**DESIGN, CONSTRUCTION, SUPPLY, INSTALLATION, TESTING AND OMMISSIONING (CIVIL, ELECTRO-MECHANICAL, ELECTRICAL, INSTRUMENTATION& OTHER NECESSARY WORKS) OF SEWAGE TREATMENT PLANT (SBR TECHNOLOGY) ALONG WITH TERTIARY TREATMENT AND SUPPLY SYSTEM TO BADKAL LAKE WITH 5 YEARS OPERATION AND MAINTENANCE AT FARIDABAD ON EPC MODEL**

**Under**

# SMART CITY MISSION (SCM)

**in**

**FARIDABAD CITY**

**(HARYANA, INDIA)**

# (VOL – II)

## SCOPE OF WORK

## &

## TECHNICAL SPECIFICATIONS

**Ref No: FSCL/2018/640**

**Issued on 29/11/2018**

**DNIT Amount: Rs. 26.46 Crores.**


**Employer:** **Faridabad Smart City Limited**

Nain Sadan, 3rd Floor, Plot No. 35

Sector 20A, Behind EF3 Mall

Near Old Faridabad Metro Station

Faridabad - 121001

(Haryana)

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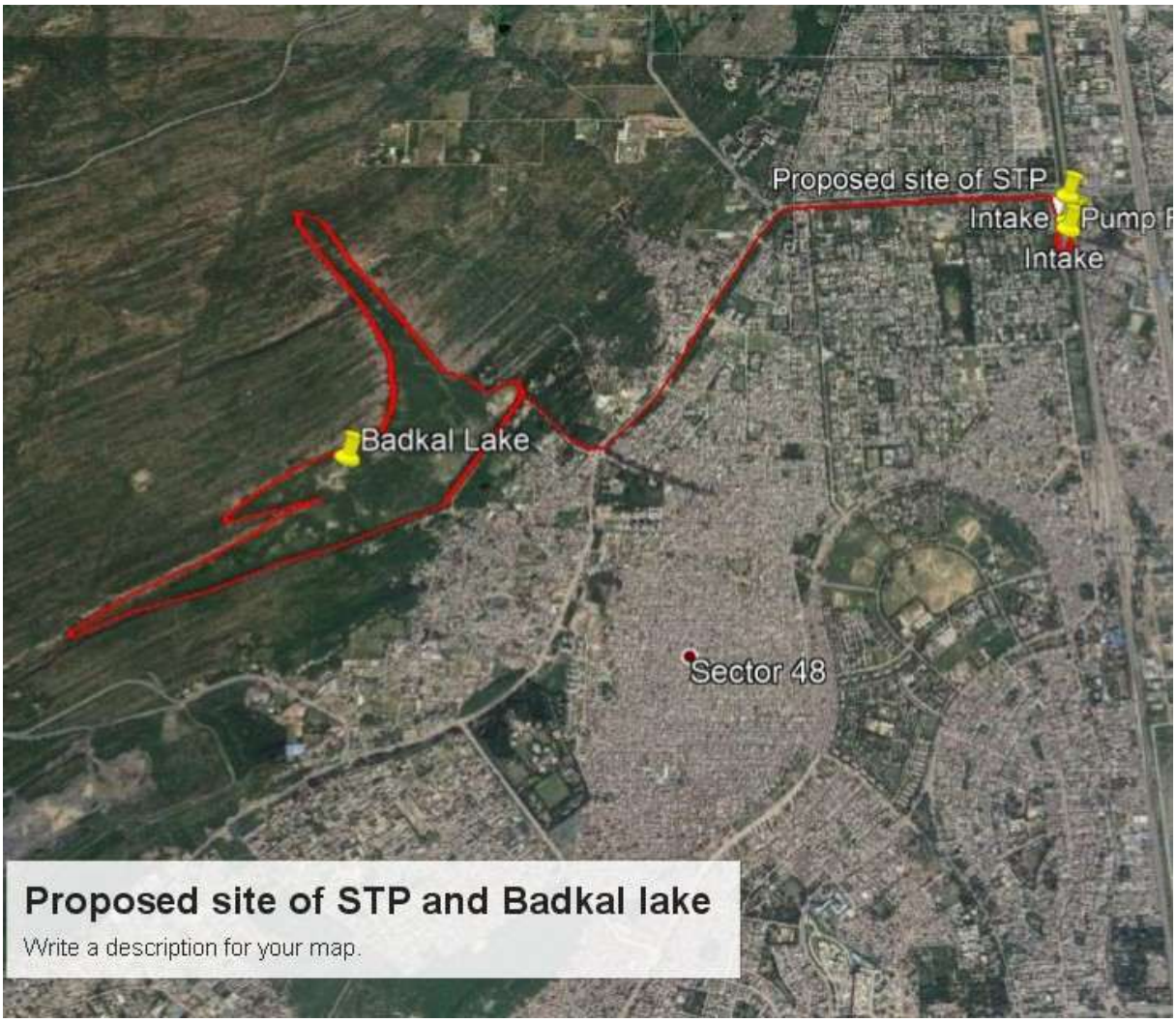
# 1. WORK REQUIREMENT

The **"Faridabad Smart City Limited"** has planned to construct a Sewage Treatment Plant of **10 MLD** capacity at sector-21-C of Faridabad with Treated Effluent Supply System to Badkal lake in Faridabad city. The proposed site of STP along with supply system to Badkal lake is shown in figure below: Presently sewage is coming in two intake wells where from it is disposed by pumping:




**Proposed Site of STP and Badkal lake**

**(TL SIR- PLEASE ARRANGE TO PASTE AN AUTO CAD MAP HERE WITH LEVELS)**

## 1.1 SCOPE OF WORK

1. The works within the scope of this agreement can briefly be described as:

**"Connecting existing sewer lines near both intakes as shown in drawing and catering the sewage to inlet chamber at proposed site of STP, Equilisation tank with pumping arrangement, Sequential Batch Reactor type Sewgae Treatment Plant along with land scaping and ancillary buildings, Tertiary treatment unit (Rapid Sand Filters), Treated water tank, pumping sets and pumping main for supply of secondary treated water to Badkal lake. All the works include Testing, Commissioning and Trial run for 3 months period, along with 60 months of Operation and Maintenance and 2 years defect libality period from the date of completion of trial run period of the project."**

2. The scope of work is divided in three categories and accordingly the BOQ is also prepared in three parts viz Part ”A”, Part “B” and Part “C” as detailed below:

a. **Part “A” - Works requiring survey, investigation, design, supply, construction, commissioning and trial run of complete Sewerage Treatment Plant and Tertiary Treatment Unit with Treated water reservoir and pumping station on turn key basis with defect liability period of 2 years, for which lump sum rate for complete work is to be quoted.**

b. **Part “B” - Works required for supply of treated water to Badkal lake, along with DI pipe line with specials including defect liability period of 2 years for which item rate per meter has to be quoted.**

c. **Part “C” - Operation and Maintenance of complete project part “A” and part “B” for a period of 60 months after completion of trial run period and commissioning of the plant.**

3. Though all related information about site of work is given in the bid document but It is strongly recommended that the bidders physically visit the site of the proposed works before bidding in order to assess the quantum and nature of works.

4. Time for physical completion of work is 18 months from the date of order, including rainy days. The 3 months trial run period shall be after physical completion of works. The commissioning of plant shall be considered after successful trial run period. The Operation and Maintenance period of 5 years (60 months) shall start after successful completion of trial run period and commissioning.

# 2. DETAILED SCOPE OF WORK

## 2.1 PART A: CAPITAL WORKS (TURNKEY WORKS)

### *1.* Preamble

This is a Turn Key lump sum Contract for Survey, Investigation, Design, Supply, Construction, Erection, testing, 3 months trial run and commissioning of Sewage treatment plant based on Sequential Batch Reactor Technology, Tertiary Treatment Unit (Rapid Sand Filters), treated water reservoir, Treated water pumping station, required SCADA system with required approach road, internal roads, pathway, storm water drain, utility ducts, administrative block, Laboratory, toilet block, Landscaping, Gardening, internal lighting and external street lighting, Security guard hut, required electric substation and boundary wall complete in all respect as per the requirement given in detailed specifications. This also includes intake arrangement from existing two number sewage pipe lines, equalization tank and Raw sewage pumping arrangement.

The location plan of proposed site and schematic layout plan for the STP/ TTP is enclosed in drawing part of document for reference, but contractor has to design the plant as per relevant standards and suggest the layout as per his design. A list of work to be taken up under this scope is being given in following para, but shall not be limited to. Since it is a turn-key job, contractor has to complete all the jobs for satisfactory operation of the plant and no additional payment over and above the lump sum rate quoted shall be admissible:

### 2. Major components of the plant

***Intake Arrangement:- 10 MLD Capacity***

- Intake arrangement by diverting existing incoming two sewage pipe lines near STP site.
- Suitably designed sewage intake pipe line suitable for peak discharge (2.0 times average discharge).

***Wet well and sewage Pumping station-10 MLD Capacity***

- Receiving Chamber
- Coarse Screen Channels
- Electric sub-station for complete plant load
- Raw Sewage Sump cum Equalisation Tank and Pump House with Diesel Generating Set to take load of complete plant including Clearwater pumping.
- Pumped Sewage water Conveyance & Flow meter

***SBR Type Sewage Treatment Plant- 10 MLD Capacity***

- Inlet Chamber
- Mechanical Fine Screen Channels
- Mechanical Grit removal facility
- Distribution Box
- SBR Process Units
- Outlet Channel
- Sludge Sump
- Sludge pump house
- Centrifuge platform/ Sludge drying mechanism
- Administration building (Office, conference room, wash room, workshop/ tool room, laboratory, MCC and Control Room)
- Blower Room
- Security cabin &Toilet Block
- Interconnecting Piping
- Plant Utilities
- All related Electrical & Instrumentation Works
- SCADA System
- Landscaping and gardening and Boundary wall

***Tertiary Treatment Unit and Treated Water pumping station- 9 MLD Capacity***

- Tertiary Treatment Unit (Rapid sand filters)
- Chlorine Contact Tank
- Chemical House
- Treated Water Reservoir equivalent to 4 hours storage (Min 1500 cum)
- Treated Water Pumping station complete with pumping sets designed on 20 hours pumping per day.

