wetted parts material shall be SS 316.~~

~~Pressure gauge shall comply with IS: 3624/BS 1780. Pressure gauge shall have siphon & cock arrangement. It shall be provided with snubber and Glycerine filled dial shall be provided as the gauge is subjected to pressure pulsation and/or vibrations. The internal parts of pressure gauge shall be stainless steel.~~

~~The zero and span of pressure gauge shall not change by more than ± 0.1 % of the span per $^{\circ}\text{C}$ changes in ambient temperature.~~

~~Material(s) of construction of the components shall be as per ISO 9001: 2000 certified manufacturers' standard models.~~

DETAILS & REQUIREMENTS FOR PRESSURE GAUGE (DATA SHEETS)

~~Data sheet with relevant details & requirements as well as materials of construction for various parts, mandatory accessories, spares & services required are given in the data sheet section.~~

~~**Contractor must go through it in depth so as to satisfy the basis, general & overall requirements of the equipment.**~~

SAFETY EQUIPMENT AND MISCELLANEOUS ITEMS

~~Following safety procedure and practice should be provided by Contractor in switchgear room/ sub station as per latest edition of IS: 5216.~~

~~Adequate provision for metallic vitrified HV/LV danger notice boards & stickers of standard sizes are to be made.~~

~~900 mm wide antiskid insulating matting as per IS: 15652 and of reputed make to be spread in front of the 11 KV, 415V switch gear panels & power DBs, DCDB etc.~~

~~First aid box with all the standard contents.~~

~~Providing rubber hand gloves suitable for 11/22 KV supply.~~

~~First aid chart made of cloth for electrical shock treatment printed in English, Hindi and Gujarati duly framed with front glasses.~~

~~Charts/drawings duly framed with front glass.~~

~~HV and LV power supply single line diagrams in adequate sizes approved by GWSSB's representative & in line with the local electrical inspector.~~

~~Routine maintenance schedule for High Voltage Switchgear, Distribution Transformers, Low voltage Switchgears, APFC panels, Fire Alarm System, UPS system etc.~~

~~Provision of portable type Class A, B, C, and D type fire extinguishers at various locations in line with the statutory requirements.~~

Fire Safety

~~The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.~~

FIRE EXTINGUISHERS (If applicable)

~~Providing fire extinguisher CO₂ charged of reputed make as per IS: 2878 & latest revision of capacity 4.5 Kg or as specified in price bid. Construction of cylinder shall be as per IS: 7285 & valve shall be brass forged & as per IS: 3224. Charge shall be CO₂ confirming to IS: 307 & filled with liquefied CO₂ gas filling ratio ≤ 0.667 . It shall be properly finished & duly painted in synthetic enamels red/fire red epoxy polyester coating. It shall be provided with wall mounting brackets.~~

~~Water Sealing & Fire Barriers at appropriate locations as specified in this specifications & good engineering practices.~~

Degree of Protection

~~The enclosures of the control cabinets, junction boxes and Marshalling boxes, panels etc. to be installed shall provide minimum degree of protection as detailed here under Installed outdoor — IP 55 Installed indoor — IP 54. The degree of protection shall be in accordance with IS: 13947 (Part I)/ IEC 947 (Part I)/ IS: 2063/ IEC 529.~~

Electrical Equipment for Hazardous Area

~~The electrical equipment for hazardous areas shall be selected as per IS: 5572. Following factors shall be considered for proper selection of electrical equipment for use in Hazardous Area.~~

~~Area Classification (Zone)~~

~~Gas Classification (Group)~~

~~The characteristics of the gas or vapour involved in relation to the ignition or energy and safe gap data.~~

~~Temperature Classification~~

~~The ignition temperature of the gas or vapour involved or lowest value of the ignition temperature, if more than one combustible material is present.~~

~~Environmental Conditions~~

~~In which apparatus is to be installed. The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies water ingress, thermal and mechanical stresses as determined by the environmental condition.~~

INSTALLATION, TESTING AND COMMISSIONING

MECHANICAL EQUIPMENT

~~1. Erection—General~~

- ~~1.1. The Contractor's staff shall include adequate and competent erection engineers with proven, suitable, previous experience on similar contracts to supervise the erection of the works and sufficient skilled, semi-skilled and unskilled labour to ensure completion of works in time. The contractor shall not remove any representative, erector or skilled labour from the site without prior approval of the Engineer-In-Charge (EIC).~~
- ~~1.2. The Contractor shall ensure that no installation or erection work shall commence until full and unconditionally approved working drawings, signed and stamped by the EIC are available at site.~~
- ~~1.3. The Contractor's erection staff shall arrive on the site on dates to be agreed by the EIC. Before they proceed to the site, however, the contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his vendor's) supply has arrived on site(s) so that there will be no delay on this account.~~
- ~~1.4. One erection engineer who shall be required to be the contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the contractor shall inform the EIC in writing which erector is designated as his representative and is in charge. Erection engineer is to report to the project manager.~~
- ~~1.5. The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels dimensions and alignment, appliances and labour in connection therewith. The checking of setting out of any line or level by the EIC shall not in any way relieve the contractor of his responsibility for the correctness thereof.~~
- ~~1.6. Erection of plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the contractor shall check the dimension of structures where the various items of Plants are to be installed and shall bring any deviations from the required position, lines or dimensions to the notice of the EIC. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless~~

~~otherwise directed by the EIC, 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 EIC's satisfaction.~~

~~1.7. The contractor shall align all equipment and holding down bolts and shall inform the Employer before proceeding with grouting in the items concerned. The contractor shall ensure that all equipment is securely held and remains in correct alignment before, during and after grouting in.~~

~~1.8. The approval by the GWSSB of the contractor's proposals for rigging and hoisting any items of the plant into final positions shall not relieve the contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Employer.~~

~~1.9. No plants or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports.~~

~~1.10. During erection of the plant the EIC 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 specifications. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the EIC.~~

~~2. Levelling and Grouting of Machinery~~

~~2.1. He shall undertake sufficiently in advance chipping of any unevenness of concrete on foundations, anchor bolt pockets, cut outs etc. to achieve uniform level of reference for erection. All concrete surfaces receiving grout shall be hacked as required to ensure better bonding with grouting.~~

~~2.2. Contractor shall undertake the inspection of all components to be erected sufficiently in advance to check their soundness and conformity to drawings and the inspection records shall be signed by the Engineer as approval for undertaking the installation of the components. Any damage, shortfalls etc. shall be made good to the satisfaction of the EIC.~~

~~2.3. All grout for equipment shall be carried out using non shrinkable continuous grout materials with suitable frame work of at least 12 mm thickness. Surfaces to receive the grout shall be hacked and roughened and laitance shall be removed by wire brushing or blast of air. Concrete surface shall be blown off by compressed air before commencing grouting. Grouting shall be done in one continuous operation from one side such that grout flows in a single wave until grout reaches all confined spaces with no air pockets and air from all confined spaces is expelled. A hydro static head of 150 mm shall be maintained during grouting operations. All grouting shall be carried out in the presence of the EIC's representative. All lines and levels shall be checked up after grout is set. Block outs shall be closed using cement concrete of the same grade as that of the parent structure.~~

~~3. Records, Procedures and Reports~~

~~3.1. 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 report shall comprise 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.~~

~~3.2. All the above mentioned records shall be submitted in the final form duly countersigned by the EIC's representative attesting conformity to specifications and his approval of installation, and duly incorporating all the additions, alternations, and information as required by the EIC 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 EIC in six copies by the contractor on his notification of the mechanical completion of erection.~~

~~4. General Preparations before Completion of the Plant~~

~~4.1. The following documents should be completed in accordance with the contract schedule before completion of erection. The Employer and the contractor shall preserve and control these documents in a safe and appropriate place on Site in order the both parties' personnel can make use of them at any time.~~

~~4.1.1. Technical Documents~~

- ~~a) Operation and Maintenance Manuals~~
- ~~b) Design documents including the contractor's design data, drawings and specifications.~~
- ~~c) Tools and test equipment list~~
- ~~d) Spare parts list~~
- ~~e) Lubricant list~~

~~4.1.2. Procedures~~

- ~~a) Mechanical testing procedure~~
- ~~b) Electrical testing procedure~~
- ~~c) Instrumentation testing procedure~~
- ~~d) Detailed Pre-commissioning and commissioning procedure~~
- ~~e) Detailed Performance Test procedure~~

~~4.1.3. General and Coordination Documents~~

- ~~a) Detailed organisation charts for pre-commissioning and commissioning showing lines of authorities and responsibility and functions of all key personnel.~~
- ~~b) The job description of the members of the team.~~
- ~~c) The scheduled dates of assignment of each member to pre-commissioning and commissioning Organisation.~~
- ~~d) A detailed schedule showing the time sequence which the contractor anticipates to follow for the various steps in completion of erection, pre-commissioning and commissioning of each unit and equipment.~~
- ~~e) The regulations for safety, hygiene and discipline.~~
- ~~f) The practical organisation of the relationship (meetings, reports, etc.) between the contractor and the Employer at the phases of pre-commissioning and commissioning.~~
- ~~g) Emergency communication route.~~

~~4.2. Manpower~~

~~4.2.1. Required manpower shall be provided as agreed between the contractor and the Employer in a manpower mobilisation plan which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Employer for the plant.~~

~~5. Completion of Installation/Erection~~

~~5.1. 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:~~

- ~~5.1.1. Plant in the scope of the contract has been erected, installed and grouted as per specifications.~~
- ~~5.1.2. Installation checks are completed and approved by the EIC.~~
- ~~5.1.3. The erected plants are totally ready for commissioning checks.~~
- ~~5.2. At the stage of completion of erection, the contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre-commissioning checks.~~
- ~~5.3. Upon achieving the completion as described above the contractor shall notify the EIC by a written notice intimating completion of erection and notify the EIC for inspection. The EIC shall proceed with the inspection of such units within 14 days of such a notice.~~
- ~~5.3.1. The EIC shall certify completion when there are no defaults in the works or~~
- ~~5.3.2. The EIC 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 pre-commissioning activities and obtain the EIC's acceptance or approval of the same before proceeding with the same.~~
- ~~5.3.3. The EIC 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 Contractors to proceed with the pre-commissioning checks when the contractor undertakes to complete such outstanding works within an agreed time during defects liability period. Taking over shall be based on rectification of all deficiencies as advised by Punch lists.~~
- ~~5.4. The erection period indicated by the contractor would be deemed to cover all the activities up to completion as stipulated in previous paragraphs, notice of completion by the contractor, inspection by the EIC for completion and contractor rectification of all deficiencies as noticed by the deficiency/Punch list, and acceptance by the EIC of such rectification's prior to tests on completion.~~
- ~~5.5. Minor defects, which in the opinion of EIC which do not hamper operability and maintainability will not be taken into account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before tests on completion. However, the EIC's decision in this regard is final.~~
- ~~5.6. The commissioning period as notified by the contractor shall be deemed to occur beyond the date of completion and shall include all periods of pre-commissioning, trials and tests on completion.~~

~~5.7. It is in the contractor's interest to offer the sections/units/systems progressively under identified milestones within overall erection period, duly completed for rectification of any deficiencies pointed out by the Engineer and to achieve mechanical completion before undertaking the tests on completion within the specified erection period. The EIC also reserves the 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 EIC.~~

6. — Pre-Commissioning

~~6.1. After the completion of erection, pre commissioning activities listed below shall be carried out to make the plant ready for commissioning. All instruments, materials and provisions necessary for conducting site tests shall be provided by the contractor at his own cost.~~

~~6.2. Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the contractor's check list. The mechanical checks and tests shall be to establish that,~~

~~6.2.1. The Plant is erected in accordance with the contractor's construction drawings, pipe work drawings, instrument diagrams, etc. issued for the plant.~~

~~6.2.2. The materials are installed and mechanically function in accordance with the contract and~~

~~6.2.3. Applicable codes as listed in the contract are followed for materials and workmanship.~~

~~6.3. Items such as painting, thermal insulation and final clean-up which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after pre commissioning or commissioning at the discretion of the contractor but before acceptance.~~

~~6.4. The contractor shall prepare and maintain at site test forms and records which shall include:~~

~~6.4.1. Description of type of test or check~~

~~6.4.2. Date and times of test or check~~

~~6.4.3. Identification of equipment and facilities~~

~~6.4.4. Test pressure, test data and results, including remarks, if any~~

~~6.4.5. Signature of the contractor's personnel attesting to data recorded, if any, checks, tests and records thereof shall be carried out by the contractors' construction forces.~~

~~6.5. Wherever the Employer's witness or attesting of the check or test is required, the GWSSB's personnel shall attend such check and test. For this purpose, the contractor shall keep the~~

~~Employer informed of a day to day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test.~~

~~6.6. Any items found incomplete or requiring repair or adjustment shall be marked as such on the test records and then reported by the contractor to the GWSSB and the contractor's personnel in charge of the relevant construction area.~~

~~6.7. Checking procedures shall be repeated until all the items on the check list are cleared.~~

~~6.8. A complete set of test records shall be handed over to the Employer on completion.~~

~~6.9. The tests on the different mechanical and electrical equipment shall include but not limited to,~~

~~6.9.1. Pumps, Pipe work and Valves~~

~~a) 1.5 times the shut off pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapping etc. for carrying out these tests shall be included 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 performance. The vibration and noise levels shall be checked to be within the specified.~~

~~e) The pump shall be tested through the operating range as per BS 5316 Part I Class C / ISO 2548 with all working (excluding stand by) pumps at a time for all the pumps.~~

~~**However, no negative tolerance shall be permitted on the tested pump efficiency.**~~

~~6.9.2. Pump motors~~

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

~~6.9.3. Cranes~~

~~—— The crane and lifting tackle shall be tested to 125 % of the safe working load. The contractor shall arrange the test load. Deflection and speed tests shall also be conducted.~~

~~6.10. Instrumentation~~

~~—— The tests on the instrumentation equipment shall include but not be limited to:~~

~~a) All cables shall be tested for polarity, continuity and insulation resistance. The common mode dc voltage at each signal input terminal shall be measured and recorded.~~

- ~~b) The pre-commissioning tests on the various main categories of plant shall be as listed below:~~
- ~~c) The resistance of each electronic loop shall be measured.~~
- ~~d) Electronic equipment shall have been energised for at least 24 hours before testing begins.~~
- ~~e) The zero setting of each display instrument including any local indicator on or associated with a transmitter shall be checked.~~
- ~~f) The correct calibration of each item in each control or monitoring loop shall be checked by the introduction of appropriate signal at each source, at five cardinal points of the range for increasing and decreasing signals.~~

~~6.10.2. The following tests methods shall be used,~~

- ~~a) Pressure operated devices—dead weight testers or portable calibrators~~
- ~~b) Level operated devices—actual level variation or simulation thereof. Instrument zero reading shall be checked against a bench mark:~~
- ~~c) For controlling devices, the contractor shall demonstrate the correct operation of the loop including the regulating devices. Each automatic controller shall be set to the appropriate estimated values of the terms which shall be optimised during the plant start-up. Each control valve shall be checked during the plant start-up. Each control valve shall be checked by operation of the manual control on the associated controller and the correct stroking verified. Valve petitioners, electro-pneumatic converters and gauges shall be checked during these tests.~~
- ~~d) All systems shall be checked for “fail safe” operation.~~
- ~~e) Initiating devices not covered by the foregoing e.g. plant stop / start controls shall be checked in conjunction with the testing of the associated switchgear and machine.~~