3. An 11KV electric power feeder shall be made available to contractor within **100 meters of STP Site.** The contractor shall have to make his own arrangements for carrying the 11 KV main, inside boundary and for construction of electric sub stations of 11/0.44 capacity as per requirement The connection at take-off structures with necessary equipment (such as insulators, ACSR, hardware, clamps and connectors etc.) shall be in the scope of Contractor.

*4.* **Site clearance:**

The contractor shall take up the works of site clearance and grading and other mobilazation works with the permission of the Engineer after award of the contract , however before taking up construction,contractor shall be responsible for preparing, submitting, checking and approval of all designs by the Engineer.

**5. Topographic Survey:**

Though Employer has carried out site surveys, however the contractor is required to carry out detailed topographic survey of plant site and along route of treated water pipe line by setting up fully equipped field office for preperation of necessary survey drawings and designs. The design office shall interact with the employer's staff to ensure team work for early submission and approval of the drawings as required. All designs and drawings have to be got checked by civil engineering department of IIT Delhi or any other IIT / NIT as decided by the Employer and have to be got approved from the employer before execution / procurement

**6. Geotechnical Investigations:**

The contractor shall carry out geotechnical Investigation work at the proposed location of treatment plant through a specialist firm, approved by the engineer. The no. of bore holes to be taken, depth of boring etc. shall be decided in consultation with the Engineer-in-Charge. The contractor has to provide the hard and soft copies of the test reports for the parameters such as, the type of soil, the strata, and the level of ground water, optimum moisture content, soil resistivity and chemical composition, safe bearing capacity, etc., as may be required.

**7. Design and Drawing of the STP**

The contractor shall prepare complete system designs including process, hydraulic, unit sizing, general arrangement, piping and structural designs with drawings of all units along with civil, architectural, electrical, mechanical, plumbing, pumping main and erection drawings. These shall be submitted and discussed with the Engineer and got approved prior to taking up the actual work at site. The designs shall also include the power supply system, automation, SCADA systems for monitoring and control, communications etc.

Sewage treatment plant shall be designed based on Sequential Batch Reactor Technology. The sewage characterstics and design effluent parameters are given in **Annexure 1.** The guidelines whereever given in bid document and mentioned in the lattest CPHEEO manual and relevant BIS shall be followed.

Contractor shall provide his own Concept of SCADA system for the turnkey works for automatic smooth operation and proper monitoring of the system subject to approval by

employer.

**8. Layout Plan:**

The layout plan shall be prepared for the entire site showing the location of pumping stations, treatment plant and disposal on the basis of process / unit sizing design indicating sizes of various units with in the area of the site. The minimum distance between the walls of adjescent structures shall be kept 2 m. The layout plan has to be got approved from the employer.

**9. Architectural Drawings:**

The architectural drawings for all building and pumping stations shall be prepared and got approved from the employer.

**10. Structural Design:**

Civil structural design calculations, reinforcement drawings and details of Bar bending schedule for each unit to be submitted for approval for excution purpose. Structural design of for all structures shall be done in accordance with the provisions in BIS Code. Water Retaining structures shall be constructed in RCC - M:30 grade and and all other RCC works shall be designed with minimum M25 grade concrete. All the foundations and sub structures shall be designed / checked for submerged or saturated soil condition as the case may be considering the ground water table/ innundation for design purpose. All the buildings shall be only framed structure and designed as per relevant BIS code (lattest).

*11.* **Electrical and Mechanical design:**

Prepration of design details for electrical and mechanical equipment, technical details of pipes , valves, pen stock gates and other drawings including single line diagram etc. As per specification mentioned under this chapter " Electrical and mechanical Specification"

*12.* **Approval of Design and Drawings:**

The Contractor shall supply to the Employer's Representative **3 (three) copies** along with soft copies each of the initial design calculations for the process and sizing of all components of the System including architectural, structural, mechanical, electrical and instrumentation equipment, supported by flow diagrams and general arrangement drawings for approval. Prior to submission the designs shall be got checked by civil engineering department of any of the IIT/ NIT as per direction of Employer. It is a matter of high priority that the Contractor ensures the submission and finalization of such designs and drawings in the stipulated time schedules as elaborated elsewhere. It is the intention of the Employer to ensure that the approval of such submissions is made expeditiously and in time. The Contractor is therefore required to setup his design office in Faridabad (fully equipped and staffed) to enable continuous submission, interaction and timely clearances. **The Employer has kept a team of experts / PMC which shall be available constantly during the design and execution period for** review / comments and approving the submissions expeditiously.

***13.*** **Submission of Drawings after approval:**

After approval of the design and drawing the contractor shall submit the following:

- Six sets of final and approved drawings and design duly bound.
- Bar Charts-CPM –Pert network for stage wise activities of construction of

sewage treatment plant, pumping stations. etc.

## 2.2 PART "B": CAPITAL WORKS (ITEM RATE WORKS)

**1. General Scope of Work under Part "B" of Capital works**

This is a Contract for providing laying and jointing pumping main with 350 mm diameter Ductile Iron pipes with inside cement mortar lining class K-9, total 3800 meter long complete with all related specials, valves, excavation in all type of soil and other related works for transfer of tertiary treated water from treated water pumping station at proposed STP site to Badkal lake, as per the proposed route shown in the drawing. The bottom of out let pipe at lake shall be 30 cm above FTL of the lake. The detailed scope of work is given in following paras and BOQ is attached. The contractor has to quote the rate for this part on per meter basis inclusive of all related works.

This rate will include providing transporting, staking, laying and jointing of 350 mm diameter Ductile Iron pipes class K-9, complete with excavation in all types of soil with minimum 1 m cover, providing and installation of all types of appurtenances complete with DI bends, Tee, scour valves, sluice valves, air valves etc required as per site condition and CPHEEO manual complete with sectional testing, testing, trial run for a period of 3 months and commissioning of the system. The payment shall be made for the actual length executed for the work.

After approval of the design and drawing the contractor shall submit the following:

- Six sets of final and approved drawings and design duly bound along with "L" section showing ground level and level of pipe line top.

- Bar Charts-CPM –Pert network for stage wise activities of laying pipe line work..

## 2.3 ADDITIONAL WORKS COVERED UNDER CAPITAL WORKS

**2. Trial Run (3 months) :**

After execution of the works the Contractor shall make testing and trial runs of the individual components, including all the units constructed under Part "A" and Part "B" (item rate based) of contract. A continuous operation of the component for a period of 7 days to the satisfaction of the Employer's Representative will be deemed to demonstrate satisfactory completion of trial run for the individual component and then after for the whole plant / system. **The cost of electricity, chemicals and other consumables for operation and maintenance of the System during the period of this trial run will be borne by the Contractor**. The costs towards the Contractor's Representative and other operating personnel during the said period of trial run, along with cost of tools and spare parts and equipment during the trial run period shall also be borne by the Contractor and shall be included in Contract Price. In the event that the System or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time till the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements.

**3. Commissioning**

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The

commissioning of the system shall be considered as fully achieved after the full system has run continuously for a period of 15 days during trial period to the satisfaction of Employer's Representative. If continuous run is not achieved fully to the satisfaction of Employer's Representative, the Contractor has to do the needful to achieve the same at his cost. All the costs thereof, including the cost of staff, maintenance, and any other consumables for operation and maintenance of the system during the period of commissioning including the chemicals used and electricity consumed during the commissioning period shall be borne by the Contractor.

**4. Any other item of works:**

Any items of work, either supply and or erection of material/equipment which have not been specifically mentioned in the specification but are necessary for operation and guaranteed performance of the entire plant, and equipment offered shall be deemed to be included within the broad scope of this specifications and shall be provided by the Contractor without any extra cost to the Employer and its total cost will be borne by the Contractor.

It is advisable that the Bidder should visit the site and appraise him-self of all site conditions prior to preparation and submission of the bid. No extra payment on any account whatsoever over the quoted lump sum prices shall be paid to the contractor.

**5. Services to be provided by the contractor**

I. The Contractor shall take the responsibility for all testing and inspection to be conducted in manner as specified in these specifications and as per relevant B.I.S / International codes such as BS, ASTM, DIN and BIS codes. These codes shall prevail over other codes wherever available. The contracter shall have to get the following equipments / materials inspected through any third agency as decided by the Employer:

a. Ductile Iron Pipes.

b. All type of Valves and Specials.

c. All type of Motors / Pumping Sets and Air Blowers.

d. Transformers, electric cables and required electric switch gears.

e. Sludge drying equipment.

f. Components of SKADA equipment.

II. Employer reserves the right to ask the contractor for getting any other item not included above for third party inspection if deemed necessary.

III. Setting up, and staffing with qualified engineers/ technicians, of suitable laboratories for following the Quality Assurance Program.

IV. Setting up of suitable labour camps with all water and sanitation arrangements and other facilities required under the relevant Labour laws.

V. Implementation of all the environmental and relevant social mitigation measures as required.

VI. Making arrangements for equipment and material required for maintaining safety of the sites and the workmen on site (helmets, boots, jackets, safety belts, gloves, scaffolding, barricading, etc.)

VII. Submission of initial work program and updating the same every month for approval by the Employer's Representative.

VIII. Transportation of all equipment from manufacturers work to the project site inclusive of all-intermediate handling and loading/ unloading / storage at site.

IX. Supply, erection, inspection, testing, and running of the equipment during trial run period at rated capacity and speed.

X. Erection, trial run and commissioning of the entire plant. The Contractor shall also arrange for maintenance of equipment during performance guarantee period commissioning period & operation & maintenance period.

XI. Application of the final paints of approved color shall be done by the Contractor after completion of erection, testing & commissioning.

XII. The Contractor shall also arrange technical experts of equipment from proprietary suppliers as and when necessary until the commissioning, for the entire project period.

XIII. Where the equipment is intended for use under corrosive / chlorinated atmosphere such as laboratory building, Chlorine dosing tanks, the design and material of equipment shall be such that it can withstand these corrosive conditions to minimize effect of corrosion on the equipment.

XIV. **Operation and Maintenance (O&M) manuals** - The Contractor shall submit 1 month before start of trial run and commissioning of the plant, 2 copies of well documented O&M manual of the entire plant with catalogues, details of treatment units, all calculations of chemicals & power etc, general operating instructions for the plant, trouble shooting, instructions for identifications of problems in running of all plant and equipment, and the remedial measures, preventive maintenance of the plant and equipment, documentation and records to be maintained for operation and maintenance of the plant for the approval of the Engineer. After Engineer's approval, the Contractor shall submit final O&M manual, well bound, in 6 sets, incorporating Engineer's comments and with original catalogues of the suppliers and as built drawings.