~~6.10.3. The contractor shall also demonstrate the data transfer as per data transfer schedule between pumping stations.~~

~~7. Commissioning~~

~~7.1. After the completion of pre-commissioning activities the final checks and preparations necessary for start-up of the plant shall be carried out. The contractor shall submit to the Employer a written notice of mechanical completion which shall include:~~

~~7.1.1. Identity of a part of the plant considered mechanically complete,~~

~~7.1.2. A copy of all relevant completed test reports,~~

- ~~7.1.3. The date on which the completion of the tests was achieved,~~
- ~~7.1.4. Check list and~~
- ~~7.1.5. A request for issuance of a mechanical completion certificate in respect of that part.~~
- ~~7.2. Within fourteen (14) days from the date of receipt of the contractor's written notice, the Employer shall:~~
- ~~7.2.1. In the case of acceptance, issue a mechanical completion certificate.~~
- ~~7.2.2. In the case of objection, submit a rejection statement setting forth remaining items to be completed or defects or deficiencies to be corrected before mechanical completion status can be accepted. When GWSSB rejects the contractor's notice the contractor shall take any necessary action to complete or correct the items marked and give the GWSSB a second notice of mechanical completion.~~
- ~~7.3. After the issuance by the Employer of a mechanical completion certificate, commissioning activities listed below shall be carried out to enable the start up and operation of the plant. Procedures are described as below:~~
- ~~7.3.1. Commissioning Procedure shall be carried out in a methodical sequence as follows~~
- ~~a) — Warming up~~
 - ~~b) — Start up~~
 - ~~c) — Initial running~~
 - ~~d) — Operability adjustment~~
 - ~~e) — Stable operation~~
 - ~~f) — Final adjustment~~
- ~~7.3.2. At all stages of commissioning sequence, the plant shall be operated at optimum plant conditions. To ensure this, the contractor may make minor adjustment to the conditions indicated in the operation and maintenance manual as necessary.~~
- ~~7.3.3. The contractor shall check the operating conditions of the plant by constantly monitoring operating data.~~
- ~~7.3.4. The contractor shall specify for each discrete part of the plant the operational data to be recorded and the manner in which the data is to be taken.~~
- ~~7.3.5. All the operating data shall be recorded by the Employer on the forms to be mutually agreed. A copy of the operating log and analytical data from initial operation through to the completion of performance test shall be made available by the Employer to the contractor for _____ evaluation.~~

INSTALLATION, TESTING & COMMISSIONING
ELECTRICAL & PLC Based INSTRUMENTATION SYSTEM & EQUIPMENT
Equipment Installation, Testing & Commissioning

Installation of Equipment

General

- ~~a) In accordance with the specific installation instructions, as shown in contractor's drawings or as directed by the EIC's representative the contractor shall unload, erect, install, wire, test and place into commercial use of all electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square, and properly aligned and oriented.~~
- ~~b) The contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.~~
- ~~c) Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts.~~
- ~~d) The contractor shall erect and commission the equipment as per the instructions of the EIC representative and shall extend all cooperation to him.~~
- ~~e) In case of any doubt/misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the EIC's representative. The contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.~~
- ~~f) The contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The contractor shall make his own arrangement for lifting of equipment.~~
- ~~g) Where assemblies are supplied in more than one section, the contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/wires. The contractor shall also carry out the adjustments/alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or~~

~~bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the contractor at his own expenses.~~

- ~~h) The contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the EIC's representative.~~
- ~~i) Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS: 10028. All commissioning tests as applicable, vide Appendix B of IS: 10028 (Part II) shall be carried out.~~
- ~~j) Switchgear control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.~~
- ~~k) After installation of all power and control wiring, the contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear / panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the contractor who shall also make all necessary for proper functioning of the equipment.~~
- ~~l) Installation and testing of the battery and battery chargers shall be done in strict compliance with the applicable standards. Each cell shall be inspected for breakage and condition of cover seals as soon as received at site. The battery shall be set up on racks as soon as possible after receipt, utilising lifting devices. The cells shall not be lifted by the terminals. Contact surface of the battery terminals and inter cell connectors shall be cleaned, coated with protective grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with a hydrometer and thermometer and the results~~

~~logged. A freshening charge, if required, shall be added. When handed over to the Employer, the battery shall be fully charged and the electrolyte shall be at the full level and of the specified specific gravity.~~

~~m) Equipment furnished with finished coats of paint shall be touched up by the contractor if their surface is spoiled or marred while handling.~~

~~o) Foundation work and grouting in of fixing bolts or channels for all transformers, switchgear, motor control panels will be carried out by the contractor.~~

Distribution Transformers

~~Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS: 10028. All commissioning tests as applicable, vide Appendix B of IS: 10028 (Part II) shall be carried out. Fire Wall of 4 hour fire rating shall be provided between two transformers.~~

HV/LV Switchgear & control Panels

~~Switchgear control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.~~

~~Following minimum clearances shall be observed while finalizing the HV/ LV panel layouts,~~

~~a) — Minimum clearance of 1.0 meter shall be maintained from the rear of the panel to the nearest wall /structure.~~

~~b) — Minimum clearance of 2.0 meter between panels facing opposite to each other.~~

~~c) — Side clearance for LV panels shall be either $\leq 200\text{mm}$ or $\geq 800\text{ mm}$.~~

~~d) — For HV metal enclosed, indoor panels, Minimum 1 meter clearance from all sides & 1.5 meter in the front.~~

~~Emergency Exit doors shall be provided for electrical room, complying with the requirements of NBC 2005 latest edition.~~

~~After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgearpanels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the Contractor who shall also make all necessary arrangements for proper functioning of the equipment.~~

Installation and Maintenance of Flow Meters

General

~~This section covers the technical requirements for installation of electromagnetic flow meters and their operation and maintenance. The installation of these meters shall be done in the existing/new water supply system. A proper care should be taken at the time of installation to minimise the disturbance in the supply. From O & M point of view a proper protection and easy access to the meters should be ensured at the time of installation of these meters.~~

Installation Philosophy

~~The installation of EMF meters shall be preferably done in line, except in those cases where, due to site condition, in line installation is not feasible, the meters shall be installed on by pass line. All the installation above 150 mm size should be done with dismantling joint.~~

~~To ensure, during measurement the meters must remain completely filled with water, care should be taken to avoid locations where chances of partial flow are high, such as pipes laid on slopes. The meter should not be installed close to the strong electromagnetic fields such as close to power transformer.~~

~~The electrode axis of the meter should be in horizontal plane for horizontal pipe runs. Care should be taken to avoid installations of meters on the downstream of the control valves, 90° or 45° elbows or partially opened valves etc. to avoid cavitation/partial flow conditions.~~

~~A minimum of 5 x D, straight pipe up stream and a run of 3 x D pipe diameter downstream or as per the recommendations of the manufacture, whichever is on the higher side must be ensured for all the installation site to avoid turbulent flow profile at the meter location. The flow direction of the water should correspond to the direction shown by the arrow on the sensor.~~

~~Specials and Fittings~~

~~It is proposed to install the meters on the existing/new common discharge header of pipe material such as Mild steel (MS) etc. All the meters shall be installed using MS fittings only.~~

~~It is desirable and advantageous to prepare the assembly of meter and pipe fittings in advance which shall be inserted at pre selected location in the system to minimise disturbance of water supply and also to ensure high degree of workmanship and fast installation.~~

~~All the flange fittings shall be installed with a proper rubber gasket for water tight joints.~~

~~Electrical Installation~~

~~The signal converter shall be installed remotely and mounted on the panel board / wall of the pumping stations or any other suitable location directed by the engineer in charge. 5 ampere single phase AC connection shall be made available, for power supply to the signal converter and the sensor. All other necessary fixers including wiring with proper cable conduit, safety fuses and other items necessary for the installation of EMF shall be provided by the bidder to the satisfaction of the engineer in charge and no extra payment shall be made on this account.~~

~~GI pipes shall be used as a conduit for connecting cables between signal converter and the sensor. First few feet of the conduit must be run in flexible conduit near sensor terminal box and at the signal converter. The signal converter shall be fitted with face sealing cable glands. Only ½" NPT glands and double compression adapters may be used.~~

~~Only the specified signal cable recommended by the manufactures shall be fitted. The conduit entry shall be sealed to prevent moisture entering the terminal box via the conduit.~~

~~Proper grounding of flow meter with the help of grounding rings shall be ensured for proper electrical contact between flowing liquid and the ground.~~

Protection of Meter

~~The flow meters if buried underground shall be with proper protection of terminal box and signal cable. The bidder shall ensure protection of meter from damages due to overburden by providing pre cast cover slabs. The space between vertical walls shall be filled with coarse sand prior to placing the cover slab.~~

~~There is a possibility that at some site, installations shall be protected by constructing RCC chamber around the meter with pre cast cover slab and locking arrangement. In case, where meter can be installed inside pump house extra protection viz. RCC chamber shall not be required.~~

Laying of Meter Assembly

~~Cutting of pipes shall be necessary for laying and fixing of meter assembly if it is to be installed on the existing underground buried pipes, if any. For this purpose, a trench of sufficient width, depth and length shall be excavated for the underground pipelines. The existing pipe shall be cut and dismantled as per the requirement without damaging the extra length of the pipes. In case the extra length of pipe has been damaged by the bidder the cost of same shall be recovered from the bidder, equivalent to rates of current SOR.~~

~~Prior to lowering the meter assembly in the trench, the bottom of the trench shall be rammed and a sand bedding of 150 mm shall be prepared. The meter assembly shall fully rest on the firm and flat bed. After the installation, the trench shall be filled with excavated soil in layer with proper compaction to the entire satisfaction of the engineer in charge. The laying of extra pipe and fixing of meter assembly shall be done as per the relevant code of practice for laying and fixing of joints for respective pipe material.~~

Testing and Commissioning

~~On completion of the installation of the meter, bidder should field test (field verification) the EMF using validation tool for the following minimum verification routine to demonstrate the health of meter,~~

- ~~Auto logging of instrument data and setting (Diameter, field power and converter outputs)~~
- ~~Measurement of power/frequency~~
- ~~Check on impedance of coil~~
- ~~Check on converter linearity by simulation~~
- ~~Check on current outputs~~

~~The field tested meters shall be commissioned at the earliest without the loss of time. The bidder should submit a field validation certificate after completing the field testing stated above and duly signed by the engineer in charge to the concerned authority for asset transfer. The date of receipt of validation cum commissioning certificate shall be treated for commencement of warranty period.~~

~~Installation Work for Earthing and Lightning Protection System~~

- a) ~~The Contractor shall install copper/steel conductors, braids, etc. required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating, drilling, brazing/soldering/welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the contractor's scope of work. All incidental hardware and consumables such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, welding rods, anti-corrosive paint as required for the complete work shall be deemed to be included by the contractor as part of the installation work.~~
- b) ~~The quantities, sizes, material of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be as shown on the project drawings.~~
- c) ~~The work of embedment of earthing conductor in RCC floors/walls along with provision of earth plate inserts/pads/earth risers shall be done by the civil contractor when the floors are cast or during construction of walls. However, when required to do so in those areas where flooring will be done after the Contractor is at site, the Contractor shall coordinate with civil contractor and shall install the earthing conductors before the commencement of the concrete work. In such cases the contractor's scope of installation shall include laying the conductors in position with 50 mm concrete cover, making welded connections to~~

~~inserts/pads/risers above the floor near the equipment. The embedded conductors shall be connected to reinforcing rods wherever necessary.~~

- ~~d) If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Contractor where required, together with associated civil work such as excavation/chipping, concreting and surfacing, if not already done by the civil contractor. The concrete cover over the conductor shall not be less than 50 mm.~~
- ~~e) Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing/welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Back fill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilising pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the contractor shall arrange for suitable material from outside.~~
- ~~f) Installation of earth connection leads to equipment and risers on steel structures/walls shall include laying the conductors, welding/cleating at specified intervals, welding/brazing to the main earth grids risers, bolting at equipment terminals and coating welded/brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment/structure.~~
- ~~g) Electrodes shall be installed (a) directly in earth or (b) in constructed earth pits, and connected to main buried earth grid, The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe/rod/electrodes in test pits and connecting to main earth conductors.~~
- ~~h) Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening/cleating/welding of the down comers on the walls/columns of the building and connection to the test links to be provided above ground level.~~
- ~~i) Installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.~~

- ~~j) Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.~~
- ~~k) Suitable earth risers shall be provided above finished floor/ground level. If the equipment is not available at time of laying of the main earth conductors. The minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided will be marked in project drawings.~~
- ~~l) Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.~~
- ~~m) An earthing mat shall be provided under each operating handle of the isolator and operating mechanism of HV breakers. Operating handle of the isolator and supporting structure shall be bonded together by a flexible connection and connected to the earthing grid.~~
- ~~n) A separate earth electrode bed shall be provided adjacent to structure supporting lightning arrestors. Each connection shall be as short and as straight as practicable. For arrestors mounted near transformers, earth conductors shall be located clear off the tank and coolers.~~
- ~~o) Wherever earthing conductors pass through walls galvanized iron sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the contractor by suitable water proof compound.~~

Earthing Connections

- ~~a) All connections in the main earth conductors buried in earth/concrete and connection between main earthing conductor and earth leads shall be of welded type.~~
- ~~b) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.~~
- ~~c) All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.~~
- ~~d) Metallic conduits and pipes shall be connected to the earthing system.~~
- ~~e) Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also, no intermediate earthing connection shall be made to lightning arrester and transformer earthing leads which shall be directly connected to pipe electrode.~~

Earth Electrodes

- ~~Electrodes shall as far as practicable be embedded below permanent moisture level.~~
- ~~Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of pipe electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by contractor. The installation work shall also include civil work such as excavation and connection to main earth grid.~~
- ~~Earth pits shall be treated with salt and charcoal if average resistivity of soil is more than 20ohm metre.~~
- ~~Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Back fill shall be placed in layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the contractor shall arrange for a suitable soil from outside.~~

Lightning Protection System

- a) ~~The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during severe weather conditions. The necessary accessories such as cleats, clamps, welding materials, bolts, nuts, shall be supplied by contractor.~~
- b) ~~Air termination systems shall be connected to earthing system by down conductors as shown in project drawings. The down conductors shall follow a direct path to earth. There shall not be any sharp bends, turns and kinks in the down conductors.~~
- c) ~~All joints in the down conductors shall be of welded type. All metallic structure within 2 metres of down conductors shall be bonded to lightning protection system.~~
- d) ~~Every down conductor shall be provided with a 'test link' at about 1000 mm above ground level housed in a suitable GI enclosure made of adequate thickness steel sheet and hot dip galvanised. The test joint shall be directly connected to the earthing system electrode.~~
- e) ~~The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However, all metal projections, railings, vents, tanks, etc. above the roof shall be bonded together to form a part of roof grid.~~

~~INSTALLATION OF CABLE RACKS AND CABLE TRAYS~~

~~General~~

- ~~a) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.~~
- ~~b) Where embedded steel inserts in concrete floors/walls for welding the supports for cable racks/trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.~~
- ~~c) Cable shall be clamped to the cable trays at every 750 mm distance.~~
- ~~d) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.~~

~~Cable Trays~~

~~All the cable tray shall be hot dipped galvanized with minimum galvanization thickness as per mentioned in this specification.~~