XV. Mandatory Spares, Laboratory Equipment etc as per list in the annexures shall be supplied 1 month before trial run period.

XVI. Contractor’s staff related to repairs and supervisory role, shall have to normally observe office timings of general shift.

XVII. Plant and equipment covered under this contract shall be totally attended to by the contractor including any “Trouble Shooting” to ensure smooth and trouble free operation.

XVIII. The operation and maintenance period shall be 5 Years from the date of completion of successful commissioning of complete project.

XIX. The contractor shall take all the measures that there shall be no flooding in the project area.

XX. The contractor shall abide by all central/state govt./Semi govt./Local Bodies rules regulations, pertaining to this contract, without any extra cost.

XXI. In the event of any damage/loss of life/theft of property, due to negligence on the part of contractor, the contractor shall be solely responsible and liable for compensation and damages, regarding negligence and the decision of Engineer-in-charge shall be final.

XXII. The contractor should maintain all kinds of securities in the premises round the clock for that he should arrange manpower to prevent theft, robberies and malpractice. The site will be open for inspection by the designated officers/official of Employer at all times during the contract period.

XXIII. The contractor should observe all safety rules and regulations corresponding to electricity, factory act, bio-chem process fire and as per building codes. If any accident occurs by oversighting the rules, the contractor at his own cost and risk shall handle the related cases. Insurance of the entire staff at site is compulsory under insurance policy declared by Govt. of Telangana. The copy of the cover note of insurance policy shall be submitted to the employer.

**6. Data provided for the guidance of the contractor:**

The following data are being provided only for guidance of the Contractor but contractor has to undertake all investigations at his level.

I. Location plan of Sewage treatment plant, Tertiary Treatment Plant and Badkal lake.

II. Topo survey details/ contour plan of proposed site of STP

III. Geotechnical investigation report at site of STP.

IV. "L" Section along route of clear water pumping main from STP site to Badkal lake

V. Characteristics of the raw sewage.

VI. The performance standards of the treated effluent after STP

VII. The performance standards of the treated water after Tertiary Treatment

**7. Equivalency of Standards and Codes**

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the contract. Where such standards and codes are national or related to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be acceptable subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. If the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the Bid Documents.

**8. Sign Board**

The Contractor at his own cost, shall provide sign boards at locations approved by Engineer, in English and Telgu at the site of the Works. The size and design shall be got approved by Engineer.

Name of the Project,

Name and addresses of the Employer and the Contractor.

Short description of the Project,

The Contract Price

The starting and proposed completion dates of project.

Contractor shall take care of signboard and redo in case of loss, damage, theft etc., as desired by the Engineer-in-Charge.

**9. Quality Assurance Plan and Sample Testing**

Contractor shall be responsible to develop a quality control program and shall arrange all necessary materials, apparatus, instruments, equipment, facilities and qualified staff for sampling, testing and quality control of the materials/ concrete etc. The contractor shall---

- Establish a testing laboratory at the site of works which will be adequately equipped and staffed to carry out all sampling and testing in accordance with the requirement set out in the tender document specifications. The laboratory shall have all field equipment and apparatus as necessary to conduct all in-situ tests and /or any tests on completion.

- Arrange for routine sampling, testing and reporting, as required, through a certified independent laboratory acceptable to the Engineer-in-Charge. The Contractor shall obtain the approval of the Engineer-in-Charge for the quality control programme developed by him and incorporate any modifications suggested by the Engineer-in-Charge at no extra cost.

- All costs of such sampling, testing and reporting of test results will be borne by the contractor, the Contractor shall include sufficient provisions in his tendered rates to allow for independent sampling and laboratory testing under the direction of the Engineer-in-Charge. The Contractor shall furnish certified copies of all test reports to the Engineer-in-Charge within 3 days of completion of the specified tests. The Contractor shall, within 14 days after the date of the issue of Letter of Acceptance, submit to the Engineer-in-Charge for his consent a detailed description of the arrangements for conducting the quality control programme during execution of the work, including details of his testing laboratory, equipment, staff and general procedures. If following submission, or at any time during the progress of works, it appears to the Engineer-in-Charge that the Contractor's quality control programme is not adequate to ensure the quality of the works, the Contractor shall produce a revised programme, as desired by the Engineer-in-Charge, which will be adequate to ensure satisfactory quality control. In case the contractor fails to ensure quality control program the action deemed fit will be taken against the contractor.

*10.* **Protection of Utilities**

The Contractor is required to carefully examine the location of the works / route of pipe line with their alignments and will enquire with all authorities concerned with such utility lines such as water supply, sewers, gas pipe, telephone (underground and/or overhead) lines, electric cable (underground and/or overhead), Trees etc., and determine and verify to his own satisfaction the character, sizes, position and lengths of such utilities from authentic records. The Contractor shall be wholly responsible for the protection and/or facilitating relocation of such utilities as may be required and shall not make any claim for extra work or extra time that may be required to protect or facilitate relocating such utilities. If any major shifting realignment of water supply, sewers, gas pipes, electric and telephone lines is necessary due to their interference with the proposed works, the same shall be

done by the contractor. The cost of such relocations will be borne by the contractor

**11. Disposal of sludge**

The dewatered sludge from centrifuge shall be disposed of to a suitable location as directed by Employer for further drying. The responsibility of sludge withdrawal and disposing it lies with the contractor within the trial run and operation and maintenance period. The contractor should explore the possibility promoting it as manure.

**12. Reuse of Treated Effluent and infrastructure for tanker filling**

In the first year after completion the treated effluent from STP and TTP, has to be used for filling Badkal lake. In later years a part of it shall be pumped to Badkal lake and rest will be used by the Employer for industrial use, horticulture and washing. Contractor has to create an infrastructure for filling of water tankers with in STP site as directed by Employer.

**13. Disposal of Excavated Stuff**

It will be the responsibility of contractor to dispose all the excavated stuff at a site as directed by Employer/ Employer representative.

**14. Safety Equipment**

Safety equipment should be provided at sewage treatment plant site as per the recommendation of Inspector of Industries. Contractor shall also take care of safety compliance as per safety rules/Factory act/Indian Electricity regulations / manuals / manufacturer's special instructions.

**15. Model of the Project**

A model of the project shall also be submitted by the contractor of a scale such that the size is not less than 1.5m x 2.5m. Model shall be kept over a table and fitted within a glass box.

## 2.4 PART C: OPERATION AND MAINTENANCE (60 MONTHS)

**1. Scope of Work :** The scope under this part includes Operation and Maintenance of the project including all facilities as constructed under Part "Ä" and part "B" of scope of capital works mentioned above for a period of 60 months after completion of trial run period and commissioning of the project.

The cost of chemicals and other consumables for operation and maintenance of the project and facilities during the O & M period will be borne by the contractor. ***However the power charges shall first be paid by contractor and later shall be reimbursed by the Employer on submission of receipt along with the monthly bill.*** The costs towards the Contractor's Representative and operating personnel along with cost of tools, repair charges and spare parts during the said period will be borne by the contractor.

***2.*** **Staff during O & M period**

The bidder shall, as a part of his technical proposal, provide a detailed staffing Schedule showing the list of persons that shall be deputed by him during O & M period indicating the duties, responsibilities and qualification against each.

**3. Training the Employers personnel:**

Three months before the completion of O & M period the Employer shall identify and depute his staff persons along with Contractors staff. The contractor shall be responsible to provide training to such employer's staff about operation and maintenance of the project along with repair and maintenance whatever is required. The contractor shall prepare a training program and submit to the Engineer In-charge for

approval. The cost of training program shall be borne by the contractor. The contractor shall ensure that the designated personnel are adequately trained before completion of O & M period to take up the responsibilities for Operation and Maintenance of the project.

**4. Taking over of project**

The complete project shall be taken over by Employer's representative on satisfactory completion of the operation and maintenance period of 60 months provided that,

- The plant/equipment is in good running condition.
- All records of operation and maintenance during the 60 months period are handed over to Employer in proper condition.
- The O & M manuals have been updated following 60 months operational experience and approved by Employer.

In case taking over is delayed on account of Contractor's failure, the O & M period will be extended further till it meets the above requirement without any extra cost to Employer.

**5. Defect Liability Period (24 months)**

The defect liability Period shall be for a period of 24 months for part A & B of capital works, which shall be effective from the date of completion of trial run period and commissioning of the project. The contractor shall be responsible to rectify any deficiencies which attribute to defects in the workmanship or quality of material, plant and equipment during this period. Thus contractor is required to quote the O & M charges for first 2 years period taking in to consideration that defects arising out during this period have to be rectified free of cost.

The contractor shall ensure uninterrupted working of the plant during this period. Thus it is the responsibility of the contractor to keep sufficient inventory of spares in advance, required to meet the contingencies in case of break-down due to any electrical or mechanical part. Non availability of spare parts shall not be an excuse for keeping the plant shut in the event of malfunction or break down.

***The cost on all the above is deemed to be included in the total cost coated by the contractor.***

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**ANNEXURE I**
**SEWAGE CHARETERSTICS AND EFFLUENT CHARACTERSTICS FOR SEWEAGE TREATMENT PLANT & TERTIARY TREATMENT PLANT**

| S. No. | Particulars | Design Parameters | Units | Sewage Inflow Characteristics to STP |
|---|---|---|---|---|
| 1 | Input Sewage Characteristics & Peak factor | Peak factor | | 2 |
| | | Temperature range | Degree Centigrade | 20-45 |
| | | pH | | 6 -8 |
| | | BOD5 at 20 deg | mg/lit | 250 |
| | | COD | mg/lit | 425 |
| | | TSS | mg/lit | 375 |
| | | VSS | mg/lit | 260 |
| | | Total Nitrogen | mg/lit | 50 |
| | | Organic Nitrogen | mg/lit | 12.5 |
| | | Ammonia Nitrogen | mg/lit | 32.5 |
| | | Nitrate Nitrogen | mg/lit | 5 |
| | | Total Phosphorous | mg/lit | 7.1 |
| | | Ortho Phosphorous | mg/lit | 5 |
| **S. No.** | **Particulars** | **Design Parameters** | **Units** | **Treated Effluent parameters from STP** |
| 2 | Treated Effluent Parameters from SBR STP | pH | | 6.8- 8.5 |
| | | BOD 5 at 20 egree C | mg/lit | <10 |
| | | TSS | mg/lit | <10 |
| | | COD | mg/lit | <100 |
| | | Faecal Coliform | mg/lit | 3< 4 |
| | | T-N Removal efficiency | mg/lit | 70-80 % |
| **S. No.** | **Particulars** | **Design Parameters** | **Units** | **Treated Water parameters from TTP** |
| 3 | Treated Water Parameters after Tertiary Treatment | pH | | 7 - 8.5 |
| | | BOD 5 at 20degree C | mg/lit | <2 |
| | | Turbidity | mg/lit | <2 |
| | | Colour at Platinum Cobalt Scale | | <5 |
| | | Nitrate as NO3 | mg/lit | 45 |
| | | Faecal Coliform | | 0 |
| | | Coliform Organism | | 0 |
| | | Free Chlorine residual | mg/lit | 0.5 |

**ANNEXURE II**
**MINIMUM NUMBER OF STAFF REQUIRED**
**DURING 3 MONTHS TRIAL RUN PERIOD FOR PLANT & TREATED WATER SUPPLY SYSTEM**

| Sr. No | Staff Category | No. of Staffs | Minimum Qualification of staff |
|---|---|---|---|
| 1 | Plant Manager | 1 | Graduate Engineer having at least 5 year experience in PH Engineering |
| 2 | Chemist ( Analyst) | 1 | Chemical Analyst shall be science graduate having at least 5 year experience in the field of Sewage Treatment Technology. |
| 3 | SCADA Specialist | 1 | Graduate in Information Technology with 5 year experience in SCADA system. |
| 4 | Electrician | 1 | ITI Pass with 5 year experience in STPs and pumping stations |
| 5 | Mechanic | 1 | ITI Pass with 5 year experience in STPs and pumping stations |
| 6 | Pipe line Fitter | 1 | ITI Pass with 5 year experience in Pipe line repair and maintenance |
| 7 | Plant operators | 3 | ITI Pass with experience of operating STPs and pumping stations |
| 8 | Helper | 5 | $8^{th}$ class pass |
| 9 | Watchman | 3 | $8^{th}$ class pass |
| **Total** | | **17** | **Total 17 numbers** |

***Note: This is the minimum staff required. Contractor may depute any additional staff if required for satisfactory trial run of the plant.***

**ANNEXURE III**
**MINIMUM NUMBER OF STAFF REQUIRED**
**DURING 60 months O&M PERIOD FOR PLANT & TREATED WATER SUPPLY SYSTEM**

| Sr. No | Staff Category | No. of Staffs | Minimum Qualification of staff |
|---|---|---|---|
| 1 | Plant Manager | 1 | Graduate Engineer having at least 5 year experience in PH Engineering |
| 2 | Chemist ( Analyst) | 1 | Chemical Analyst shall be science graduate having at least 5 year experience in the field of Sewage Treatment Technology. |
| 3 | SCADA Specialist | 1 | Graduate in Information Technology with 5 year experience in SCADA system. |
| 4 | Electrician | 1 | ITI Pass with 5 year experience in STPs and pumping stations |
| 5 | Mechanic | 1 | ITI Pass with 5 year experience in STPs and pumping stations |
| 6 | Pipe line Fitter | 1 | ITI Pass with 5 year experience in Pipe line repair and maintenance |
| 7 | Plant operators | 3 | ITI Pass with experience of operating STPs and pumping stations |
| 8 | Helper | 5 | $8^{th}$ class pass |
| 9 | Watchman | 3 | $8^{th}$ class pass |
| **Total** | | **17** | **Total 17 numbers** |

***Note: This is the minimum staff required. Contractor may depute any additional staff if required for satisfactory operation and maintenance of the plant***

**ANNEXURE IV**
**LIST OF LABORATORY EQUIPMENTS FOR PLANT SITE FOR PROPER O & M**

1.Electronic Analytical Balance with minimum wighing capacity of 1 mg and accuracy of +/-2%
2.Autoclave for sterilization - capacity 100 litres.
3.Laboratory Centrifuge
4.Chlorine Comparator Apparatus
5.Distilled Water Apparatus
6.Dissolved Oxygen Meter
7.Drying Oven Hot Air (1050 C)
8.Hot Plates
9.Incubator with settings of 270 C and 200 C for BOD
10. Magnetic Stirrers
11. COD Apparatus
12. Muffle Furnace 600 Deg of 20 litres capacity
13. pH Meter
14. Refrigerator 230 liters with 2 separate compartment – i.e. separate freezer (65 liters) and lower compartment maintaining a temperature of 8 deg C+/-2Deg C of 165 liters capacity
15. Soxhlet Extraction Unit – for Oil/Grease
16. Spectrophotometer for above tests
17. Hydro Extractor
18. Laboratory Furniture comprising of Laboratory bench, 1.0 m wide x 4.0 long, treated with anticorrosive paint, comprising of almirah underneath for storage of glass wares, side racks for storage of reagents bottles, two laboratory sinks with taps, valves and drain pipe etc.
19. Glass Ware comprising of beakers, conical flask, burette, pipette, volumetric flask titration and gravimetric analysis, sampling bottles etc.
20. Stock of chemicals sufficient for six months testing.

***Note: If any additional Laboratory equipment are required for satisfactory O &M of the plant, the same shall also be provided by the contractor***

**ANNEXURE V**
**LIST OF MANDATORY SPARES FOR PLANT SITE**

1. Gland packing for Valves- 2 sets for each size.
2. Oil seal for gear box- 2 sets for each size and type.
3. Fans for motor- one number for each size and type.
4. One set of rubber bushes, bolts & nuts for each flexible coupling.
5. One set of fuses for all ampere ratings in use at the plant.
6. MCB – one MCB of each ampere rating being used at plant
7. Indicator lamps- 2 no of each colour.
8. Contractors- one number of each rating in use at plant.
9. Thermal overload relay- one number of each rating used.
10. Push button- one number for start & one number for stop.
11. Rubber Squeegees- one set for Grit Separator and one set for thickener

**ANNEXURE VI**
**LIST OF FURNITURES / FIXURES TO BE PROVIDED IN THE OFFICE BUILDING**

i. Wooden conference table 2.4 m x 1.2 m with eight chairs- One set.
ii. Tables 1.2 m x 0.75 m, six number with drawers.
iii. Chairs Six nos.
iv. Steel cupboards (store well / Godrej or any other standard make)- 4 numbers.
v. Two nos. filing cabinet with 4 drawers
vi. Vertical blinds to all Windows
vii. Air Conditioners and Celling fans for the entire administrative block and labrotory.
viii. All necessary laboratory furnitures ( Table, chairs and cupboards etc)

**ANNEXURE VII**
**LIST OF TOOLS TO BE SUPPLIED**

1. Fix spanner sets (large) – 2 sets
2. Ring Spanner Set (Large) – 2 sets
3. Pliers large – 2 no.
4. Buckets 20 liters capacity – 2 nos
5. Cutters, hacksaws
6. Hammers – 3 number of different weight as per requirement
7. Pipe threading equipment
8. Super sieve pipe cutters
9. Grease gun
10. Large scissors, tongs
11. Lubrication Cans with long neck-2 nos
12. Pipe wrench 350, 450 and 600 mm size one each
13. Sheer legs and tripods
14. Set of screw drivers 2 sets
15. Chain pulley block- 2000 kg capacity
16. Shovels- 4 nos
17. Set of chiesels as per requirement
18. Telescopic Ladder (aluminum) max. height 5 m

**ANNEXURE VIII**
**LIST OF CONSUMABLES (INVENTORY)**

1. Cotton waste
2. Oils of different grades
3. Greases of different grades
4. Kerosene, Diesel, petrol, spirit as per the requirements for the plant
5. Nuts, bolts, washers, nipples etc. shall be as per the compilation on the basis of manufacturer's recommendations for various equipments.
6. Rubber hose (pipe) 25 mm, L =50 m with coupling
7. Neoprene rubber pads
8. Liquid Chloreine Gas, Lime solution, Allumina ferric- min 2 months stock all time.
9. Other chemicals as required for operation of the plant, min 2 months stock all time

**ANNEXURE IX**

## SCHEDULE OF STAGE PAYMENTS FOR THE PROJECT

**Note: Stage payments shall be made on achieving the mile stone as described in tables below. Further bifurcation of stage payment for mechanical equipment can be done (if desired by contractor) by mutual discussion between the employer and the contractor. But decision of employer shall be final.**

### PART "A" OF CAPITAL WORKS (SBR TYPE STP, RAPID SAND FILTERS INCLUDING CIVIL AND ELCTRO MECHANICAL WORKS WITH SCADA SYSTEM & TREATED WATER STORAGE WITH PUMPING STATION COMPLETE)

| S No | Particulars of Component | Milestone percentage | Cumulative percentage |
|---|---|---|---|
| | **Inlet works, Wet well with pumping station, Pre-treatment units up to inlet to SBR aeration units and Electric sub station** | **(8 percent of total amount quoted for part "A" of project)** | |
| 1 | Survey, Investigation, design, approval and submission of approved design and drawings | 2% | 2% |
| 2 | On completion of laying and jointing of Collecting sewer lines | 3% | 5% |
| 3 | After completion of civil works for inlet chamber and coarse screen channels/ chambers | 5% | 10% |
| 4 | On completion of civil works for wet well up to ground level | 12% | 22% |
| 5 | On completion of civil works for wet well cum pump house up to roof level | 8% | 30% |
| 6 | On completion of civil works for fine screen chambers/ channels, grit chamber and channel up to splitter box | 10% | 40% |
| 7 | Supply and installation of all electro-mechanical/ electrical / instrumental works | 50% | 90% |
| 8 | On completion of 3 months trial run period and commissioning | 2% | 92% |
| 9 | On completion of 2 years defect liability period | 8% | 100% |
| | **SBR units, Aeration system, Decanter system, Sludge sump cum pump house, centrifuge system, laboratory, complete with all electro-mechanical, electrical, instruments and SCADA system** | **(72 percent of total amount quoted for part "A" of project)** | |
| 1 | Survey, Investigation, design, approval and submission of approved design and drawings | 2% | 2% |
| 2 | On completion of civil works of all units up to foundation level | 8% | 10% |
| 3 | After completion of civil works up to half the height of all the structures. | 14% | 24% |
| 4 | After completion of civil works up to full height including roof | 16% | 40% |
| 5 | Supply and installation of all electro-mechanical/ electrical / instrumental works | 50% | 90% |
| 6 | On completion of 3 months trial run period and commissioning | 2% | 92% |
| 7 | On completion of 2 years defect liability period | 8% | 100% |
| | **RGF plant, chemical house, chlorination chamber, Treated water reservoir, Pump house, Diesel generating system complete with all electro- mechanical/ electrical system and related instruments** | **(11 percent of total amount quoted for part "A" of project)** | |
| 1 | Survey, Investigation, design, approval and submission of approved design and drawings | 2% | 2% |
| 2 | On completion of civil works of all units up to foundation level | 8% | 10% |
| 3 | After completion of civil works up to half the height of all the structures. | 14% | 24% |
| 4 | After completion of civil works up to full height including roof | 16% | 40% |
| 5 | Supply and installation of all electro-mechanical/ electrical / instrumental works | 50% | 90% |
| 6 | On completion of 3 months trial run period and commissioning | 2% | 92% |
| 7 | On completion of 2 years defect liability period | 8% | 100% |
| | **All remaining ancillary works as per scope of work including administrative building, control room, staff quarters, boundary wall, land scaping, internal roads, campus lighting etc complete** | **(9 percent of total amount quoted for part "A" of project)** | |