- ~~a) Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1.25 mm for trays up to 100 mm width, not less than 1.5 mm for trays from 100 mm to 150 mm width and not less than 2.0 mm for trays from 150 mm to 300 mm width.~~
- ~~b) All the cable trays above 300 mm width shall be of ladder type with minimum thickness of 2.5 mm.~~
- ~~c) Cable tray for use in areas where chlorine gas may be present shall be constructed from U-PVC or GRP. Cable tray supports shall be of a compatible finish with the associated cable tray.~~
- ~~d) All cable trays tees, intersection units, bends, turns and sets shall be prefabricated (made by the manufacturer) and shall be of a matching design to the main section of cable tray.~~
- ~~e) Tray shall only be joined by couplers supplied by the manufacturers. The joint shall be secured in accordance with the manufacturer's instructions.~~
- ~~f) Cable tray supports supplied by a manufacturer or made up on Site shall have adequate strength to maintain rigid support to the fully laden cable tray along its~~

~~entire length and shall ensure that the deflection of any one section does not exceed 15 mm at mid span.~~

- ~~g) — Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, the bared ends or damaged section of the tray shall immediately be given a coat of zinc rich cold galvanized paint. All site manufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.~~
- ~~h) — All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Purchaser's Representative, together with proprietary nylon fasteners and/or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mm at mid span. All brackets and tray work shall be suitable for withstanding a temporary weigh of 125 kg.~~
- ~~i) — Cable trays shall not be cut to allow the passage of cables through the surfaces of the tray~~
- ~~j) — The sizing of the cable tray shall provide a minimum of 20% spare capacity.~~
- ~~k) — The tray shall be run at least 300 mm clear of plumbing and mechanical services.~~
- ~~l) — Bends in the installation shall take account of the minimum bending radii of cables to be installed.~~
- ~~m) — All the cable trays shall be supplied with cable tray supports (of adequate size) at no more than 1.2 Meter interval.~~
- ~~n) — Other cable tray details & cabling system shall be as per typical drawings attached with the specifications.~~

Cable Trunking — Metal

- ~~a) — Cable trunking shall be manufactured from mild steel of not less than 1.25 mm and shall be hot dipped galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50 mm x 50 mm minimum size.~~
- ~~b) — Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.~~
- ~~c) — The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the~~

~~self-retaining 'quick fix' type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.~~

- ~~d) Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.~~
- ~~e) Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.~~
- ~~f) Trunking shall be supported at intervals not greater than 2 meters horizontally or 2.5 meter vertically.~~
- ~~g) Crossings over expansion joints shall be made in flexible conduit.~~
- ~~h) Should it be necessary to cut or drill a section of trunking or a trunking fitting the bared ends shall immediately be given a coat of zinc rich cold galvanizing paint.~~
- ~~i) Cable and conduit/ trunking runs shall be determined by the Contractor and agreed by the Purchaser's Representative before any work is started. The run shall be at least 300 mm clear of plumbing and mechanical services.~~

~~Conduit/trunking systems erected outside a building shall be weatherproof.~~

~~CABLE INSTALLATION~~

~~General~~

- ~~a) Cable installation shall be in accordance with IS 1255: 2001 latest edition.~~
- ~~b) Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.~~
- ~~c) Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.~~
- ~~d) Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cable.~~

~~Table of Separation Distances in mm between different Categories of Cable~~

Cable Category	HV Power	LV Power	C&I/ Protection	Tele- communication
HV Power	N/A	300	600	600
LV Power	300	N/A	300	300
C&I/ Protection	600	300	N/A	200
Tele-communication	600	300	200	N/A

- e) ~~These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.~~
- f) ~~A distance of minimum 300mm shall be maintained between the cables to be laid on trays/conduits carrying low voltage AC and DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HV and LV signals.~~
- g) ~~In order to make economic use of the cable support system, cables shall be arranged in groups of 50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.~~
- h) ~~In order to make the most economic use of cable tray and duct capacity, multicore cabling shall be utilized in order to connect instrumentation groups by using suitably located sub distribution junction boxes. The junction boxes shall be suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labelled junction boxes shall be constructed of die cast Aluminium and provide degree of protection IP 65.~~
- i) ~~Instrumentation cables shall be continuous without any joints. Separate cables shall be used for digital and analogue signals at all times. Digital and analogue signals shall be segregated within junction boxes.~~
- j) ~~Cables shall be laid in a manner such that any electrical interference between cables shall not have a detrimental effect on the life and operation of Plant.~~
- k) ~~Where practical a separate cable support system shall be provided for power and non-power cables. Where this is not practical a separation as per indicated in above table shall be maintained between power and non-power cables when run on the same support system.~~

- ~~l) Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. FRP/GRP cable support systems shall be used in areas used for the storage and handling of chlorine. These systems shall be used to route cables around walls and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made in sizing the cables.~~

~~Laying of Cables~~

- ~~a) Each instrumentation and power supply cable shall be terminated to individual panel/terminal box.~~
- ~~b) Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by Contractor.~~
- ~~c) Cables shall be laid in accordance with layout drawings and cable schedule which shall be prepared by Contractor and submitted for approval.~~
- ~~d) All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end.~~
- ~~e) Various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables.~~
- ~~f) A loop of 1.0 meter shall be left near each field instrument before terminating the cable.~~
- ~~g) Cables shall be complete uncut lengths from one termination to the other.~~
- ~~h) Separate cables shall be used for digital and analogue signals.~~
- ~~i) All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedules.~~
- ~~j) Identification tags shall be securely fastened to the cables at both the ends.~~
- ~~k) Cable shall be rigidly supported on structural steel and masonry, using individually cast or malleable iron galvanized clips, multiple cable supports or cable trays.~~
- ~~l) The Contractor shall take the actual measurement of the cables and the associated accessories such as cable trays, conduits etc. required at site, prior to the placement of order on the cables.~~

~~Cables Laid Direct in Ground~~

- ~~a) Buried cable up to 1.1 KV shall have a laid at a minimum depth of 750 mm measured from FGL to the top of the highest cable. On crossing roadways the cable shall be run through a PVC-U duct of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.~~
- ~~b) Cables of greater than 1.1 KV shall be buried at a minimum depth of 1 meter.~~
- ~~c) The bottom of the cable trench shall be freed of sharp stones and such like and 75 mm of sieved sand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable. For HV cables sand bedding shall be of 150 mm & cables shall be covered with half round Hume pipes of twice the diameter of cable.~~
- ~~d) Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked 'Danger Electric Cable' in English and the vernacular shall be laid on top of the sieved sand. Covers shall extend the whole length of the cable trench and shall overlap cables by a minimum of 50 mm.~~
- ~~e) Warning tape shall be laid a minimum of 200 mm above the protective covers.~~
- ~~f) Cables are to be installed without tees or through joints unless otherwise approved by the Purchaser's Representative. Single core cables shall be run in trefoil formation.~~

~~Cables Laid in Underground Ducts~~

- ~~a) Underground ducts shall be constructed of impact resistant PVC-U and laid at a minimum depth of 750 mm, ducts shall be surrounded by at least 75 mm of sieved sand except at road crossings where it shall be 1.0 meters deep and encased on all sides by 150 mm of concrete.~~
- ~~b) The Contractor shall ensure that sufficient draw in points have been provided and that adequate room has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.~~
- ~~c) Where cables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the EIC's Representative. The stopper shall have a fire resistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated. However, for two different trefoil formations, they shall be laid in separate ducts.~~

~~Cables installed in Conduit~~

- ~~a) Conduits shall be galvanized heavy gauge solid drawn or welded screwed steel type and be in accordance with IS 9537, Part 2 or BS 4568. Accessories shall either be malleable cast iron screwed type or pressed steel and galvanized.~~
- ~~b) A space factor of 40% shall not be exceeded, but in any case, conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing shall be properly reamed with all sharp edges removed before erection.~~
- ~~c) Where a number of conduits converge, malleable cast iron or heavy gauge sheet steel adaptable boxes shall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.~~
- ~~d) Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and/ or fittings are attached to equipment casings, the material or case of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings shall be used.~~
- ~~e) Heavy hexagonal lock nuts shall be used at all positions where running joints are required and care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or other adjacent accessories. All junction boxes, draw in boxes, and inspection fittings, shall be so placed that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.~~
- ~~f) Generally, not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the GWSSB.~~
- ~~g) Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.~~
- ~~h) Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.~~

Surface Installation

- a) ~~Surface conduits shall be secured and fixed by means of distance spacing saddles or approved purpose made clips at every 500mm, which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. All surface conduit runs shall be marked out for approval by the GWSSB before the installation is carried out. Where large multiple parallel conduit runs would occur, use may be made of galvanized cable trunking. Conduits installed on structural steelwork shall be secured at spacing not exceeding those for surface conduit by girder clips, otherwise fixing shall be as for surface conduits on walls, drilled and tapped to the metalwork. Power driven fixings shall only be used with the express permission of the GWSSB. Any drilling or access which is required through any structural member of the building shall be agreed with the GWSSB/EIC before carrying out the work.~~
- b) ~~Exposed threads and places where galvanizing has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc-based paint. This treatment shall be applied as the work proceeds.~~

Concealed Installation

- a) ~~Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crumpets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.~~
- b) ~~At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.~~
- c) ~~Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.~~

- d) ~~The conduit installation shall be inspected by the EIC's Representative before the building operation conceals the work.~~

~~Cable Installed in Flexible Conduit~~

- a) ~~Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.~~
- b) ~~Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a through type box and the flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment by properly designed earthing screws. The use of lid facing screws, etc., will not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.~~

~~Cable Clipped Direct~~

- a) ~~All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed. Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.~~

~~Cable Installed in Internal Floor Trench~~

- a) ~~In shallow trenches (maximum depth 500 mm)~~
- b) ~~In shallow trenches used for electrical services only, cables may be laid in a neat and orderly manner on the floor of the trench. One layer only shall be allowed. Additional cables shall be installed on the walls of the trench in an acceptable manner & such a way that, in no case the distance between two different types of cable shall not be less than the separation distance tabulated above.~~
- c) ~~Where the trench is shared by other services, cables shall be installed on the walls of the trench in an acceptable manner & such a way that, minimum separation distance of 300mm shall be maintained.~~
- d) ~~All other trenches including walk through service ducts~~

- e) ~~Cable trenches & cable installation shall be in accordance with the attached typical cabling system drawings.~~
- f) ~~Where other services are present the cables shall be segregated from them by separation distances as mentioned above and wherever possible kept above 'cold' wet services. Cables should not be run if at all possible, above or in close proximity to 'hot' services.~~
- g) ~~The cabling shall be installed in such a manner as to allow access to the other services for normal maintenance without disturbance of the electrical installation~~

Cable Terminations and Joints

a) ~~Power Cable Terminations~~

- i. ~~Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors.~~
- ii. ~~Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.~~
- iii. ~~Each cable entry into a terminating box shall be made through a suitable gland, which shall have provision for securing the armour where applicable. Where single core glands are required these shall be of the non-magnetic type and the associated box bottom plate, where the core passes through, shall not have a continuous magnetic path.~~
- iv. ~~Adequate provision shall be made to bond the cable armouring to the box and/or switchgear casing of a suitable size to withstand the prospective short circuit fault current of the system, glands shall be fitted with earth bonding tags where intimate screwed contact between gland and cable box is not possible.~~
- v. ~~Where cable glands are exposed to the weather these shall be protected by heat shrink plastic sleeve or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.~~
- vi. ~~Where terminations of multicore type have to be made on to items of Plant which have to be dismantled for maintenance, these shall be made off through glands into an adaptable box containing terminals and flexible single cores taken into the equipment via flexible waterproof plastic covered conduit, and a separate earth core linking the box to the equipment.~~
- vii. ~~Where single core cables are glanded to or pass through cabling plates the gland~~

~~plate or cabling plate shall be constructed of non-magnetic material.~~

~~b) Power Cable Joints~~

- ~~i. Through joints shall only be allowed with the approval of the GWSSB. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shall preferably be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Purchaser/ Purchaser's Representative prior to filling the box with compound. Wrapped pressure type joints will not be accepted.~~

~~c) Multi-core or Control Cable Terminations~~

- ~~i. A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.~~
- ~~ii. Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.~~
- ~~iii. Terminals which remain energized when the main equipment is isolated shall be suitably screened and labelled.~~
- ~~iv. Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labelled.~~

~~Cable Fixings~~

- ~~a) Ties and strapping shall be suitable for securing cable and cable groups to cable tray or ladder. They shall be resistant to chemical and marine corrosion. Plastic coated metal ties used in order to obtain corrosion resistance shall not be acceptable. Nylon ties shall be resistant to the effects of ultra-violet light and shall be self-extinguishing.~~
- ~~b) Large single cables shall be secured with cable clamps or cable cleats.~~

~~Cable Identification~~

~~At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of PVC and shall be indelibly marked to the approval of the GWSSB. The label shall be retained using~~

~~proprietary nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.~~

~~—— Marking Locations of Underground Cables~~

- ~~a) The location of all underground cables shall be engraved on brass or other non-corrodible plates to be fixed to the exterior surface of all walls of buildings 300 mm above ground level and directly above the point where cables pass through the wall.~~
- ~~b) Cable route markers as per the attached drawing shall be installed at an interval not more than 30 meter & at bending/ road crossings the interval shall be at every 10meter.~~
- ~~c) The minimum depth for laying of underground cable route markers shall be as per indicated in the typical drawings attached with this tender.~~

~~—— Additional Requirements for Cable Installations~~

- ~~a) The Contractor shall install, test and commission the cables specified in the specification. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per drawings, which are to be prepared by Contractor & approved by GWSSB. Contractor's scope of work includes unloading, laying, fixing, jointing, bending, and termination of the cables & all related accessories. The Contractor shall also supply the necessary materials and equipment required for jointing and termination or the cables.~~
- ~~b) All apparatus, connections and cable work shall be designed and arranged to minimize risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor.~~
- ~~c) Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Contractor shall check the pull required and suspend pulling until further procedure has been approved by the Engineer's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress~~

~~or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.~~

- ~~d) After pulling the cable, the Contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags shall further be attached at 10 meter intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.~~
- ~~e) Sharp bending and kinking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified below:
 - ~~i. 11 KV, XLPE insulated, multicore : 15 times the overall Dia. of the cable armoured cables~~
 - ~~ii. 1.1 KV, XLPE insulated, multicore : 12 times the overall Dia. of the cable armoured cables~~
 - ~~iii. (If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Engineer in charge)~~~~
- ~~f) Power, control and instrumentation cables shall be laid in separate cable racks/ trays.~~
- ~~g) Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.~~
- ~~h) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at no less than one meter depth.~~
- ~~i) Cables laid in ground shall be laid on a 75 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation~~

~~wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 75 mm in the centre and tapering towards the sides of the trench.~~

- ~~j) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.~~
- ~~k) Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directly into cantilevered cable trays where practicable, but in some cases, it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.~~
- ~~l) Cable splices will not be permitted except where permitted by the GWSSB. Splices shall be made by Contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturers' and the EIC. Before splicing, insulated cables shall have conductor insulation stepped and bound or pencilled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.~~
- ~~m) Jointing of cables shall be in accordance with relevant Indian Standards Codes of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the Contractor. Cables shall be firmly clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.~~
- ~~n) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialized in this class of work.~~
- ~~o) Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the GWSSB for the various control circuit, by code marked wiring diagram.~~

- ~~p) When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.~~
- ~~q) Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the GWSSB. Before joining is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.~~
- ~~r) After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/ tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings.~~
- ~~s) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current~~