| | | | |
|---|---|---|---|
| 1 | Survey, Investigation, design, approval and submission of approved design and drawings | 2% | 2% |
| 2 | On completion of civil works of all units up to foundation level | 15% | 17% |
| 3 | After completion of civil works up to half the height of all the structures. | 23% | 40% |
| 4 | After completion of civil works up to full height including roof | 30% | 70% |
| 5 | Supply and installation of all electro-mechanical/ electrical / instrumental works | 20% | 90% |
| 6 | On completion of 3 months trial run period and commissioning | 2% | 92% |
| 7 | On completion of 2 years defect liability period | 8% | 100% |

**PART "B" OF CAPITAL WORKS (TREATED WATER PIPE LINE UP TO BADKAL LAKE)**

| S No | Particulars of Component | Milestone percentage | Cumulative percentage |
|---|---|---|---|
| **B** | **Providing Laying, Jointing, testing and commissioning of Ductile Iron Pipe line with cement mortar lining 350 mm diameter Inlet works, wet well, electric sub-station, and Pre-Treatment works** | **(Quoted amount payable for total length)** | |
| 1 | Survey, Investigation, design, approval and submission of approved design and drawings | 5% | 5% |
| 2 | On completion of laying jointing with all appurtenances valves etc and sectional testing of 35% of total length | 25% | 30% |
| 3 | On completion of laying jointing with all appurtenances valves etc and sectional testing of 70% of total length | 25% | 55% |
| 4 | On completion of laying jointing with all appurtenances valves etc and sectional testing of 100% of total length | 25% | 80% |
| 5 | On completion of 3 months trial run period and commissioning | 10% | 90% |
| 6 | On completion of 2 years defect liability period | 10% | 100% |

**PART "C" OPERATION AND MAINTENANCE OF COMPLETE PLANT (PART "A" AND "B") FOR A PERIOD OF 60 MONTHS**

Operation and Maintenance of complete project including Sewage Treatment Plant, Tertiary treatment Plant and treated water supply system up to Badkal lake complete with all civil mechanical electrical and SCADA related works under Part "A" and Part "B" of Bid document and all project related buildings complete with all required consumables, chemicals, tools and plants but excluding the power charges. The operation and maintenance has strictly to be done as per O & M specifications and related manuals. **The payment of O & M charges will be made on monthly basis @ charges quoted for the year divided by 12.The bill will be submitted by the contractor at the end of each month**

## ANNEXURE IX

## MILESTONE FOR DEVELOPMENT OF THE PROJECT

| Sr. No | Particulars of work | Duration of Time in months | | | Schedule of Works in Months | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimated Time | Start | Finish | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **Part A** | **Treatment plant and other allied works** | **18** | **1** | **18** | | | | | | | | | | | | | | | | | | |
| 1 | Mobilization | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | |
| 2 | Survey, investigation, design and drawing | 2 | 2 | 3 | | 2 | 3 | | | | | | | | | | | | | | | |
| 3 | Approval | 1 | 4 | 4 | | | | 4 | | | | | | | | | | | | | | |
| 4 | Construction of all components up to GL | 4 | 5 | 8 | | | | | 5 | 6 | 7 | 8 | | | | | | | | | | |
| 5 | Construction of all components up to Finish level | 6 | 8 | 13 | | | | | | | | 8 | 9 | 10 | 11 | 12 | 13 | | | | | |
| 6 | Supply of Electromechanical works of plant | 4 | 10 | 13 | | | | | | | | | | 10 | 11 | 12 | 13 | | | | | |
| 7 | Installation of Electromechanical works | 5 | 12 | 16 | | | | | | | | | | | | 12 | 13 | 14 | 15 | 16 | | |
| 8 | Testing commissioning and trial run | 3 | 16 | 18 | | | | | | | | | | | | | | | | 16 | 17 | 18 |
| **Part B** | **Pipe line work for raw sewage and Treated effluent Supply System with collection tank** | **18** | **1** | **18** | | | | | | | | | | | | | | | | | | |
| 9 | Mobilization | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | |
| 10 | Design and drawing | 1 | 2 | 2 | | 2 | | | | | | | | | | | | | | | | |
| 11 | Approval | 1 | 3 | 3 | | | 3 | | | | | | | | | | | | | | | |
| 12 | Supply of Pipes at site | 2 | 11 | 12 | | | | | | | | | | | 11 | 12 | | | | | | |
| 13 | Laying and jointing of treated water supply line and sewage carrying pipe lines | 3 | 13 | 15 | | | | | | | | | | | | | 13 | 14 | 15 | | | |
| 14 | Construction of RCC Storage Tanks in Parks | 3 | 13 | 15 | | | | | | | | | | | | | 13 | 14 | 15 | | | |
| 15 | Testing commissioning and trial run | 3 | 16 | 18 | | | | | | | | | | | | | | | | 16 | 17 | 18 |
| **Part C** | **Operation and Maintenance Works** | **120 Months after completion of trial run and commissioning** | | | | | | | | | | | | | | | | | | | | |

# 3. SPECIFICATION FOR PROPOSED WORKS

The broad design parameters and specifications for the works are provided in this section of document, but the general specifications for all works are provided in subsequent sections.

**SEWAGE TREATMENT PLANT**

**Brief Process Description:**

The plant shall be based on Sequential Batch Reactor Technology popularly known as SBR Technology. The treatment of sewage undergoes physical, chemical and biological treatment. The first part of Physio- Chemical treatment is the Primary treatment, which covers the physical activities such as screening, de- gritting, flow measurement, flow distribution etc. The plant is to be designed in accordance with the characteristics of influent sewage and desired characteristics of effluent and following the guide lines laid by CPHEEO manual, published by Govt. of India . The detailed description of individual units and their functions are given below.

**Raw Sewage Pumping Station:**

The Raw Sewage Pumping Station is designed to handle peak flows. It includes transfer of sewage from existing two sewage lines. The coarse screen chamber is provided ahead of sump to screen raw sewage. The screened sewage is then allowed to flow to Raw Sewage collection cum Equalization tank. Necessary non clog submersible pumps shall be provided to pump the screened raw sewage for further treatment.

**Primary Units:**

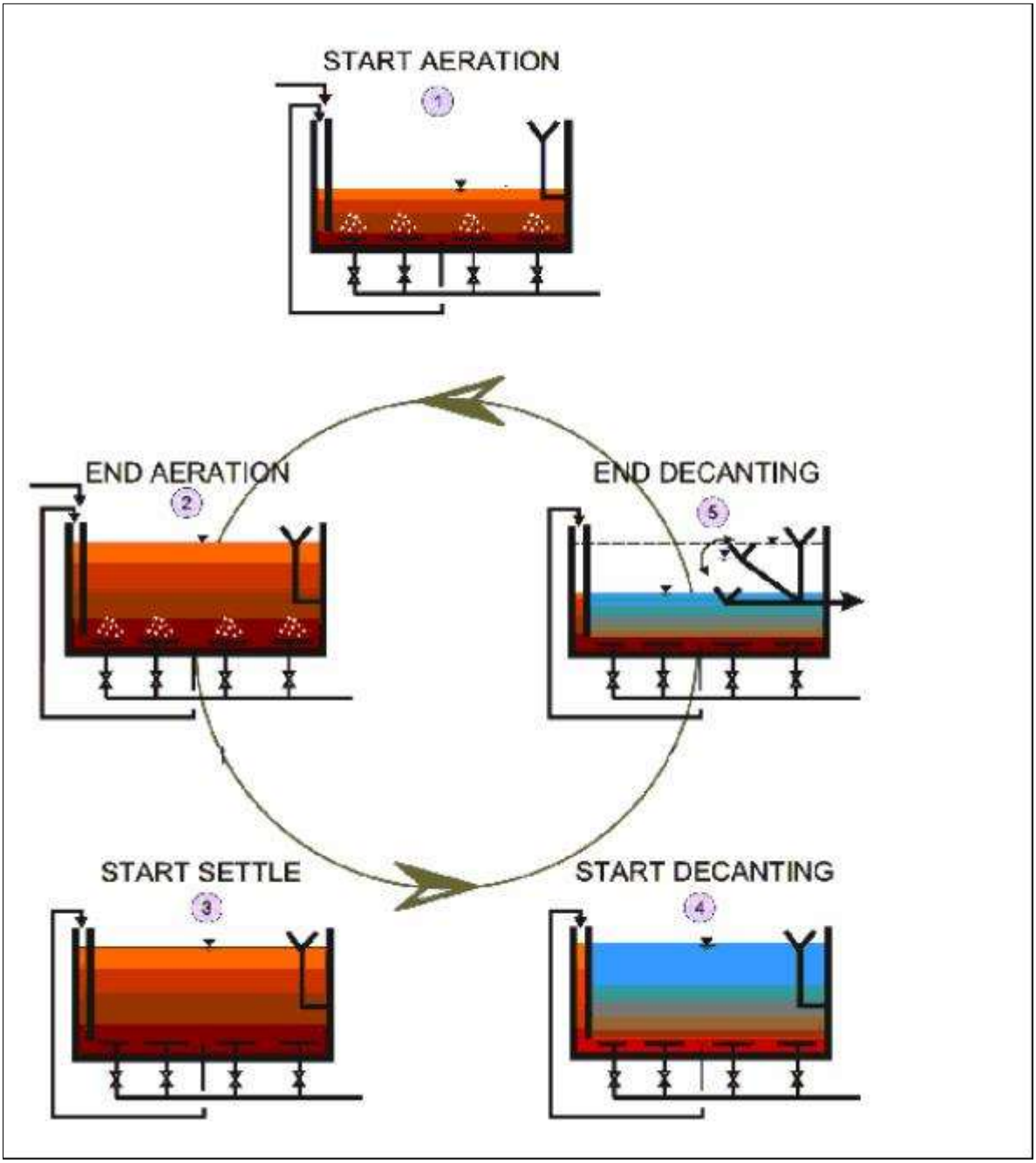
The first unit of Primary treatment is the Distribution Chamber, in which the discharge from rising main through Raw Sewage Pumps is received. The distribution chamber is used to smoothly distribute the flow to fine screen channels. The screenings are to be conveyed to disposal through a conveyor belt. The screened effluent flows to the Grit chamber, where heavy Inorganic matter is separated. The grit free effluent thus flows to SBR Basin.