Lighting System Installation

This covers the requirements of installation of the following

a)	Lighting fixtures complete with lamps and accessories
b)	Main Lighting distribution board
c)	Lighting panels
d)	Receptacles and lighting control switches
e)	Point wiring
f)	HPSV lighting system
g)	Multi core cables for street and boundary lighting
h)	Maintaining equipment/materials during storage and being responsible for the equipment/material until they are handed over to Employer.

i)	Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.
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Applicable Standards

a)	Electrical wiring installations (system voltage exceeding 650 V)	IS: 732
b)	Code for practice for interior illumination (Part 1)	IS: 3646/BS: 8206
c)	Code of practice for street lighting installation	IS: 1944
d)	Code of practice for industrial lighting	IS: 6666
e)	Code of practice for fire safety of building	IS: 1646
f)	Boxes for enclosure of electrical accessories	IS: 5133 (Part 1)
g)	Guide for safety procedures and practices in electrical work	IS: 5216
h)	Ceiling roses	IS: 371

Lighting Fixtures

- a) ~~The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings. The unit rates quoted for installation shall include all materials required to mount the fixtures. Hooks in RC slabs for suspension of high bay fixtures shall be provided wherever not already provided. Cost of supply and installation of such hooks shall be included in the cost of installation of lighting fixtures. Unit rate for installation of lighting fixtures shall include cost of installation of control gear box wherever applicable.~~
- b) ~~Installation of receptacles and switches shall be carried out suitably. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the unit rates quoted for installation of receptacles/ switches.~~
- c) ~~Lighting distribution boards shall be installed at the suitable location. Installation rates quoted for installation of lighting distribution boards shall include supply and installation of base channels, foundation bolts etc.~~
- d) ~~Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000 mm (minimum) above the grade level. Cost of construction of~~

~~concrete plinth shall be included in the unit rates quoted for installation of outdoor lighting distribution board. No cement and steel will be supplied by GWSSB. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.~~

Point Wiring

~~Wiring of lighting fixtures shall be on point wiring basis. Two types of point wiring have been envisaged viz. primary point wiring and secondary point wiring. Bidder shall quote primary point and secondary point wiring rates for each building/area specified, on the basis of lighting layout drawings prepared by the contractor.~~

~~Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches of receptacle units.~~

Primary Point Wiring

~~Primary point wiring covers the wiring between circuits of the lighting panel to the junction box of the first lighting fixture/receptacle unit and between junction boxes of the subsequent lighting fixture connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/receptacle unit in that circuit.~~

Secondary Point Wiring

~~Secondary point wiring covers the wiring of the remaining lighting fixtures/receptacle unit other than that covered under primary point of that circuit in the lighting panel.~~

~~Secondary point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches and control switches of receptacle units.~~

Point Wiring for HPSV/LED Lighting

Primary Point Wiring

~~Primary point wiring covers the wiring between the lighting distribution board and the junction box of the first lighting pole or flood light tower and between the junction boxes of the subsequent lighting poles or flood light towers connected to a circuit in the lighting distribution board.~~

Secondary Point Wiring

~~Secondary point wiring covers the wiring between the junction box and the lighting fixture on the pole in case of street light and between junction box mounted near the~~

~~base of the tower and all subsequent junction boxes mounted on that tower and also between junction box and the flood light fixture. The above refers to the remaining fixtures covered under the circuit referred under primary point wiring. Secondary point also covers the wiring of the associated control fuses, switches, looping of terminals, etc. as required.~~

~~Supply and Installation of Conduit Point Wiring~~

- ~~a) The point wiring shall include supply of necessary materials for the conduit wiring such as galvanised rigid steel conduit, galvanised MS fixing saddles with spacer plates, nylon/ fibre fixing plugs, galvanised MS fixing screws, 12 SWG galvanised steel earthing wire, PVC insulated copper or aluminium conductor wires, control switches and pulling, termination of the earthing/PVC insulated wires as required, installation of control switches, drilling holes in brick walls/RCC roof slabs for taking the wiring conduits and refinishing and any other works/material necessary for making point wiring complete in all respects.~~
- ~~b) Wires used for conduit point wiring of lighting fixtures/ceiling fans, 5 A receptacles and receptacles above 15 A shall be 1100 V grade, PVC insulated, single core, stranded copper conductor wires of sizes not less than 1.5 sq. mm and 2.5 sq. mm respectively. Wires shall conform to IS: 694 and shall bear the ISI mark.~~
- ~~c) Bidder shall take into consideration necessary galvanised MS fixing clamps when the wiring conduits are to be supported from steel roof truss/structural members.~~

~~Supply and Installation of Cable Point Wiring~~

- ~~a) The point wiring shall include supply of necessary materials for the cable wiring such as 1100 V grade multi core, stranded aluminium conductor, PVC insulated, armoured cables of sizes 4 sq. mm and 6 sq. mm for wiring of lighting and receptacles in buildings and outdoor areas, where cable wiring is specified, conforming to IS: 1554, galvanised MS fixing saddles with spacing plates, junction boxes, nylon/fibre fixing plug galvanised MS fixing screws, control switches and installation/termination of cables including supply of cable glands as required, installation of control switches, junction boxes, drilling holes in brick walls/RCC roof and grouting necessary conduit sleeves for taking the cables and any other work materials necessary for making the point wiring complete in all respects.~~

- ~~b) Bidder shall take into consideration necessary galvanized MS fixing clamps when the wiring cables are to be cleated along steel roof trusses/structural members.~~
- ~~c) Bidder shall take into consideration any specific material finish, other than galvanising, such as corrosion resistant, epoxy painting or chlorinated rubber painting of all the installation accessories as called for in the relevant lighting layout drawings.~~

~~Supply & Installation of Point Wiring for Street and Flood Lighting~~

~~Work includes supply and installation of cables required between LDB and junction box mounted on street lighting pole/flood lighting tower and also between junction box mounted on flood light tower to metal enclosed control gear box located near flood light fixture, supply and installation of all the termination accessories such as crimping type cable lugs and double compression cable glands at each junction box and fixture, termination, testing and commissioning of cables. Contractor's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of HDPE pipes for road crossing etc. supply and installation of necessary cleating arrangement for cabling on flood light tower, supply of labour, supervision, welding equipment, all tools and tackles and testing equipment as required. Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary the same shall be provided by the contractor and a joint marker shall also be provided without any extra cost. Earthing of street light pole/flood light tower, lighting fixtures, etc. are included under point wiring.~~

~~Point wiring rates shall also include/hold good for the following~~

~~Supply and installation of lighting control switches and switch boxes complete with fixing accessories.~~

~~Drilling holes in brick/RCC wall and roof for taking cable or conduit, sealing and refinishing with cement plaster.~~

~~Testing, commissioning and handing over the lighting system in commercial working condition.~~

~~— Marginal shifting of any fixture/accessory from the location indicated in the lighting~~

~~— Layout drawings.~~

~~Outdoor Lighting (Street and Flood Lighting)~~

- ~~The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.~~
- ~~Installation of multi core/single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.~~
- ~~Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination, testing and commissioning of cables.~~
- ~~Contractor's scope shall also include excavation and preparation for buried cables. Supply and installation of route markers, supply and installation of HDPE pipes for road crossing shall also be included in the scope of installation of point wiring.~~
- ~~Supply and installation of necessary cleating arrangement for cabling on flood light poles.~~
- ~~Contractor shall provide necessary foundation for erecting street light pole / flood light tower and install the same. Contractor shall prepare foundation drawings with necessary details to EIC for approval.~~
- ~~Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the contractor and joint marker shall also be provided without any extra cost.~~
- ~~Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation of point wiring. Contractor shall earth street light pole/flood light poles and junction box with 25 x 3 mm GI strip / flat tap off from the 25 x 3 mm MS flat earthing grid along the street lighting included in scope. The contractor shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate pole.~~
- ~~Installation of lighting brackets for switchyard area Outdoor Lighting Work includes supply and installation of HPSV light brackets etc. including associated junction boxes with fuses, links and terminals for junction boxes and junction boxes near each flood light fixtures.~~

- ~~Installation of Lighting Distribution Board, Lighting Panels (AC), 240 V, AC Single Phase Distribution Boards~~
- ~~Installation of above items shall include necessary foundation channels, bolts/nuts etc. for grouting lighting distribution boards, iron brackets/grouting brackets, bolts/nuts for wall/ column mounted panels and associated civil works.~~

Work Requirement

~~Details of work requirements are covered in lighting installation notes and details and typical drawings which form the part of specification. Any changes if necessary due to site conditions/requirements shall be carried out after obtaining approval of EIC. The changes carried out shall be marked clearly in the layout drawings by contractor and 'AS BUILT DRAWING' shall be prepared by the 'contractor' and this shall be forwarded to EIC's office.~~

Wiring

~~Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Exposed wiring when run along wall shall be as near the ceiling as possible. Where cable wiring is specified cable shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.~~

~~Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.~~

~~Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wire the following colour wires shall be used.~~

i	R Phase	Red
ii	Y Phase	Yellow
iii	B Phase	Blue
iv	Neutral	Black

- ~~There shall be a circuit breaker or a linked switch on each live conductor of supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in neutral wire in the form of switch or fuse unit.~~
- ~~Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.~~
- ~~Receptacles and lighting fittings in general shall be fed from different circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.~~
- ~~Each final sub-circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.~~
- ~~For long conduit wiring runs, inspection/pull boxes shall be provided at intervals not exceeding 10 m. Such facilities shall also be provided at conduit bends.~~

General Practices

- ~~All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.~~
- ~~Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts a ceiling rose or any similar attachment shall not be used.~~
- ~~A socket outlet shall not embody fuse terminals as integral part of it. The switch controlling the socket outlet shall be on the live side of the line.~~
- ~~All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.~~

Earthing

- ~~Conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints.~~
- ~~Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.~~
- ~~For outdoor lighting poles the earthing conductor shall be terminated up to the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting.~~

INSTALLATION OF OUTDOOR SWITCHYARD EQUIPMENT

HV Circuit Breaker

- ~~The outdoor HV shall be transported to the erection site in dismantled condition. The contractor shall check, clean and assemble all the different units as per manufacturer's instructions. The three poles of the circuit breaker shall be erected on the base steel structures, previously installed and levelled by the contractor. The operation mechanism shall be installed on a steel structure pedestal to be provided by some other agency and connected to the three poles of the circuit breaker. The breaker shall be operated slowly to the closed position and all adjustments carried out as per manufacturers' instructions. The poles and operating mechanism shall be accurately positioned so as to cause no undue strain on the terminals. Each pole of the breaker and operating mechanism shall be earthed.~~

HV Isolators (if any)

- ~~The isolators shall be transported to site in the dismantled condition. All the insulators will be also supplied loose. The contractor shall inspect, clean, assemble and install the isolator on the base structure previously fabricated, erected and levelled by him. The operating mechanism shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position and carrying out the necessary adjustment as per the manufacturer's instructions. The earthing switches, frames and operating handles etc. shall be earthed. Arcing horns shall be adjusted to the recommended gap setting, if provided.~~

Lightning Arrestor

- ~~The lightning arresters shall be transported to site. The contractor shall check, clean, assemble and install these on the base structure previously fabricated installed and levelled by him. The phase to phase clearance between three units shall be accurately adjusted so as to cause no strain on the terminals. Surge counters and other accessories shall be properly installed as per the recommendation.~~

Switchyard Fencing

~~All materials for fencing of the switch yard including double leaf hinged gate with all hardware including civil work shall be supplied and installed by the contractor.~~

Galvanised Steel Structure

~~All steel structures shall be fabricated from steel conforming to IS: 2026 and each section shall be hot dip galvanised after fabrication. Hot dip galvanising of steel structures shall~~

~~confirm to IS: 728 and galvanising of each section shall be done in one complete impression. All bolts, nuts and washers shall be hot dip galvanised and shall comply with the requirements in section 3.5 of IS: 800 / 1962. EIC shall have a right to insist on re-galvanising at the contractor's cost of any such batch of steel work found not confirming to specification and showing non uniformity, roughness and acid spots. Prefabricated galvanised steel structures shall be installed and levelled as per requisite drawings.~~

Commissioning

~~All checks and tests shall be as per the Manufacturer's drawings manuals, relevant codes of installation and commissioning check lists as given below:~~

- ~~• Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards/International Standards. All tests to be carried out in the presence of EIC's representative.~~

~~For Transformers~~

- ~~• Dielectric strength of transformer oil, operation of all protective equipment, voltage/turns ratio at all taps, winding resistance at all taps, vector group test, phase sequence test, Buchholz relay operation (alarm and trip) (if any), OLTC control indicating and alarm circuits (if any), lightning arrester installation, test the bushing oil for dielectric strength.~~

~~For Switchgear~~

- ~~• Power frequency high voltage test, operation tests.~~

~~For Relays~~

- ~~• Check internal wiring, relay settings.~~

~~Satisfactory operation over their whole operating range by secondary injection. Check minimum pick up voltage of DC coils, megger all terminals to body and AC to DC terminals.~~

~~Circuit breakers~~

~~Manual operation of breakers, power closing/opening operation manually and electrically, breaker closing and tripping time, trip free and anti-pumping operation, control wiring for correctness of connections, continuity and IR value, electrical and mechanical interlocks, all functional checks, checks on CTS, checks on spring charging motor.~~

Battery

- ~~Special gravity test, cell voltage check, capacity test as per IS, Initial charging cycle.~~

Battery charger & DC Distribution board

- ~~Functional check of auxiliary devices such as alarms, indicating etc. measurement of voltage regulation.~~

Isolators

- ~~Manual and electrical operation and interlocks, earth connection of structures and operating handle, clearance in open and closed position.~~

Voltage transformers

- ~~Polarity test, ratio test on all cores, oil level and leakages, 'Insulation resistance test', earthing connection.~~

Current Transformer

- ~~Megger between windings and winding terminal to body, polarity test, capacitance and tan delta test.~~

Cables

- ~~All new cables shall be megger tested before terminating/jointing. After terminating/jointing is completed of LV (i.e. 650/1100V) cable shall be megger tested by 1000V megger. All HV Cables (i.e. 6.6 KV) shall be megger tested by 2500 V motor operated megger and hipot.~~

Cable core shall be tested for

- ~~–Continuity~~
- ~~–Absence of cross phasing~~
- ~~–Insulation resistance to earth~~
- ~~–Insulation resistance between conductors~~

Earthing and Lightning Protection System

- ~~The Contractor shall ensure the continuity of all conductors and joints. The Employer may ask for earth continuity tests earth resistance measurements and other tests which in his opinion are necessary to prove that the system is in accordance with design, specification and code of practice and electricity rules. Earth resistance value should be not greater than one (1) ohm.~~

Lighting System

- ~~Before putting complete system into service, commissioning tests stipulated in applicable standards and code of practice shall be carried out by the Contractor in the presence of the Engineer's Representatives covering all lighting system equipment.~~
- ~~The Contractor shall carry out insulation resistance tests by megger of following rating~~
~~Control circuits up to 220 V — 500 V megger~~
~~Power circuits up to 6.6 KV — 1000 V megger~~

~~INSTRUMENTATION, CONTROL & AUTOMATION SYSTEM~~

~~General~~

- ~~Instrumentation, Control & Automation installation shall be in accordance with manufacturer's recommendation, approved drawings and best engineering practices. A Centralized Control Room (CCR) shall be provided to house PLC based control equipment.~~
- ~~The test equipment, meters, instruments etc. used for testing shall be calibrated at recognized test laboratory at regular intervals and valid certificates shall be made available to the Purchaser at the time of testing. The calibrating instruments used as standards shall be traceable to international standards. Calibration certificates for test instruments shall be produced from a recognized laboratory for the Purchasers consent in advance of testing and if necessary, the instruments shall be recalibrated or substituted before the commencement of the test.~~

~~Commissioning/Site Acceptance Test~~

- ~~At site, the system shall be properly installed taking care of manufacturer's recommendation, after which Site Acceptance Tests (SAT) shall be carried out taking into the actual field instruments/equipment in the loops.~~
- ~~The Site Acceptance Test shall be held at site after the system has been installed as per the finalized SAT procedures. The tests shall be witnessed by Purchaser.~~
- ~~The minimum tests to be carried out shall be as indicated in table below.~~
- ~~A log of all failed/mal operating components/modules in a sub-system shall be maintained by Contractor, with description of the affected components/modules, cause of failure, effect of failure on the sub system and number of hours of operation before it failed. This will start from the date of powering 'ON' of the system for cold commissioning.~~

Test & Acceptance Criteria

Following tests shall be performed as a minimum for automation system, during both FAT & SAT, in presence of authorized representatives and documented test results shall be compiled.

Sr. No.	Description of Test	FAT	SAT
1.	Check of supply completeness	✓	✓
2.	Visual & dimensional check	✓	✓
3.	Check of complete system configuration loading	✓	-
5.	Check of system diagnostic features. These shall include failure of any sub-system, module, power supply, interface unit, failure of transfer to redundant module on main module failure etc.	✓	✓
5.	Power off and power on of any single unit	✓	✓
6.	Test of alarm system	✓	✓
7.	Check of correct functionality of keyboards	✓	✓
8.	Testing of proper working of the printers	✓	✓
9.	Simulation of power failure and restart. Self booting up of system configuration & program after power restoration.	✓	✓
10.	Analogue/digital input/output check	✓	✓
11.	Check of scan time for PLC	✓	✓
12.	Check of scan time, screen update time and loop cycle time.	✓	✓
13.	Check of loop configuration for correct entry of ranges, limits etc.	✓	S
15.	Check of HMI displays (all kind of displays)	✓	S
15.	Checking of HMI screen refresh rate, data base update and display call up time.	✓	S
16.	Check of system internal loading (processor, communication system etc.)	✓	-
17.	Check of various log formats, shutdown reports etc.	✓	S

18.	Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/deletion of a rung or an element in a rung generation of dynamic graphics and other views, report generation etc.	✓	✓
19.	100% checking of logic configured in the PLC by connecting switch/lamp at input/output.	✓	-
20.	Checking of output status on processor failure for PLC & checking of first out alarm generation.	✓	✓

~~FAT= Factory Acceptance Test; to be performed at Contractor's workshop. SAT= Site Acceptance Test; to be performed at site. ✓ = Complete test; 100% of devices/functionality will be tested. S = Sample test All the necessary simulation kits as may be required for testing of software shall be arranged. Acceptance of any equipment or the exemption of inspection shall in no way absolve the Contractor of the responsibility for delivering the equipment meeting the entire requirement specified in this specification and also as may be required for satisfactory operation of the process.~~

Acceptance Criteria

~~Automation system shall be suitable to meet the below minimum acceptance criteria, which are to be demonstrated by the successful tenderer during testing of the system.~~

Sr. No.	Description of	Criteria
1	Availability of Automation System	99.8% (calculated over a period of seven (7) working days)
2	HMI screen refresh time	1 sec
3	I/O scan time/ data up gradation time	250 millisec for analog signals 100 millisec for digital signals Priority processing shall be provided for the data requiring faster scan rate.
5	Network bandwidth utilization (Average of 5 minutes to be measured over continuous period of 8 hours)	< 10%

5	Spare (free) memory capacity available (for system, server & PCs, PLC controller)	50% (after commissioning)
6	Spare I/O capacity of each type at each location, spare ports of networking switches	20% (after commissioning)

**PRE-COMMISSIONING TESTS ON ELECTRICAL SYSTEM EQUIPMENT TO BE CARRIED OUT AFTER
ERECTION**

List of Electrical System Equipment

- 01 — Switchyard bus, shielding and grounding.
- 02 — Lightning arrester
- 03 — Isolator
- 04 — Insulator
- 05 — Power Distribution Transformer
- 06 — HV Switchgear Panels
- 07 — LV Switchgear panels, motor control centre & APFC Panels.
- 08 — HV / LV Cable
- 09 — Control panels for miscellaneous equipment
 - i. — Earthing system
 - ii. — Safety Procedure and Practice

TECHNICAL SPECIFICATIONS FOR PRE-COMMISSION TESTS

~~Switchyard Bus, Shielding and Grounding~~

~~1. Insulation resistance test between each phase and earth and between phases. All transformer terminals, CT-PT connections and lightning arresters disconnected using 5000 V motorised megger~~

~~2. Thermography, if arranged by customer.~~

~~This is done after switchyard is charges and loaded. Scan all bus sections, insulators, droppers and joints with an AGA Thermo vision Camera and find out hot spot if any.~~

~~Defects noticed in the hot spot locations are to be rectified on priority basis.~~

~~Lightning Arrester~~

~~1. IR Values~~

~~2. Thermography, if arranged by customer~~

~~Isolator~~

~~1. IR Values~~

~~2. Contact resistance measurement by milli-volt drop test method~~

~~3. Manual Closing and Opening~~

~~4. Drive motor operation for closing and opening in Local and Remote position~~

~~5. Mechanical interlock between isolator and earth switch~~

~~6. Electrical interlock between isolator, earth switch and circuit breaker~~

~~Insulator~~

~~1. IR Values of insulator~~

~~2. Thermography similar to item 1. If arranged by customer~~

~~Circuit Breaker (6.6 KV If any)~~

1. ~~Mechanical charging closing tripping of breaker~~
2. ~~Electrical charging closing tripping of breaker~~
3. ~~Tripping of breaker through protective relays and trip circuit healthiness~~
4. ~~Mechanical interlocks of breaker~~
5. ~~Closing and opening time measurement of each pole~~
6. ~~Contact resistance of measurement of each pole~~
7. ~~IR Values~~
8. ~~Operation of breaker auxiliary switches~~
9. ~~Electrical closing at 85% of rated control voltage~~
10. ~~Electrical tripping at 70% of rated control voltage~~
11. ~~Space heater and illumination circuits of cubicle~~
12. ~~Anti-pumping device operation~~
13. ~~Control circuit and operational tests in local remote position~~
14. ~~Check on spare contacts for customer use~~

~~Power Distribution Transformer~~

1. ~~Insulation resistance test HV side, LV side and HV LV side.~~
2. ~~Magnetising current test at rated tap.~~
3. ~~Winding resistance test at rated tap.~~
4. ~~Voltage Ratio & Tap continuity test at all tap.~~
5. ~~Vector group test at rated tap.~~
6. ~~Magnetic Balance Test at rated tap.~~
7. ~~Buchholz Relay Test~~

- 8.—— Neutral CT Test
- 9.—— Winding Temperature Indicator/Oil Temperature Indicator Test
- 10.—— Polarisation Index Test (For LV windings 3.3 KV and above)
- 11.—— Cooling System.
- 12.—— Local/Remote operations of OLTC
- 13.—— No load test and performance observation

HV Switchgear Panels

- 1.—— Local/Remote operations in test as well as service position including all electrical interlocks
- 2.—— Control circuit and operational tests
- 3.—— Tripping through relays and trip circuit health
- 4.—— Anti pumping device operation
- 5.—— Auto Manual bus transfer scheme (ABT Scheme)
- 6.—— Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits
- 7.—— IR values of power and control circuits
- 8.—— HV Test DC High voltage on switchboard
- 9.—— Panel indication, annunciation and space heater circuits
- 10.—— Spare contact for customer use

Breaker

- 1.—— Mechanical charging closing tripping of breaker
- 2.—— Electrical charging closing tripping of breaker

- ~~3. — Mechanical and opening time measurement of each pole~~
- ~~5. — Contact resistance measurement of each pole~~
- ~~6. — IR values~~
- ~~7. — Operation of breaker auxiliary switches~~
- ~~8. — Electrical closing at 85% of rated control voltage~~
- ~~9. — Electrical tripping at 70% of rated control voltage~~
- ~~10. — High voltage test on VCB Circuit breaker.~~

~~Current Transformer~~

- ~~1. — IR Value between Primary and Earth, Secondary and Earth and Primary — Secondary~~
- ~~2. — Polarity Test.~~
- ~~3. — Ratio and circuit test~~
- ~~4. — Knee point voltage, exciting current and secondary resistance in case of class — PS — CT — Magnetisation characteristic~~

~~Potential Transformer~~

- ~~1. — IR Value between Primary and Earth, Secondary and Primary — secondary~~
- ~~2. — Polarity Test~~
- ~~3. — Ratio & Circuit Test~~
- ~~4. — Secondary winding resistance~~

~~LV Switchgear Panels: PMCC~~

- ~~1. — IR Values of power and control circuits~~
- ~~2. — Mechanical charging — closing — tripping of breaker~~
- ~~3. — Electrical charging — closing — tripping of breaker~~

4. ~~_____ Trip circuit healthiness and tripping through relays~~
5. ~~_____ Remote closing/Tripping/Interlocks circuits~~
6. ~~_____ Indication/Annunciation/Panel space heater circuit/Space contacts for~~
~~_____ Customer use.~~
7. ~~_____ Secondary injection testing of protective relays~~
8. ~~_____ Auto manual bus transfer (ABT) scheme testing~~
9. ~~_____ CT testing for polarity, ratio, IR values and magnetisation for class PS characteristics~~
10. ~~_____ PT testing for polarity, ratio, IR values~~
11. ~~_____ IR Values of breaker~~
12. ~~_____ Testing of modules for Either DOL or Star/Delta starting or any other starting method~~
~~as per the schematic drawings applicable.~~

~~HV Bus Duct~~

1. ~~_____ IR Values before Hipot~~
2. ~~_____ Hipot Test~~
3. ~~_____ IR Values after Hipot~~
4. ~~_____ Measurement of contact resistance~~

~~HV Cable~~

1. ~~_____ IR Values before Hipot~~
2. ~~_____ Hipot Test — Measurement of leakage current~~
3. ~~_____ IR Values after Hipot~~

~~Earthing Resistance~~

1. ~~Earthing resistance of each electrode~~

2. ~~Earthing resistance of grid.~~

12 Safety Procedure and Practice

~~Following safety procedure and practice should be provided by electrical contractor in switchgear room/sub station as per latest edition of IS: 5216.~~

a) Rubber matting

i) ~~In front of 11 KV switchgear and 11 KV capacitor panel, soft start panel.~~

ii) ~~In front of 415 V switchgear and other panels in switchgear room.~~

iii) ~~Shock treatment charts~~

~~iv) One chart near 11 KV switchgear room~~

~~v) One chart near 415 V switchgear room~~

b) Caution/Danger Board

~~i) 11 KV switchgear panel : 2 Nos.~~

~~ii) 415 V PMCC panel : 1 No.~~

~~iii) 415 V APFC Panel : 1 No.~~

~~iv) Transformer near HV cable box : 2 Nos.~~

~~v) All power Distribution board : 1 No.~~

c) Fire Safety

~~The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.~~

d) Contractor's License

~~The Contractor shall possess the necessary License/Authorisation from the Licensing Board of the locality/State for carrying out the installation work. The persons deputed by the contractor's firm should also hold valid permits issued/**recognised** by the Licensing Board of the locality/State in which the work is to be done.~~

~~The electrical installation work shall be carried out by licensed electricians only and approved by appropriate authorities. It is the responsibility of Contractor to get approval of complete system from the appropriate authority.~~

Specials

- ~~Power system analysis, short circuit calculations, relay coordination using renowned software, relay settings for over current, earth fault and unit protection of motors etc. shall be submitted at the time of testing.~~
- ~~Equipment / instruments which shall be used for testing should be calibrated as per ISO 9000.~~

~~APPROVED VENDOR LISTS~~

~~(Mechanical, Electrical, Instrumentation & Civil Items)~~

~~The approved lists of vendors for Mechanical/Electrical/Instrumentation/Civil equipment and accessories to be supplied under this contract/bid is available on GWSSB's official website.~~

~~For pumping machinery i. e. HSCF Type Pump Set and Mono submersible along with its Prime Mover i. e. LV Induction Motors, where total working HP per pumping station exceeds 350 H.P. Pumps and Motors & All other associated and relevant Electro Mechanical Equipent/Items will have to be supplied from manufacturers (i.e. vendors) who are registered in "A" Group category as per Approved & Prevailing Vendor List.~~

~~The lists of approved vendors as prevailing on the date of submission of the BID will hold true. However subsequent addition/deletion in above vendors' lists by the competent authority of GWSSB shall also be applicable at the time of approval of QAPs. However, decision of the competent authority of GWSSB shall be final & binding in this regard.~~

TECHNICAL DATA SHEETS

MECHANICAL EQUIPMENT

~~Pump & Motor Set (If applicable)~~

~~1.0~~

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
1.0	LIQUID DATA		
1.1	Liquid handled	Treated Water	
1.2	Specific gravity	1.0	
1.3	Residual chlorine in ppm	2 to 3	
1.4	Temperature	Ambient temp.	
2.0	PUMP DATA		
2.1	Make	As per Approved List	
2.2	Pump type	Horizontal Split Case	
2.3	Pump Model	Pl. Furnish detail	
2.4	Number of pumps—Nos.	As per price bid	
2.5	Type of duty	Continuous	
2.6	Design capacity—m ³ /hr.	As per price bid	
2.7	Total Rated Head—m.	As per price bid	
2.8	Guaranteed min. Pump efficiency at rated capacity in %	Pl. Furnish detail	
2.9	Guaranteed Overall Pump set efficiency at rated capacity %	Min. w/o -ve tolerance	
2.10	Pump input at rated duty KW	Pl. Furnish detail	
2.11	Rated Speed of pump—RPM	(Synchro.) max. (FLS of Ele. Motor)	
2.12	Max. BkW @ Rated Impeller.	Pl. Furnish detail	
2.13	Reco. Drive motor rating—KW	Pl. Furnish detail (Min. as per BOQ)	
2.13.1	Guaranteed min. Motor efficiency at rated capacity. w/o coating %	Min. IE—3 w/o -ve tolerance	
2.14	Full load speed of motor—RPM	Pl. Furnish detail	
2.15	N.P.S.H. required—m	Pl. Furnish detail	
2.16	Shut off head—m	Pl. Furnish detail	
2.17	Location	Indoor	