**Sequential Batch Reactor:**

The SBR process has to provide highest treatment efficiency possible in a single step biological process. The system is operated in a batch reactor mode, which eliminates all the in efficiencies of the continuous flow process. Minimum three modules are to be provided to ensure continuous treatment assuming one shall be in filling mode, second one in decanting mode and third one to take care in case repair / cleaning of one of the unit. The complete process shall take place in a single reactor, with in which all biological treatment steps shall take place sequentially. No additional settling unit / secondary clarifier is required. The complete biological operation is divided into cycles. Each cycle may be of about 12-15 hours HRT, during which all treatment shall take place.
One cycle shall comprise of:

- Fill and Aeration (F / A)
- Settling ( S )
- Decanting ( D )

During the period of a cycle, the liquid shall be filled in the SBR basin up to a set operating water level. Aeration Blowers shall be started simultaneously for aeration of the effluent. After the aeration cycle, the biomass shall be allowed to settle under perfect settling conditions. After settling the supernatant shall be removed from the top by using the DECANTER. The cycle shall further be repeated. All operation shall be controlled through properly designed SCADA system. The cycle is graphically being repeated in following diagram:




**Details about different units in STP are being described below:**

**(i) WET WELL CUM EQUALISATION TANK AND SEWAGE PUMPING STATION**

**Receiving Chamber with velocity control device**

The raw sewage has to be taken into a Receiving chamber. The function of the Receiving chamber is to divert the flow to process units. The Receiving Chamber shall be designed for peak flow. The Receiving chamber shall consist of sluice gate on down stream for flow regulation. Sluice gate shall be installed such that it is possible to operate them manually as well as through SKADA system. The inspection as well as operation can be possible by standing on a platform constructed at a suitable elevation adjoining the inlet chamber. The inlet chamber shall be of adequate size (minimum 60 seconds) to meet the requirements of workability inside it. The receiving chamber shall be water tight to prevent seepage of the sewage out of the inlet chamber. The entire construction shall be in M30 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC access platform of minimum 1000 wide with railing as per specifications shall be provided on one side of the chamber. Free board shall be 500 mm.

**(ii) Mechanical Coarse Screen Chambers**

Two mechanical screens of 20 mm opening and one as standby working manually is to be provided in the screen chamber. The screen channels shall be designed for peak flow. The mechanical and manual bar screens shall be made of Stainless Steel (SS 316) flats. Conveyor Belt and chute arrangement shall be provided to take the screenings. The screenings dropped from chute will be collected in a container (to be supplied by contractor) of approx. 1.5 m3 capacity. Manually operated aluminum gates are to be provided at the upstream and down stream ends to regulate the flow.

RCC Platforms shall be provided at the upper level to enable operation. RCC Platform with Railings shall be provided around the entire periphery. The entire structure is to be constructed in CC - M 30, with sulphate resistant cement and is to be designed as per IS 3370.

RCC staircase 900 mm wide shall be provided for access from the ground level to the top of the unit & to the operating platforms. Information related to screen and screen channel is summarized below:

| Parameters | Values |
|---|---|
| Cross section of the bars | 50 mm x 10 mm |
| Opening in screen | 20 mm |
| Free board | 0.5m |
| Angle of inclination | 75 degree |
| Gates 1 for each channel at inlet and outlet. | Manual CI Gate |
| MOC | Stain less Steel (SS 316) |
| Operation | Timer operated |
| Reduction Gear Box Type | Worm / helical |
| Reduction gear Material of Construction | Standard |
| Motor HP | As per approved design |
| Accessories | Conveyor belt for conveying the screened materials to Wheeled trolleys |

**(iii) Sewage Sump cum Equalization Tank and Pump House with Diesel Generating Set**

Sewage enters into wet well of the pumping station after screening. The wet well may be circular or rectangular in shape. The capacity of the wet well cum equalisation tank should be kept such that the detention time in the wet well shall be minimum 30 minutes of peak flow and the maximum detention time shall not exceed 90 minutes at average flow.

Following criteria's shall be considered to size the sump:

- The arrangement of the submersible pumps as per pump manufacturer's data i.e. spacing between pumps, minimum space between pump and wall etc.
- The side water depth shall be minimum 3 meter. In addition to the above liquid depth an additional depression shall be provided to ensure adequate submergence of the pump as per the manufactures recommendations. Pumping station should have a room adequate for installing electrical panels. Suitable arrangement should be provided for lifting of pumps.

The wet well, piping and appertenances have to be designed as per IS: 3370 and IS: 4111 (part 1 to 4). Pumping machinery shall be designed for **peak flow (2.0 times the average flow).** 100% stanby pumping sets shall be provided in wet well. The pumps shall be Submersible raw sewage pumps with centrifugal, non-clog type design. The synchronous speed of pump and prime mover shall be 1500 rpm. The impeller should be of a non-clog design with smooth passage and solid handling capability of 20 mm size.

Pump shall run smooth without undue noise and vibration. Noise level shall be limited to 85 db at 1.86 m.

Vibration shall be limited as per BS 4675 Part I.

Bearing shall be easily accessible for inspection and maintenance. The bearings shall be having a minimum life of 25000 hours of working. The motor shall be squirrel cage type. Suitable for three phase supply continuous duty with class 'F' insulation. Motor shall have integral cable ports and the cable entries shall be sealed. The cables shall be leak tight with respect to liquids and firmly attached to the terminal block. The Motor shall be designed for non-overloading characteristic of quantity. The Motor HP shall be sufficient to handle input required by pump at ( - ) 25% and ( + ) 10% of rated head, and shall be at least 10% more than HP required at duty point pf pump.

Complete rotor shall be balanced dynamically. The moisture sensor of the tripping unit shall be located inside the oil chamber. Information related to wet well is summarized below:

| Parameters | Values |
|---|---|
| No. of pumps | Min 2 Nos. Working + 100% Stand by. |
| Capacity of each pump | As per design |
| Wet Well material of Construction | RCC M:30, with sulphate resistant cement |
| Speed (nominal) | 1450 RPM, Synchronous speed 1500 RPM |
| Motor | HP, 415 V, 3 phase, 50 Hz f |
| MOC | CI casing, CF-8M impeller, SS-410 shaft |
| Insulation | Class F |
| Protection | IP 68 |
| Hrs of operation | 24hours |
| Type of pump | Submersible, non-clog, Centrifugal |
| MOC | CI |
| Level switch | Level switch in pump for tripping off at low level and high level with alarm |

The size of the sump shall be suitable to accommodate the number of pumps required for operation and easy maneuverability of pumps. There shall be an Integral Control Panel room for the pumps and coarse Screens located near the sump.

The room shall be suitably sized to house the Control Panel, space for spare parts and a maintenance area, etc. and be complete with the following accessories:

A Diesel Generator Set of suitable capacity to operate wet well pumps and campus lighting shall be installed near to wet well, to take care of gravity inflow of sewage during power break downs. Suitable electric panel with change over mechanism shall also be provided.

(a) Hoist – comprising of I- Girder and a chain pulley (the chain pulley block capacity to be 1½ Ton or 3 times the maximum single unit/ weight that may be required to be removed for maintenance) with horizontal travel on the I-beam.

(b) Ventilation in the room shall be as per NBC norms specified in the Civil Construction manual.

(c) The shed shall be suitably designed to allow the natural light.

(d) Adequate number of fire extinguishers is to be provided as per Electricity Employer norms.

(e) Internal Illumination and campus lighting shall be of levels as per relaevant BIS and National Building Code.

**Testings :**

(a) Hydrostatic Testing : All pressure parts of pumps prior to assembly, shall be subjected to hydrostatic tests at 1.5 times the maximum pressure obtained with the delivery valve closed

and suction pressure at maximum, or twice the working pressure whichever is higher for a duration of 10 minutes.

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

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

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

**(iv) Pumped Sewage water Conveyance & Flow meter**

The pumped flow from the pumping station to the inlet chamber of the plant shall be taken through a DI K-9 Class pipeline. The rising main shall be designed for a peak factor of 2.0 times the average flow. An electromagnetic flowmeter shall be installed in the rising main for measurement of flow.

(a) The pipeline shall be adequately sized to have a minimum velocity of at least 0.6 m/s at minimum flow conditions and not more than 3 m/sec at pumped peak flow.

(b) The pump head shall be adequately designed to give a residual discharge head as per CPHEEO manual.