2.18	Pump Speed	As Per BOQ	
2.19	Minimum Efficiency	As per BOQ	
3.0	Constructional Feature		
3.1	No. of stage	Single/ Double	
3.2	Casing	Volute type	
3.3	Impeller	Pl. Furnish detail	
3.4	Impeller dia. mm	Max. / Rated / Min.	
3.5	Shaft / Drive Transmission	Direct Coupled	
3.6	Shaft sealing	GI packed Stuffing Box-sealed	
3.7	Mounting Orientation	Horizontal	
3.8	Nozzle orientation and size mm		
	Suction	mm / Side	
	Discharge	mm / Side	
3.9	Flange drilling	As per IS 1538, FF	
3.10	Direction of rotation	Pl. Furnish detail	
3.11	Type of Starter	As per standards	
3.12	Suction	Single/ Double	
4.0	MATERIAL OF CONSTRUCTION		
4.1	Pump Casing	Cast Steel WCB	
4.2	Impeller	CF 8 M	
4.3	Shaft	AISI 410	
4.4	Shaft Sleeve	AISI 410-H	
4.5	Casing /Impeller Wearing Ring	SS 316	
4.6	Strainer	SS 304 of 5 mm bar	
4.7	GI Bolt and Nuts	SS 316	
4.8	Hardware in contact with liquid / non-wetted	Wetted: SS 304 Non- Wetted: G.I.	
4.9	Liquid deflector	Natural Rubber	
4.10	G.I.	CI IS 210 Gr FG260	
4.11	Painting	Pl. Furnish detail	
4.12	Base plate (Drain rim type)	G.I.	
5.0	ACCESSORIES and SERVICES REQUIRED		
5.1	Pin Bush Type Coupling	YES	
5.2	Coupling guard	YES	
5.3	Set of foundation bolts and Nuts	YES	
5.4	Base Plate	YES	
6.0	WEIGHT		
6.1	Weight of pump kg	Pl. Furnish detail	

6.2	Weight of motor kg	Pl. Furnish detail	
7.0	DRAWINGS		
7.1	ISO efficiency Perform. curve	Pl. Furnish detail	
7.2	GAD Drawing. of Pump set	Pl. Furnish detail	
7.3	C/S Drawing. of pump with part list	Pl. Furnish detail	
7.4	Catalogue of products	Pl. Furnish detail	
7.5	QAP of products	Pl. Furnish detail	
7.6	Speed Torque curve	Pl. Furnish detail	
8.0	TESTING		
8.1	Hydrostatic test	Required for review	
8.2	Performance test	100 % qty. Witness with Job motor	
8.3	Dynamic balancing test	T.C. verification	
9	The shut-off head should not be less than	Min. 120 % of the total head of the pump	

DATA SHEET FOR HORIZONTAL MONO-SUBMERSIBLE PUMP SET			
Name of RWSS:			
Name of Pumping Station:			
Sr. No.	Particulars	Departmental Requirement	Bidders' Data
1	Capacity	As per price bid	
2	Head	as per detail site survey	
3	Type of pump	Horizontal mono-submersible	
4	Minimum submergence required in meter	Manufacturers' Standard	
5	Make	As per Approved List	
5	Motor Details		
5.1	Type of motor	Submersible	
5.2	Rated Voltage	415 Volts	
5.3	No. of phases frequency	3 Phase, 50 Hz	
5.4	Method of Starting	Up to 7.5 HP DOL, 7.6 HP to 20 HP Star Delta, 21 to 100 HP ATS, above 100 HP Soft Starter	
5.5	Class of insulation	"F" Class	

5.6	Fill of motor	Water	
5.7	Ambient reference temperature	45 ^o	
5.8	Motor HP rating	Manufacturers' Standard	
5.9	Synchronous motor speed	3000 RPM	
5.10	Motor input at duty point	Pl. furnish detail	
5.11	Reserve power of motor	As per CPHEEO Manual	
6	Cable	PVC flat submersible copper	
6.1	Size	Pl. furnish detail	
6.2	Maximum current carrying capacity of Cable	Pl. furnish detail	
7	Overall efficiency of pump set		
7.1	at Full Load	Pl. furnish detail	
7.2	at duty Point	Pl. furnish detail	
7.3	Hydrostatic test	Required for review	
7.4	Performance test	100 % qty. Witness	

LT MOTOR FOR HSCF PUMP (If applicable)

Sr. No.	Particulars	Departmental Requirement	Bidders' Data
1	General	-	-
1.1	Make	-	-
1.2	Application	Pump Motor	-
2	Type	-	-
2.1	Type of motor	Squirrel cage induction motor	-
2.2	Rated Voltage	415 Volts	-
2.3	No. of phases and frequency	3 Phase, 50 Hz	-
2.4	Type of duty / designation	Continuous / S1	-
2.5	Method of Starting	Please Specify	-
2.6	Class of insulation & temperature rise by thermometer	"H" (Temperature rise restricted to class B)	-
2.7	Ambient reference temperature	45-55 ^o	-
2.8	Type of Cooling	TEFC	-
2.9	Degree of Protection	IP 54	-
2.10	Nominal speed Corresponding to 50 Hz frequency	1450 RPM	-
-	-	-	-
3	Rating/Performance	-	-

3.1	Ratings in kW	Please specify (As per BOQ)	-
3.2	Motor frame size	Please Specify	-
3.3	Efficiency of Motor		
	1) at Full Load	Please Specify (IE 3 Class: Minimum acceptable efficiency as per IE 3)	
	2) at Duty Point		
	3) At 3/4 Load	Please Specify	
	4) At 1/2 Load		
3.4	Power Factor		
	1) at Full Load	Please Specify	
	2) At 3/4 Load		
	3) At 1/2 Load		
3.5	Starting torque % of full load torque	Sufficient starting torque to start the pump with delivery valve closed and when other pumps are running	
3.6	Pull out torque % of full load torque	Sufficient to bring the motor to normal speed in minimum time	
3.7	Full load current	Please Specify	-
3.8	No load current	Please Specify	-
3.9	Starting current	Please Specify	-
3.1	Type of bearings	Ball/Roller/Thrust	-
3.11	Shaft orientation	Horizontal Solid Shaft	-
3.1	Supply System fault level	20 MVA	-
3.1	Supply Neutral	Resistance earthed	-
4.0	Performance	Third party inspection as per relevant IS	-
		Type test certificate (not older than 02 years from the date of inspection) for identical rating of motor to be produced	
4.1	Visual inspection check	Required	-
Certified characteristic curves for motor: load v/s power factor, load v/s efficiency, load v/s speed, load v/s current) are to be submitted duly certified by the motor manufacturer at the time of submission of QAP for approval.			

SLUICE VALVE				
Sr. No.	Particulars	Unit	Departmental Requirement	Bidders' Data
1.0	General	-	Manual / Electrical	-
1.1	Type	-	Both ends flanged / Non rising spindle type with hand wheel/ Electrical Actuator Operated	-
1.2	Make	-	As per vendor list	-
1.3	Rating of valves	-	PN 1.0 / PN 1.6/ PN 2.0 or As per Price Bid/Approved CDR	-
1.5	Manufacturing Standard	-	IS 14846 – 2000	-
1.6	Sizes and quantity	-	As per price bid	-
2.0	Materials of construction	-	-	-
2.1	Body	-	CI – IS 210 FG 260 or DI – IS 1865 Gr 500/7 or Cast steel ASTM A216 Gr. WCB	-
2.2	Bonnet	-	CI – IS 210 FG 260 or DI – IS 1865 Gr 500/7 or Cast steel ASTM A216 Gr. WCB	-
2.3	Non rising stem	-	High tensile brass as per IS or High tensile steel AISI – 410	-
2.4	Wedge	-	CI – IS 210 FG 260 or DI – IS 1865 Gr. 500/7 (Core fully encapsulated with EPDM rubber with integral wedge nut (For non rising resilient seated valves)	-
2.5	Stem Nut	-	Bronze IS: 318 LTB-2	-
2.6	Renewable body seat/wedge face ring	-	Bronze Grade IS: 318 LTB – 2	-
2.7	Stem packing (renewable valve open on stem)	-	Jute & Hemp IS: 5414	-
2.8	Hand Wheel	-	CI – IS 210 Gr. FG – 260	-
2.9	Bonnet Nuts	-	Carbon steel as per IS – 1367 CL 4.0	-
2.10	Bonnet Bolts	-	Carbon steel as per IS – 1363 CL 4.6	-
2.11	Bonnet Gasket	-	Rubber IS: 638 Type – B	-
3.0	Hydrostatic test Pressure	-	-	-
3.1	Body	-	As per IS	-
3.2	Seat	-	As per IS	-

REFLUX VALVES (FOR PUMP HOUSE)			
Name of Head Works: All			
Sr. No.	Particulars	Departmental Requirements	Bidder to Specify
1.0	GENERAL		
1.1	Type	Both Ends Flanged	
1.2	Make	As per Vendor List	
1.3	Rating	PN 1.6 / P.N 1.0	
1.4	Manufacturing Standard	IS 5312 — Latest Edition (Design & Testing) & IS: 1538 — 1976 (For Flanges Drilling Standard)	
1.5	Sizes and Quantity	As per BOQ	
1.6	Weight of Complete Valve	As per IS 5312 — Latest Edition	
1.7	Dimensions of Complete Valve (L x B x H in mm)	IS 5312 — Latest Edition	
2.0	MATERIALS OF CONSTRUCTION		
2.1	Body, cover, door, bearing holder, Hinges	CI — IS 210 Gr. FG — 260	
2.2	Plate & Plate Seat (Disc / Plate & Seat)	Cast Steel IS 2062 Gr. BA 216 GR WCB with 13% Cr. Steel overlay (On seating surface only)	
2.3	Hinge pin, door pin and door suspension pin	Stainless Steel AISI 316	
2.4	Body seat rings, Door face ring, Plugs for hinge pin / Air release plug	Bronze IS: 318 LTB — II or SS	
2.5	Bearing bushes / Bearing block	Bronze IS: 318 LTB — II or PTFE	
2.6	Bolts	Carbon Steel IS 1367 CL 4.6	
2.7	Nuts	Carbon Steel IS 1367 CL 4.0	
2.8	Gaskets	Rubber	
3.0	HYDROSTATIC TEST		
3.1	BODY	IS 5312 — Latest Edition	
3.2	SEAT	IS 5312 — Latest Edition	

EXPANSION BELLOW (If applicable)

Name of Pumping Station:				
Sr. No.	Particulars	Unit	Departmental Requirement	Bidders' Data
1	Make	-	As per vendor list	-
2	Type	-	Single metallic	-
3	Quantity	Nos.	As per Price Bid/Approved CDR	-
4	Manufacturing Standards	-	EJMA	-
5	Design Pressure (PN)	-	PN 1.0 / PN 1.6/ PN 2.0 or As per Price Bid/Approved CDR	-
6	Axial Extension	mm	Minimum 05 mm	-
7	Axial Compression	mm	Minimum 15 mm	-
8	Material of construction	-	-	-
	Bellows / Collar / Internal sleeve		SS 240 GR 304	-
	Limit rods		CS IS :1367, CL 4.6	-
	Nut & lock nut		CS IS :1367, CL 4.0	-
	Lugs / Flanges / Weldends		IS: 2062 Gr. B	-
9	Design Life	-	Minimum 7000 cycles	-
10	Hydrostatic test pressure	Kg / Cm ²	Atleast double the design pressure	-

ELECTRICALLY OPERATED TRAVELING CRANE/HOIST (If applicable)

ELECTRICALLY OPERATED TRAVELING CRANE/HOIST (FOR PUMP HOUSE)			
Sr. No.	Particulars	Departmental Requirements	Bidder to Specify
1.0	GENERAL		
1.1	Item	E.O.T. Crane with Electrical Hoist	
1.2	Location	Indoor in Pump House	
1.3	Quantity	01 No.	
1.4	Capacity in TON	As per BOQ	
1.5	IS Standard	IS - 807 & 3177	
2.0	CRANE DATA		
2.1	Make	Pl. furnish detail	
2.2	Model	Pl. Furnish detail	
2.3	Type	Double Girder (circular if needed)	
2.4	Class of Hoist	Medium Duty CI — II as per IS 3177 with latest amendments	
2.5	Lift in m.*	As per BOQ (or as per site requirement)	
2.6	Span in m.*	As per BOQ (or as per site requirement)	
2.7	Bay length in m.*	30.0 (or as per site requirement)	
2.8	No. of Falls	2/4	
2.9	Travel speed in meter./min. ▲ Longitudinal ▲ Cross	15 10	
2.10	Main Hoist speed — m/min.	2 to 2.5	
2.11	Creep speed in m./min.	0.5	
2.12	Fixed Girder Required	Pl. Furnish detail	
2.13	Type of Suspension	Hook	
2.14	Track	Min. 40 X 40 mm MS Sq. Bar	
2.15	Brakes	Electromagnetic type	
2.16	Method of Operation	Pendant Push Button	
3.0	CONSTRUCTIONAL FEATURE		
3.1	End Carriage	Pl. Furnish detail	
3.2	Bridge	Box Type/Standard I beam Type	
3.3	End Stopper	Steel End Stopper on either side of the bridge.	

3.3.1	Wheelbase	Pl. Furnish detail	
3.4	Gear	Made of EN 24 / EN 9—precision machined, teeth cutting by hobbing machine & duly hardened.	
3.5	Wire Rope	Steel Wire rope 12 mm, 6 X 36 construct. Flex. Steel wire rope as per IS 2266 or as per design	
3.6	Hook	Forged steel single shank type—confirming to IS 15560 with thrust bearing., latch & anti locking arrangement	
3.7	Rope Drum & Sheaves	MS Drum with grooving as per IS 3938	
3.8	Wheels	Made of Forged Steel confirming to IS 2707 GR-II duty/Steel cast EN—9, double flanged straight trade type	
3.9	Shaft	High Tensile Steel	
3.10	Trolley	MS Frame with wheels of Forged steel / EN—9	
3.12	Bearings	All moving parts be supported on SKF/FAG anti friction Ball/Roller bearing.	
3.13	Maintenance Platform/ access walkway	Maintenance basket type Platform for One man seat Required	
3.14	Painting	Required. Furnish detail.	
4.0	ELECTRICAL DETAILS		
4.1	Supply Condition	415 V +/- 10 % variation 50 Hz +/- 5 % variation +/- 10 % Combined variation	
4.2	Motor Standard	IS 325	
4.3	Control Voltage	110 V	
4.4	Class of Insulation / Drawing of Protection	F / IP 55	
4.5	Temperature	Ambient 50 Drg. C	
4.6	Make	As per Tender specs.	
4.7	Type of Motor	Hoist Duty	
4.8	Main Hoisting	Pl. Furnish detail	
4.9	L.T.	Pl. Furnish detail	
4.10	C.T.	Pl. Furnish detail	
4.11	Method of starting	Pl. Furnish detail	

4.12	Type of cooling	Pl. Furnish detail	
4.13	Total Connected Load kw	Pl. Furnish detail	
5.0	ACCESSORIES & SERVICES REQUIRED		
5.1	Mech. Stopper for LT & C.T	YES	
5.2	Pendant with hanging chain/rope	YES	
5.3	Limit Switches for <ul style="list-style-type: none"> ■ over hoisting ■ over lowering ■ over cross travel ■ over long travel 	YES	
5.4	Trailing cable system	YES	
5.5	Control Panel	YES	
5.6	Isolation Switch for electric Power	YES	
6.0	WEIGHT		
6.1	Weight of Hoist in kg	Please furnish	
6.2	Weight of Bridge in kg	Please furnish	
7.1	GA & Dimensional drg. of Crane assembly	Pl furnish	
7.2	Data as required by IS 3177-77, Appendix B, clause 2.2	Pl furnish (In Separate Sheet)	
7.3	Complete Electrical circuit Diagram	Pl furnish	
7.4	Catalogue of products	Pl furnish	
7.5	QAP of products	Pl furnish	
8.0	TESTING		
8.1	Visual inspection and Dimensional Check	Witnessing	
8.2	Performance test	Witnessing	
8.3	Overload test at 125% load	Witnessing	
8.4	Deflection Test	Witnessing	
8.4	Material Test certificates	Required	

Note: ~~01. Manufacturer / supplier shall submit separate data sheet for each duty.~~
~~02. For components (marked M) material certificates shall be furnished~~
~~03.(*) Contractor shall visit the site and obtain the data about span, lift, bay length, etc suitable for existing pump house and shall furnish in data sheet~~

TAMPER PROOF AIR VALVE (FOR PUMP HOUSE)			
Sr. No.	Particulars	Departmental Requirements	Bidder to Specify
1.0	GENERAL		
1.1	Type	Temper proof Double acting kinetic air Valve with Isolation valve	
1.2	Make	As per Vendor List	
1.3	Rating	PN 1.6 / P.N 1.0	
1.4	Manufacturing Standard	AWWA C 512 (For Valve) & IS: 1538—1976 (For Flanges Drilling Standard)	
1.5	Sizes and Quantity	As per Tender Specifications	
1.6	Weight of Complete Valve	Bidder to Specify	
1.7	Dimensions of Complete Valve (L x B x H in mm)	Bidder to Specify	
2.0	MATERIALS OF CONSTRUCTION		
2.1	Body	CHS 210 Gr. FG260	
2.2	Cover	CHS 210 Gr. FG260	
2.3	Float	SS 410	
2.4	Seat	EPDM	
2.5	Float Guide	SS 410	
2.6	Orifice	SS 410	
2.7	Gasket	EPDM	
2.8	Flange End	IS 1538	
2.9	Nut Bolt	Carbon steel	

(B) ELECTRICAL EQUIPMENTS

~~PMCC PANEL (L.V. PANEL) (If applicable)~~

Name of Pumping Station:				
Sr. No.	Particulars	Unit	Departmental Requirement	Bidders' Data
1	Site Conditions			
1.1	Maximum ambient temperature	°C	50 ^o	-
1.2	Minimum ambient temperature	°C	06 ^o	-
2.0	Operating Conditions			
2.1	Voltage	V	415	-
2.2	Frequency	Hz	50 ± 3 %	-
2.3	System & No. of phase	-	4 wire / Three phase	-
2.4	System fault level	-	50 Ka at 415 V for 1 second	-
2.5	System earthing	-	Solidly earthed	-
2.6	Control supply for:	-	-	-
	Protective Relays	V AC	220 V AC	-
	Indicating lamps	V AC	220 V AC	-
	Panel illumination lamp	V AC	220 V AC	-
	Contactor coils	V AC	220 / 415 V AC	-
3.0	General & Other Details			
3.1	Make	-	-	-
3.2	Type	-	Fixed / Floor Mounting	-
3.3	Degree of protection	-	IP 42 (For Indoor)	-
3.4	Overall weight of complete panel	Kg	-	-
3.5	Overall dimensions: Length x Depth x Height	mm	-	-
3.6	Dimensions of largest shipping section: Length x Depth x Height	mm	-	-
3.7	Recommended clearances			
	Front	mm	-	-
	Rear	mm	-	-
	Above	mm	-	-
3.8	Clearance in air of main bus bars			
	Phase to phase	mm	25	-
	Phase to earth	mm	19	-
3.9	Main Bus Bar Details			

	Current rating at design temperature (50°C)	-	* As per price bid, current density 0.75 amperes per square mm maximum of reputed make as per specifications with test certificate of lot	-
	Material	-	Electrolyte grade Aluminum PVC sleeved & colour coded	-
	Size	-	Please specify	-
	Location	-	-	-
3.11	Vertical bus bar details (if required)	-	-	-
	Current rating / size	-	-	-
3.12	Insulating material	-	PVC heat shrinkable	-
3.13	Earth bus size / material	Sq mm	Min. Aluminum 25 x 6 for MCC	-
3.14	1 second short circuit withstand capacity	KA	50 KA CPRI test certificate	-
3.15	Peak dynamic withstand capacity	KA	105 KA CPRI test certificate	-
4.0	Pump selector switch	No.	3 working + 2 standby configuration / As per Price Bid/Approved CDR	-
5.0	Outgoing Main Motor Feeders	No.	VFD	-
6.0	Moulded Case Circuit Breakers	-	-	-
6.1	Make & type (s)	-	-	-
6.2	Rated voltage, frequency	-	415 V at 50 Hz	-
6.3	Normal current under site conditions	-	* As per price bid	-
6.4	Symmetrical interrupting current	-	* As per specifications	-
6.6	Operating mechanism	-	Quick make / Quick Brake	-

6.7	Shunt trip	-	As required	-
6.8	Relays / Releases	-	As per Approved CDR / Microprocessor based for MCCB	-
7.0	Contactors			
7.1	Make	-	-	-
7.2	Type	-	Air Break	-
7.3	Rated voltage	-	-	-
7.4	Rated current (AC-3 duty)	-	-	-
7.5	Thermal rating	-	-	-
7.6	Making capacity	-	-	-
7.7	Breaking capacity	-	-	-
7.8	Switching frequency	Operations/ Hour	-	-
7.9	Life (Mechanical)	Operations (@ rated vol)	As per specifications	-
7.10	Life (Electrical)	Electrical operations	As per specifications	-
7.11	Coil consumption pick-up	VA at P.F	-	-
7.12	Coil consumption hold-on	VA	-	-
7.13	Closing time	Seconds	-	-
7.14	Opening time	Seconds	-	-
7.15	No. of aux. contacts	-	To be provided as required	-
8.0	Thermal Overload Relays			
8.1	Make	-	-	-
8.2	Setting range	-	As per specifications	-
8.3	Type of operation (Direct / CT operated)	-	As per specifications	-
9.0	Current Transformers			
9.1	Make & type	-	Approved / Cast Resin	-
9.2	Ratio	-	As required Primary / Secondary 5	-
9.3	Burden	-	15 VA	-
9.4	Accuracy Class	-	Class 1.0	-
10.0	Multi function digital meter			
			One for incoming with required CT and wirings and as per detailed specifications	-
11.0	Time totalizer			
			Digital and One for each feeder	-

12.0	Ammeter with selector switch 03 CTs		Digital, One for each outgoing feeder of class 1.0 accuracy as per specifications	
13.0	Capacitor details		APP type	
13.1	Applicable standards		IS 2834	
13.2	Total loss at rated voltage		2.5 watts per KVAR	
13.3	Dielectric losses at rated voltage		1.5 Watts per KVAR	
13.4	Rated voltage		440 Volts	
13.5	Over current capacity of individual capacitor		130%	
13.6	Over voltage capacity of individual capacitor		110%	
13.7	Type of impregnant		Vacuum	
13.8	Type of insulation		Oil NPCB	
13.9	Average life		Please Specify	
14.0	APP fixed capacitor bank with contactor, MCB etc. for power factor improvement	KVAR	As per Approved CDR	
15.0	Extra feeders for scf pumps, Lighting & Filter etc. with MCBs of required amperage with necessary internal wiring etc		TPN MCB of 32 Amps 10 kA: 03 Nos. & 63 Amps 10 kA: 02 Nos, & 125 Amps 10 kA: 02 Nos.	
16.0	Separate instrumentation compartment for flow indicators / integrators of flow meters with necessary internal wiring		Required of minimum size of 300 x 300 mm wired up to terminal	

APFC PANEL (If applicable)

Sr. No.	Particulars	Unit	Departmental Requirement	Bidders' Data
A	Applicable Standard	-	IS 16636 / 2017 & IEC 60831-1/2	-
B	Rating	KVAR	As per Approved CDR	-
1	Site Conditions			
1.1	Maximum ambient temperature	°C	50 ^o	-
1.2	Minimum ambient temperature	°C	06 ^o	-
2.0	Operating Conditions			
2.1	Voltage	V	415	-
2.2	Frequency	Hz	50 ± 3 %	-
2.3	System & No. of phase	-	4 wire / Three phase	-
2.4	System fault level	-	50 KA at 415 V for 1 second	-
2.5	System earthing	-	Solidly earthed	-
2.6	Control supply for:	-	-	-
	Protective Relays	V AC	220 V AC	-
	Indicating lamps	V AC	220 V AC	-
	Panel illumination lamp	V AC	220 V AC	-
	Contactor coils	V AC	220 / 415 V AC	-
3.0	General & Other Details			
3.1	Make	-	-	-
3.2	Type	-	Fixed / Floor Mounting	-
3.3	Degree of protection	-	IP 42 (For Indoor)	-
3.4	Overall weight of complete panel	Kg	-	-
3.5	Overall dimensions: Length x Depth x Height	mm	As per Approved CDR	-
3.7	Recommended clearances			
	Front	mm	-	-
	Rear	mm	-	-
	Above	mm	-	-

3.8	Clearance in air of main bus bars	-	-	-
	Phase to phase	mm	25	-
	Phase to earth	mm	19	-
3.9	Main Bus Bar Details			
	Current rating at design temperature (50° C)	-	* As per price bid, current density 0.75 amperes per square mm maximum of reputed make as per specifications with test certificate of lot	-
	Material	-	Electrolyte grade Aluminum PVC sleeved & colour coded	-
	Size	-	Please specify	-
	Location	-	-	-
3.12	Insulating material	-	PVC heat shrinkable	-
3.13	Earth bus size / material	Sq mm	Aluminum 25 x 3	-
3.14	1 second short circuit withstand capacity	KA	50 KA CPRI test certificate	-
3.15	Peak dynamic withstand capacity	KA	105 KA CPRI test certificate	-
4.0	Moulded Case Circuit Breakers			
4.1	Make & type (s)	-	-	-
4.2	Rated voltage, frequency	-	415 V at 50 Hz	-
4.3	Normal current under site conditions	-	* As per price bid	-
4.4	Symmetrical interrupting current	-	* As per specifications	-
4.6	Operating mechanism	-	Quick make / Quick Brake	-
4.7	Shunt trip	-	As required	-
4.8	Relays / Releases	-	Microprocessor based for MCCB	-

7.0	Contactors			
7.1	Make	-	-	-
7.2	Type	-	Capacitor Duty Air Break	-
7.3	Rated voltage	-	-	-
7.4	Rated current (AC 3 duty)	-	-	-
7.5	Thermal rating	-	-	-
7.6	Making capacity	-	-	-
7.7	Breaking capacity	-	-	-
7.8	Switching frequency	Operations/ Hour	-	-
7.9	Life (Mechanical)	Operations (@ rated vol)	As per specifications	-
7.10	Life (Electrical)	Electrical operations	As per specifications	-
7.11	Coil consumption pick up	VA at P.F	-	-
7.12	Coil consumption hold on	VA	-	-
7.13	Closing time	Seconds	-	-
7.14	Opening time	Seconds	-	-
7.15	No. of aux. contacts	-	To be provided as required	-
8.0	APFC Relays			
8.1	Make	-	-	-
8.2	No. of steps	-	Minimum 12	-
8.3	Communication	-	RS 485	-
9.0	Current Transformers			
9.1	Make & type	-	Approved / Cast Resin	-
9.2	Ratio	-	As required Primary / Secondary 5	-
9.3	Burden	-	15 VA	-
9.4	Accuracy Class	-	Class 1.0	-
10.0	Multi function digital meter	-	One for incoming with required CT and wirings and as per detailed specifications	-

11.1	Minimum display parameter Total and Individual capacitor bank		A, V, PF & KVAR	
11.2	Minimum display parameter load		A & PF	
11.3	Display		LED / LCD	
12.0	Ammeter with selector switch 03 CTs		Digital, One for each outgoing feeder of class 1.0 accuracy as per specifications	
13.0	Capacitor Details		APP type	
13.1	Applicable standards		IS 2834	
13.2	Total loss at rated voltage		2.5 watts per KVAR	
13.3	Dielectric losses at rated voltage		1.5 Watts per KVAR	
13.4	Rated voltage		440 Volts	
13.5	Over current capacity of individual capacitor		130%	
13.6	Over voltage capacity of individual capacitor		110%	
13.7	Type of impregnant		Vacuum	
13.8	Type of insulation		Oil NPCB	
13.9	Average life		Please Specify	
13.10	No. & KVAR of individual capacitor feeder	KVAR	As per QAP / Data Sheet (Minimum 08 Nos. /Maximum 12 Nos.)	

NOTE: The bidder has an option to build MCC panel & APFC panel in a common enclosure of required & appropriate size subject to approval of CDR as well as data sheet by the competent authority. However sizing & rating of internal components shall be adequate & acceptable to the competent authority.

POWER, CONTROL & INSTRUMENTATION CABLES

Sr. No.	Description	Unit	Particulars	Bidder to Specify
1	11 kV (E), Stranded Aluminium XLPE insulated, inner & outer extruded PVC sheathed, G I flat / strip armoured heavy duty power cable	LS	As per Tender Specifications of Required Core, Size & Amperage	
1.1	Make		As per Vendor List	
1.2	Applicable Standards		As per IS 7098 Part II	
2	1.1 kV Grade, Stranded Aluminium XLPE insulated, inner & outer extruded PVC sheathed, G I flat / strip armoured heavy duty power cable	LS	As per Tender Specifications of Required Core, Size & Amperage	
2.1	Make		As per Vendor List	
2.2	Applicable Standards		As per IS 7098 Part I	
3	1.1 KV, Flat PVC sheathed Copper Submersible Cable (for Drain Pump)	LS	As per Tender Specifications of Required Core, Size & Amperage	
3.1	Make		As per Vendor List	
3.2	Applicable Standards		As per IS 694	
4	Cable Accessories			
4.1	Cable Gland		Double Compression Brass type to suit the size of cable & of required MOC	
4.2	Cable Lugs		Crimping type to suit the size of cable & of required MOC	
4.3	Cable Accessories		To be provided as per specifications & requirements	

EARTHING AND LIGHTNING PROTECTION SYSTEM

Sr. No.	Description	Unit	Particulars	Bidder to Specify
1	Main Earthing Grid		To suit as per maximum S. C. rating & design criteria	
2	Conductor leads to Equipment		Minimum 2 distinct earthing leads for equipment having > 125 V & 1 earthing lead for equipment	
3	Other Items			
3.1	Main Lighting D.B, Control Panels and Sub Lighting Distribution	LS	GI, 25 x 6 mm	

	Boards			
3.2	Hand Rails	LS	GI, 25 x 3 mm	
3.3	Cable Trays	LS	GI, 25 x 3 mm	
3.4	Tanks	LS	GI, 25 x 3 mm	
3.5	Street lighting, flood lighting poles and junctions' boxes,	LS	GI wire, 8 SWG	
3.6	Lighting Fixtures, Single Phase Receptacles, Lighting Conduits	LS	GI wire, 12 SWG	
3.6	Push Button Stations, Limit Switches	LS	GI wire, 12 SWG	
3.7	Crane rail,	LS	GI, 25 x 3 mm	
3.8	Metallic Non Current Carrying Structures	LS	GI, 25 x 3 mm	
4	Lightning Conductors	LS		
4.1	Lightning Protection Down Comers for Building	LS	GI, 25 x 6 mm	
4.2	Lightning Protection Horizontal Roof Conductor for Building	LS	GI, 25 x 6 mm	

5	Earth Electrodes			
5.1	Pipe in Pipe Technology (Earth Pit of Minimum bore dia. of 150 mm)	Min. No.	10	Pipe in pipe outer dia. 50 mm & inner dia. 25 mm with GI pipe 2000 mm long with back filling compound minimum 25 Kg per each job as per relevant IS for two pole structure with transformer body etc. HV & LV PMCC APFC Panels & Motors etc.
5.2	Maintenance Free UL Listed Earthing System	Min. Nos.	06	Copper bonded rod 17.2 mm dia. with 3000 mm length & minimum copper bonding of 0.25 mm with 95% Carbon based earth enhancement material of 30 Kg for each job with pit cover as per relevant IS for LA of two pole structure and transformer neutral with copper strip of 25 x 6 mm.
5.3	Maintenance Free UL Listed Earthing System	01 No.		Copper bonded rod 17.2 mm dia. with 3000 mm length & minimum copper bonding of 0.25 mm with 95% Carbon based earth enhancement material of 30 Kg for each job with pit cover as per relevant IS for Instrumentation Panels with copper strip of 25 x 6 mm.