**(V) Mechanical Fine Screen Channels**

Two mechanical screens of 6 mm opening as working and one manual screen of 10mm opening as standby are proposed in the screen chamber. The screen channels shall be designed for peak flow. The clear opening for mechanical screen shall be 6mm. The mechanical and manual bar screens shall be of 6 mm thick Stainless Steel (SS316) flats. Conveyor Belt and chute arrangement shall be provided to take the screenings to the drop point, from where it will be collected in a trolley of approx. 1 m3 capacity. This trolley will be housed in a roofed enclosure with proper access, screen washing arrangement and drain. Manually operated gates shall be provided at the upstream and down stream ends to regulate the flow. RCC Platforms shall be provided at the upper level to enable operation of the gates. Railings shall be provided around the entire periphery of the platform. The entire structure is to be in M 30 concrete with sulphate resistant cement and as per IS 3370. RCC staircase 900 mm wide shall be provided for access from the ground level to the top of the unit & to the operating platforms. Information related to fine screen is summarized below:

| Parameters | Values |
|---|---|
| Number of screen channels | 3 Nos |
| Number of Screens | 2 Mechanical working (Each 50% Peak flow) + 1 Manual standby (100% Peak flow) |
| Design flow considered to each Channel | Average Flow |
| Approach Velocity at Average Flow ( m/s) | 0.3 minimum |
| Min. Velocity through Screen at Average flow ( m/s) | 0.6 |
| Max. Velocity through Screen at Peak Flow in m/s | 1.2 |
| Opening in screen | 6 mm for Mechanical and 10 mm for manual |
| Channel Size | Approved Design |
| Minimum Free Board | 0.5m |
| Angle of inclination of screens | 45 |
| MOC | 6 mm thick Stainless Steel (SS316) |
| Operation | Timer operated |
| Reduction Gear Box Type | Worm / helical |
| Reduction gear Material of Construction | Standard |
| Motor HP | As per approved design |
| Accessories | Conveyor belt for conveying away the screened materials with 2 wheeled trolleys |

**(Vi) Mechanical Grit Removal Facility**

Two mechanical grit chambers, both working, are proposed after screening unit. The mechanical grit chambers shall be Square Mechanical Detritus Tank each designed for average flow.

Detritus tank chamber shall have the following:

- One tapered inlet channel running along one side with deflectors for entry of sewage into the grit chamber. The minimum SWD of the units shall be adopted on the basis of design of the unit.
- One tapered outlet channel for collecting the degritted sewage, which overflow over a weir into the outlet channel. Outlet channel of adequate size and shall be designed to ensure that no settling takes place.
- One sloping grit classifying channel into which the collected grit will be classified.
- The grit from classifier will be collected in a wheeled trolley (to be supplied by contractor) of approx. 1.5 m3 capacity. This trolley will be housed in a roofed enclosure with proper access, grit washing arrangement and drain.
- A grit scraping mechanism with adjustable influent deflector.
- Reciprocating rake mechanism to remove the grit.
- Organic matter return pump

Aluminum gates shall be provided at the entrance and at the outlet of the chamber. To enable easy operation of the gates, RCC platforms with Gl railing shall be provided at the upper level. Access shall provided from this level to a mechanism supporting beam of the grit chamber. The entire construction shall be in M 30 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC staircase 900 mm wide shall provided for access from the ground level to the top of the unit & to the operating platforms. Information related to grit chamber is summarized below,

| Parameters | Values |
|---|---|
| No. of grit chambers | 2 |
| Type | Square type RCC construction |
| Detention Time | 1 minute |
| Particle size to be removed | 0.15 mm or more |
| Grit storage space | As per design |
| Free board to be provided | 500 mm |
| MOC | M30 ,RCC |
| Accessories | Scraper mechanism with bridge, screw conveyor, chute for grit dumping |

**(VII) Distribution Box**

The designed peak flow shall be equally divided using adjustable aluminum overflow weir plates and distributed to SBR Process units via pipe / channel. Sluice gates including all specials shall be provided on all weirs for isolation. RCC access platform, staircase, railing and covers over division boxes are provided as per requirement.

**(vIII) SBR Process Units**

**(a) SBR Unit**

(i) Minimum number of SBR units shall be 2.

(ii) The biological treatment section comprising SBR process has to be installed and equipped for the average flow. .

(iii) All openings / appartenances has to be designed for handling peak flow. In addition, 0.5m free board shall be provided to each tank. Maximum liquid depth of tank shall be restricted to 5.5m.

(iv) SBR Process basins will be constructed in M 30 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC staircase 900 mm wide is provided to each basin for access from the ground level to the operating platforms, and a 1.2 m wide balcony all

around the SBR tanks to be provided. All platforms and walkways shall be provided with hand railings as per tender specifications. 1.2 m Plinth protection along periphery shall be provided as per technical specifications.

(v) The system should work on a intermittent influent condition.

(vi) Typical Design parameters for design of SBR Basins is given below:

| S No | Parameters | Value for Intermittent Flow & Decant SBR | Units |
|---|---|---|---|
| 1 | F / M Ratio | 0.05 – 0.3 preferably 0.15 | $d^{-1}$ |
| 2 | Sludge Age | 4 - 20 | days |
| 3 | MLSS | 3500 - 5000 | Mg / L |
| 4 | HRT | 12 to 16 | hours |
| 5 | Each Cycle Time | 2.5 - 6 | hour |
| 6 | Settling time | More than 30 | minutes |
| 7 | Decant Depth | 2.5 | meter |
| 8 | MLVSS to MLSS | 0.6 to 0.7 | |

**(b) Decanting Device**

Clarified effluent is removed during the decant period .The contractor shall provide necessary suitable decant mechanisms for the purpose to achive the performance parameters as per bid document . There should be minimum 1 decanter per basin.

**(c) Aeration System**

**Diffusers**

Only fine bubble EPDM / PU membrane diffusers shall be acceptable with minimum membrane diffuser to floor coverage area of 5%. Diffusers shall be submerged shall have fine bubble / fine pore, high transfer efficiency, low maintenance, non-buoyant type. Diffusers shall be tubular (membrane) type. Material of construction for (entire under water system including accessories shall be non corrosive). Complete diffuser as a unit shall be assembled at the manufacturere at factory level.

**Blowers**

The air blower arrangement shall be capable of handling Total Water Level and Bottom Water Level operation conditions, controlled by process sensors for temperature and level.

Each set of blower shall have dedicated standby. Minimum One working air blower in each set shall operate via VFD into each tank while others may be operating at a fixed constant speed on soft starter configuration.

The blowers for air diffuser system shall be positive displacement (roots) type, and head for blowers shall be decided on the basis of standard oxygen requirements (S.O.R). of diffusers and maximum liquid depth in tank duly considering the losses between point of delivery (diffusers) and the blowers. The number of standby blower shall be minimum 50% (fifty percent) of the number of working blowers. Blowers shall be complete with motor and accessories like base frame, anti vibratory pad, silencer, non return valve, air filter etc. as per requirements. Vibration due to operation of blowers shall be restricted, so as to avoid damage to structures.

The blower and air diffuser system shall include PLC (Programable Logic Controler) based control for diffuser operation. The operation and speed of blowers shall be automatically adjusted using parameters like Oxygen Uptake Rate, Dissolved Oxygen and Temperature, Incoming flow and liquid level in the basin such that the DO is supplied as per demand and power utilisation for operation of blowers is optimised.

The main air header/ring main shall be in MS as per relevant IS painted both outside and inside with corrosion resistant paint as per manufacture’s recommendations. The header / ring main shall be supported on saddles at suitable intervals or will be protected against external corrosion in case

they are laid below ground. The header shall have auto valves to facilitate switch over aeration cycle from one basin to other by PLC operation. The header shall supply air to diffuser grids at various locations through air supply pipes.

Air supply pipe above water level shall be in Gl and below water level it shall be of uPVC as per relevant standards. All under water lateral pipes shall be of uPVC. Junction between air header and air supply pipe shall be suitably protected against corrosion due to dissimilar materials.

All other accessories, whether specified or not, but required for completeness shall form part of contractors scope.

**(d) Excess Sludge Pumps**

Excess sludge pumps shall be provided for each basin. The pump shall be of submersible / horizontal centrifugal type suitable for handling biological sludge of 1 – 2% solids consistency. Capacity and heads shall be decided based on SBR Process requirements. Each SBR Process basin shall be provided with suitable lifting arrangements to facilitate lifting of pump, if required for maintenance.

**(e) Return Sludge Pumps**

Return sludge pumps shall be provided for each basin. The pump shall be of submersible / horizontal centrifugal type suitable for handling biological sludge of 1 – 2% solids consistency. Capacity and heads shall be decided based on SBR Process requirements. Each SBR Process basin shall be provided with suitable lifting arrangements to facilitate lifting of pump, if required for maintenance.

**(f) Automation and Control of SBR Unit (SCADA)**

PLC based automation system with application software based on Rockwell hardware or equal shall be provided to control all pumps, valves, blowers, VFD, decanters, limit switches and probes as per manufacturer's design with power supply arrangement, UPS etc. It also include supply of 20% spare parts as per recommendations of manufacturer.

HMI Panel along with PC, monitor, printer, mouse, internet connection, RS-view, RS-links (gateway version), entire process and operator software with dynamic flow charts, pictures, screens, alarms, historical trends, reports etc.

SACDA based Automation system to monitor continuously the followings in each tank and also to automatically operate the valves etc as per necessity of the process:

(a) Filling volume

(b) Filling quantity

(c) Discharge quantity

(d) DO-level

(e) Temperature

(f) Oxygen Uptake Rate

(g) Energy requirements

(h) Blower speeds

(i) Decanter speed

(j) Equipment operation hours

**(j) Sludge Sump**

Sludge sump shall be provided to collect the excess sludge from SBR Process Basins. There shall be one common sludge sump for all basins. There shall be auto gate valves on discharge sludge pipe of each SBR Process basin. Diameter of valve shall be same as that of sludge pipe.

Sludge tank shall be constructed in M 30 grade concrete and as per IS: 3370. The sump shall be

equipped with coarse bubble air grid made from HDPE / PVC pipes and Air Blower Assembly to facilitate mixing of contents of sludge sump on continuous basis.

**(k) Sludge Pump House**

Pump house shall be attached with the sludge sump. This shall be RCC framed brick masonry structure. Minimum height of the pump house shall be 4m from the plinth level. It shall be provided with rolling shutter and doors and windows as per technical specifications. Mono rail gantry of minimum 2 T capacity shall be provided in the pump house to lift the pump assembly. Flooring of the pump house shall be IPS flooring. Pump house shall be plastered from inside and from out side as per tender specifications. Sludge sump shall be painted inside with bituminous paint. All other accessories, whether specified or not, but required for satisfactory operation shall form part of contractors scope

Centrifuge feed pumps shall be provided in Sludge Pump House to feed secondary Sludge to centrifuge. The pump shall be of screw type suitable for handling biological sludge of 1 – 2% solids consistency.