6	Earthing Resistance to be achieved		As per IEEE Std. 80 2000	
6.1	Transmission substation	Ohm	≤1	
6.2	Distribution substation	Ohm	≤5	

LIGHTING & RECEPTACLE SYSTEM AND EQUIPMENT				
Sr. No.	Description	Unit	Particulars	Bidder to Specify
1	AC Voltage			
1.1	3 Phase, 4 wire 50 Hz system			
1.2	Nominal	V	415	
1.3	Maximum	V	460	
2	DC Voltage			
2.1	Rated	V	24 / 110	
2.2	One minute withstand voltage		2000 V AC	
3	System short circuit level			
3.1	At 415 V AC	KA (rms)	10	
3.2	At 110 V DC	KA (DC)	6	
4	Reference Ambient Temperature		50 ^o C	
5	Distribution Board / Panels			
5.1	Make		As per Vendor List	
5.2	Applicable Standards		As per Tender Specifications	
6	Main, floor mounted distribution boards			
6.1	Main LDB (AC)		As per Requirement	
7	Bus Bars		Al / Cu	
7.1	Bus Bar Current Rating	A	As per Requirement	
7.2	Incoming		As per Requirement	
7.3	Outgoing		As per requirement (With Minimum 2 spare feeders)	

7.4	Cable Entry		Bottom	
7.5	Earthing terminals		50 x 8 mm GI flat	
8	Emergency Lighting Panel		As per requirement	
8.1	Bus bars		Copper	
8.2	Bus bar current rating	A	As per Requirement	
	Incoming and outgoing feeders		As per requirements (With Minimum 2 spare feeders)	
8.3	Cable entry		Bottom	
8.4	Earthing terminals		50 x 6 mm GI flat	
9	Sub DBs, wall / structure mounting panels			
10	SLDB for indoor area		As per requirement	
10.1	Bus bars		Copper	
10.2	Bus bar current rating	A	As per requirement	
10.3	Incoming and outgoing feeders		1 No. incoming TPN MCB* (Minimum 32A) with ELCB As per requirement Outgoing 10/16A MCB-SPN and DP ELCB per phase with PPI (With Minimum 2 spare feeder circuits; a single circuit consists of SPN MCBs for R, Y, B phase)	
10.4	Cable Entry		Bottom / Top	

11	SLDB for outdoor area		As per requirement	
11.1	Bus bars		Copper	
11.2	Bus bar current rating	A	As per requirement	
11.3	Incoming		1 No. For Incoming * A TPN, MCB (Minimum 32A) with ELCB with timer (0- 24 hours)	
11.4	Outgoing		As per actual requirement, Outgoing 10/16 A SPN MCB with switch contactors. (With Minimum 2 spare feeder circuits; a single circuit consists of SPN MCBs for R, Y, B phase)	
11.5	Cable entry		Bottom / Top	
12	Paint Finish			
12.1	Colour shade (Interior/ Exterior)		As per industry Standard	
12.2	Epoxy paint required		Yes	
13	Earthing terminals suitable for conductor			
13.1	Size	mm x mm	25 x 3 flat	
13.2	Material		GI	
14	Receptacle Units			
14.1	Make			
14.2	Decorative (complete with flush / surface mounted boxes / cover plates etc.)			

14.2.1	3 pin 1 phase & N with switch and plug tops	A	5 / 15 A, Indoor Type	
14.2.2	Industrial (complete with surface mounted, prefabricated CRCA boxes)			
14.2.2a	3 Pin, 230V AC		As per required	
	With ELCB (30mA) & plug	A	15A, Indoor Type	
14.2.2b	5 pin, 3 Phase, 415V with ELCB (30mA) & plug	A	As required 63 A, Outdoor type and 32 A, Indoor type	
15	Lighting Wires			
15.1	Make 1100V, PVC insulated		As per Vendor list	
15.2	Conductor		Stranded Copper	
15.3	Size (sizes mentioned are minimum & size to be decided on circuit load & voltage drop criteria)	Core mm²	Lighting 2 x 1 C x 1.5 mm² Receptacle / Sockets Decorative 2 x 1 C x 1.5 mm² Industrial 1 Phase 2 x 1 C x 4 mm² 3 Phase 4 C x 6 / 16 mm²	
16	Conduits			
16.1	Make			
16.2	Material		Galvanized Iron (GI)	
16.3	Size	mm	20	
17	Street light poles and flood light poles			
17.1	Make		As per Vendor List	
17.2	Street Light Pole			

17.2a	Typical drawing (if any)		-	
17.2b	Total Height	m	8.5/10/12	
17.2c	Quantity	Nos.	As per Requirement	
18	Junction Box with Pole			
18.1	Typical drawing (if any)		-	
18.2	No. of cable entries	Nos.	Two	
18.3	Cable entry suitable for		4 C x 16 mm² Al. Conductor, PVC insulated, armoured cable	
18.4	Earthing terminal suitable for		8 SWG / 25 x 3 mm GI Flat	
19	Floodlight Light Pole			
19.1	Total Height	Mts.	8.5/10/12/High Mast	
19.2	No. of floodlights to be fixed per pole	No.	Minimum One / as required	
19.3	Painted		Yes	
19.4	Earthing terminal suitable for	mm x mm	8 SWG / 25 x 3 mm GI Flat	
19.5	Quantity	Nos.	As per requirement	
20	Luminaire (Lighting fixture complete with prewired control gear terminal block & suitable lamps)	LS	As per E-M Technical specifications and Actual Requirement	
21	Note			
	Supply of conduits, wires / cables, all fixing hardware, terminal connectors, cable termination kits and associated accessories for lighting, receptacles, earthing, cabling & wiring works, required civil works etc. are included invariably in Contractor's scope. Entire works shall be carried out to ensure sufficient level of illumination level as per relevant standards. All ELCBs for lighting circuit shall be with 100 mA sensitivity. All ELCBs for receptacle circuit shall be with 30 mA sensitivity.			

PROPELLER EXHAUST FANS (If applicable)			
Name of Pumping Station:			
Sr. No.	Description	Department's Requirements	Bidder to Specify
1	Make	As per Approved Vendor List	
2	Applicable Standards	IS: 2312	
3	Fan Dia. Size (mm)	450	
4	Free Air Delivery (m ³ / hr)	3900	
5	Quantity	As Per Actual Requirements	
6	Rating (mm of water static)	5	
7	Motor		
7.1	Make	As per Approved Vendor List	
7.2	Rating (kW)	Bidder to Specify	
7.3	RPM	900	
7.4	Sound Level	Bidder to Specify	
7.5	No of Phase	Bidder to Specify	
7.6	Total Quantity	Bidder to Specify As per Actual Requirement Depending On size of Pump House	
8	WEIGHT / DIMENSIONS		
8.1	Total Weight (kg) of Complete Assembly	Bidder to Specify	
8.2	Over all Dimensions of Complete Assembly L X B X H (mm)	Bidder to Specify	

FULL BORE ELECTRO MAGNETIC FLOW METER**Name of Pumping Station / Pumping Section:**

Sr. No.	Particulars	Departmental Requirement	Bidder to Specify
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1.0 GENERAL

1.1	Service	Water Flow Measurement & Analysis	-
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1.2	Line Size	Full bore on common discharge header pipe of pumps for all pumping sections at all pumping stations as per E-M technical specifications	-
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1.3	Range Setting	As per actual requirement	-
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1.4	Liquid Type	Raw Water	-
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1.5	Type of Solid	Silt Particles	-
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1.6	Operating Pressure	1.0 Mpa (10 Kg / Cm²) OR 1.6 Mpa (16 Kg / Cm²)	-
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1.7	Operating Temperature	0^o C to 50^o C	-
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1.8	Overall Accuracy of Measurement	± 0.5 % of Full Scale / Measured Value	-
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1.9	Quantity	One each on common discharge header of all pumps as per E-M technical specifications	-
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2.0 FLOW SENSOR

2.1	Type	Full bore type Electromagnetic (Compatible to GSM / GPRS Connectivity)	-
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2.2	Measuring Principle	Magnetic Induction	-
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2.3	Weather Protection Class	IP 68 of IS: 13947 Part (I)	-
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2.4	Measuring Principle	Magnetic Induction	-
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2.5	Type	Pulsed DC excitation	-
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2.6	System	Separate with Cable Output	-
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2.7	Power Supply	240 V AC, 50 Hz	-
2.8	End Connections	Welded Flanges of Carbon Steel	-
2.9	Flange Rating & Material	PN 1.0 or PN 1.6 Cast steel as per IS: 1538 / DIN / ANSI	-
2.10	Electrodes	Measuring, Reference and Empty Pipe Electrodes with Empty Pipe Detection & Alarm Facility	-
2.11	Electrode Material	Stainless Steel 316 / Platinum / Tantalum	-
2.12	Meter Tube	Stainless Steel 304	-
2.13	Electrode Type	Round Head Electrodes (Bullet Nose)	-
2.14	Lining Material	Neoprene / Polyurethane / EPDM	-
2.15	Protection Category (Housing Ingress)	IP 68 IS: 13947 Part (I)	-
2.16	Measuring Accuracy	± 0.5% of Measured Value inclusive of Linearity, Repeatability, Pressure Effect and Hysteresis between 0.5 – 4 m/s Velocity	-
2.17	Coil Housing	SS 304 with Fully Welded Construction / Die Cast Aluminium / Cast Steel with Anticorrosive Epoxy Paint	-
2.18	Connection / Junction Box	SS 304	-
2.19	Earthing	Grounding Rings in SS 316 / Built in Earthing Electrodes in SS 316	-
2.20	Fluid Conductivity	> 5 \square Siemens/cm	-
2.21	Marking	Direction of Flow with Arrow, Size, Sr. No. & Make	-
3.0	FLOW TRANSMITTER		
3.1	Type	Microprocessor Based of Modular Design (Remote / Integral Mounted)	-

3.2	Display Language	English	-
3.3	Ambient Temperature	-2 ^o C to + 60 ^o C	-
3.4	Display	Minimum 2-line back-lit LCD for Indication of Actual Flow Rate / Instantaneous Flow Rate, Forward, Reverse, Cumulative Flow, Sum Totalizers, Alarm Indicator	-
3.5	Outputs	One Current Output (4 – 20 mA) One Scalable Pulse Output One Status Output	-
3.6	Protection Category (For Transmitter Ingress)	IP 68 IS: 13947	-
3.7	Enclosure	Die Cast Aluminium with Polyurethane Finish with Glass Window / SS 316	-
3.8	Programming	Through key / keypad on front fascia /optical touch key	-
3.9	Power Supply	230 V AC, 50 Hz	-
3.10	Cable Gland	½" NPT (4 Glands of Double Compression Type)	-
3.11	Mounting	Wall Mounted	-
3.12	Interface	RS 485, based on EIA R 422 / 485 Standard, or HART	-
3.13	Power Failure Mode	Provision of RAM / PROM to Store Parameter entered and Measured Flow Data during power failure	-
3.14	Maximum Separation	Up to 200 meters between sensor & transmitter without any signal boosters	-

3.15	Terminals	Shock — hazard protected push lock terminals	-
3.16	Error Identification	0/3.6/22 m Amp	-
3.17	Interchangeability	Fully Interchangeable with all sizes of flow sensors	-
3.18	Safety Classification	General — Purpose Certification	-
4.0	FLOW INDICATOR AND INTEGRATOR		
4.1	Type	Microprocessor Based	-
4.2	Display	Digital, Seven Segment Back-Lit LCD Display	-
4.3	Flow Indicator Totalizes	Internal 8 Digit LCD Totalizes	-
4.4	Digit Height	14 mm or Higher	-
4.5	Number of Digits for	-	-
	Flow Indicator	5 Digits	-
	Flow Integrator	8 Digits	-
4.6	Zero and Span Adjustment	Required	-
4.7	Manual Reset Facility for	Required (shall be key operated)	-
4.8	Engineering Units for	-	-
	Flow Rate Indicator	Bidder to specify in M ³ /Hr	-
	Flow Integrator	Bidder to Specify in MI	-
5.0	ACCESSORIES		
5.1	Prefabricated Integral Cables for Connecting Sensors and Transmitter	As — per — Actual Requirement in Single Length (Minimum 20 Meters) from Source of Power Supply	-
5.2	Constant Voltage Stabilizer	One with each flow meter required to supply stabilized voltage	-
<p>This is sample data sheet and agency has to submit data sheet, GA drawings for flow meters for all pumping sections and pumping stations covered in this tender separately duly certified by the original manufacturer.</p> <p>Note: Flow meter manufacturer must have NABL approved/accredited testing facility.</p>			

PRESSURE GAUGE**Name of Pumping Station & Pumping Section:**

Sr. No.	Particulars	Departmental Requirement	Bidders' Data
1.0	GENERAL		

1.1	Make	Krohne Marshall, Baumer, Wika or Equivalent	-
1.2	Service	Individual Pump Discharge & Common Discharge Header	-
1.3	Fluid	Clear water	-
1.4	Area of Classification	Non Hazardous	-
2.0	MATERIAL OF CONSTRUCTION		
2.1	Type	Bourdon	-
2.2	Sensor and Other Wet Parts M.O.C	SS-316	-
2.3	Process Connection	½" NPT (M)	
2.4	Dial Size	150 mm	
2.5	Material of Dial	Aluminium with White Background and Black Numerals	
2.6	Glass	Shatterproof	
2.7	Housing Material	Die Cast Aluminium with Epoxy Coating	
2.8	Accuracy	± 1% of Full Scale or better	
2.9	Over Range Protection	125% of Maximum Pressure	
2.10	Gauge Protection	IP-65	
2.11	Temperature	50 ^o C Ambient	
2.12	Range	0 to 6 Kg/Cm ²	
2.13	Accessories	Snubber, 3 Way Isolation Valve, Impulse Tubing, Fittings, All Other Installation Hardware	
2.14	Diaphragm Seal MOC	SS-316	
2.15	3-Way Isolation Valve MOC	SS-316	
2.16	Impulse Tube Fitting MOC	SS-316	

PUMP RUNNING HOUR METER (PANEL MOUNTED)

Sr. No.	Particulars	Departmental Requirement	Bidder to Specify
1	Make	L & T, Siemens, Alcor, Selec, Elmeasure, Muller, Omron	
2	Service	Pump Motor Running Hour Meter	
3	Type	Microprocessor Based	
4	Mounting	Panel Mounted	
5	Quantity	One Per Pump (Total: 06)	
6	Output	4-20 mA	
7	Alarm Contacts	SPDT (As per requirement)	
8	Communication	RS-485, Modbus with PLC	

Note: For data sheets of all mechanical, electrical, equipment & accessories following undertaking is to be given by original equipment manufacturer / panel builder / sub vendor & principal contractor.

I/We are bound to supply the above item(s) of stated manufacture having rated capacity, material(s) of construction and all other general & specific / particular requirements mentioned in the concerned technical specifications and data sheet(s).

SIGNATURE of CONTRACTOR

**EXECUTIVE ENGINEER
GWSSB**