**(l) Centrifuge Platform**

The SBR Basins operate on an Extended Aeration Mode to generate fully digested sludge. The excess sludge from the SBR Basins is pumped through excess sludge pumps and collected in the Sludge tank. The consistency of this sludge is 0.8 to 1.0%. The sludge is then pumped to Solid Bowl Centrifuge for dewatering up to 20%.

Provision should be made to dose Dewatering Polymer online prior to Centrifuge Feed to enhance the Dewatering capacity of Centrifuge. The Dosing System includes one no of solution preparation and one no of Solution Dosing Tank of minimum 12 Hrs capacity. Each Tank is equipped with Slow Speed Mixers and Positive Displacement Pumps with stand by arrangements. The Dewatered Sludge in the form of Truckable Sludge with 20% consistency from Centrifuges will be collected and disposed off suitably as directed by Engineer. This Sludge can also be used as Manure for Green Belt. The supernatant from centrifuge shall be taken to the wet well by gravity while sludge cakes shall be disposed off by vehicle. The centrifuge building is two storied building, Centrifuge shall be placed on first floor dosing system and collection of dried sludge shall be located in ground floor.

**TERTIARY TREATMENT UNIT**

**(i) RAPID SAND FILTER**

Effluent from the SBR unit shall be treated in Rapid sand bed filters. Minimum number of beds shall be 2 numbers. The design parameters are given below:

| S No | Parameter | Data | Unit |
|---|---|---|---|
| 1 | Number of beds | 2 | Numbers |
| 2 | Rate of filtration | 5 | Cum/ sqm/ hr |
| 3 | Ratio length to Breadth of bed | 1.25 to 1.33 | |
| 4 | Effective size of sand | 0.5 to 0.7 | mm |
| 5 | Uniformity coefficient of sand | 1.3 to 1.7 | |
| 6 | Depth of sand bed | 600 | mm |
| 7 | Depth of gravel media | 450 | mm |
| 8 | Total area of orifices | 0.30 | % of filter area |
| 9 | Area of laterals | Twice | Orifice area |
| 10 | Area of manifold | 1.5 to 2 | Times laterals |
| 11 | Air wash rate | 600 to 900 | Lpm/sqm |
| 12 | Wash Water Rate | 500 | Lpm / sqm |
| 13 | Wash Tank capacity | 1.5 times | Of one filter wash |

**Chlorine Contact Tank**

For Chlorination of final treated sewage a provision shall be made so that no harm is caused to the receiving water body such as river. Decanted treated water from SBR Process shall be taken to chlorine contact tank by RCC channel/pipe. Tank shall be provided for dosing of chlorine to the effluent from SBR Process. The tank shall be constructed in M 30 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC platform 1000mm as per specifications shall be provided. RCC staircase 900 mm wide shall be provided for access from the ground level to the top of the unit and to the operating platforms.Baffle walls shall be provided to achieve proper disinfection. The baffle walls shall be constructed in M 30 grade concrete and 20 cm thick plaster in CM 1:3 on either side.

| Parameters | Values |
|---|---|
| Number of chambers | 1 |
| Design Flow | Peak Flow |
| MoC | M-30, RCC |
| Internal mixing arrangement | Longitudinal Baffle Wall at 1.5 m c/c distance |
| Maximum Water depth | 2.5m |
| Detention Period | 20 minutes |
| Free Board | 0.5m |

**Chlorine House**

There will be one chlorinator with evaporator as working and one as standby in the chlorination plant. Liquid chlorine shall be drawn from chlorine tonner and it will then pass through evaporator for vaporization. The gaseous chlorine shall be injected through ejector after mixing with water. Ultimate chlorine solution shall be dosed in chlorine contact tank. In chlorine contact tank, chlorine solution diffuser shall be provided for proper mixing of the solution. Besides chlorinators in chlorination plant there will be 2 nos chlorine tonners to supply chlorine. One toner shall be connected to the chlorinator and other shall remain as standby. Additional one tonner shall be kept spare for transit.

Chlorination system shall cover chlorine tonners.(1 woeking, 1 standby and 1 in transit for each STP), chlorinator, water feed pumps, piping, booster pumps, ejector, trunions, lifting device with weighing scale, leak detection and leak absorption system, safety equipments like canisters, gasmasks etc and other ancillary. Chlorine house of minimum 40-sqm plinth area shall be provided for each STP. It shall have sufficient ventilation as per the latest norms for safety purpose with necessary lifting arrangement and EOT of minimum 2 T capacity. All other accessories, whether specified or not, but required for proper operation shall form the part of contractor's scope.

| Parameters | Values |
|---|---|
| No. | Two (1 Working & 1 standby) |
| Capacity | 6kg/hr for 20 MLD plant and 1.5 kg/hr for 4 MLD plant |
| Type | Vacuum Type |
| No. of evaporator | Two (1 working + 1 standby) |
| Chlorine leak detector | One no. to sense chlorine in atmosphere and to give alarm |
| Safety and handling devices | One set |
| Chlorine absorption system for Leakage | One set consisting of absorption tower, caustic solution tank, caustic solution recirculation pump, |
| No. of chlorine toners ( min) | 3 Nos. |

**Treated water reservoir and pumping station**

The treated water reservoir shall be designed for a capacity equivqlent to four hours pumping capacity

(minimum 1500 cum). The entire structure is to be in M 30 grade of concrete and designed as per IS: 3370 for construction of water reservoirs. The pumping machineries along with pump house shall be provided for supply of tertiary treated water to Badkal lake.

The pumping sets shall be horizontal split casing type capable to discharge 62.50 lps at 35 m head coupled with squirrel cage induction motor of 35 kW. In all three pumping sets shall be installed, two shall be working and one shall be standby. The contractor may design the pumping sets based on topographical survey done by him , at 20 hours pumping per day. The Motor HP shall be at least 10% more than required at duty point and shall be suitable for power requirement by pumps at (-) 25% and (+) 10% of design head.

The control panel room and the pump room shall be suitably designed to house the pumping sets and electric switch gears. The height of pump room shall be minimum 3 meters above plinth, and shall be suitably designed in RCC framed structure and brick walls, with Internal Illumination as per National Building Code.

**(a) Interconnecting Piping**

All piping including valves, specials and other appurtenances, auxiliaries and accessories required as per process design and scope of work shall be deigned for peak flow. In case of pumping mains thrust blocks shall be provided wherever required. In case of buried pipes warning tapes of appropriate colours shall be provided. The material for major interconnecting piping shall be as follows:

| Sr. No. | From | To | Class / Material of Pipe |
|---|---|---|---|
| 1 | Rising Main | Stilling Chamber / Equalisation Tank | DI-K9 |
| 2 | Air Blower discharge header | SBR Process | MS Epoxy painted |
| 3 | SBR Process | Chlorination Tank | RCC NP3 |
| 4 | Gravity Bypass Line from Distribution box | Discharge Point | RCC NP3 |
| 5 | Chlorination Tank | Discharge Point | RCC NP4/ RCC Channel |
| 6 | Air Grid piping | SBR Process | PVC |
| 7 | All sludge pipes | SBR Process | SS304 |
| 8 | All sludge pipes | Sludge Handling system | DI |

**(b) Administration Building and Staff Qtrs 2 number**

***The STP site should have the following provisions as detailed below.***

The administrative building may be single storied or double storied as per availability of land at site and shall accommodate office, workshop, toolroom, administrative block, conference hall, laboratory, wash room, toilets and SCADA Control Centre for the easy and smooth operation of plant. The minimum floor area required for each unit shall be as follows:

- Office : 12.0 Sqm
- Conference Room : 24.0 Sqm
- SCADA control Centre: 24.0 Sqm
- Work shop : 12.0 Sqm
- Tool Room : 12.0 Sqm
- Laboratory : 24.0 Sqm
- Toilet male & female : 4.0 Sqm

The building structure shall be RCC framed structure with walls of 230 mm thick brick masonry, plastered and painted with oil bound distemper on the inner face and snowcem on the outer face. RCC slab roofing with roof height of minimum 3 meters from the floor shall be provided. The doors shall be of first quality wood and aluminium sliding windows of approved quality shall be provided. Before commencing the construction of the office, the contractor shall submit the design and drawing of the building to the Employers Representative for approval. This shall include all the architectural and finishing details fully elobarated. The location of the office building shall be finalized after taking approval of the Employer's representative. The office shall be maintained through out the contract
period with office boy. Power and water supply shall be arranged by the contractor either with the

available resources or from independent sources (DG sets, bore well, etc.)

The office building shall be provided with adequate forced ventilation and exhaust fans. Flooring for the office shall be of vitrified tiles. Toilets shall be provided on the each floor. Adequate number of toilets and washbasins shall be provided separately for men & women. A covered service water tank shall be suitably provided to cater to the water requirements of laboratory and office building. Space for keeping plant records shall be provided in the administration building.The list of furniture to be supplied in the office building is detailed in **Annexure.**

**(c) Mandatory Laboratory Tests in the treatment plant site**

The laboratory provided at each STP, shall be able to perform following tests at site it self. The equipments required have already been listed at **Annexure IV** of Scope of Work.

(i) pH
(ii) Turbidity
(iii) Suspended Solids – Total , Fixed, Volatile
(iv) Dissolved Oxygen
(v) Oil & Grease
(vi) COD by Chromate Reflux Method
(vii) BOD at 27 Deg C and 20 deg C
(viii) Coliform Measurement using both MPN and Millipore Filter/Plate count technique

**(d) Residential quarters**

Contractors has to built two number residential quarters of minimum 64 sqm floor area at STP site for the staff required to handle emergencies during 0 & M of the plant:

The general specifications for the staff quarters shall be as follows:

| Sl. No. | Components | Specification |
|---|---|---|
| 1 | Foundation | RCC Colum footing |
| 2 | Plinth | 0.60m. above Road Level |
| 3 | Wooden frames | Sal or haldu. |
| 4 | Doors | 35mm thick, paneled shutter doors. |
| 5 | Windows | 35mm thick, partly paneled and partly glazed shutter. |
| 6 | Plaster | 12mm inside &15mm outer wall in CS mortar 1:6 |
| 7 | Floor | Kota stone flooring |
| 8 | Finishing | Distempering & painting with synthetic enamel. |

**(e) Security cabin & Toilet Block**

The STP site shall have a security cabin at entry gate of plant. Minimum size of security cabin shall be 2m x 2m.A separate toilet block shall be provided for the labourers comprising of 2 numbers of Bathrooms cum WC and 2 numbers of Urinials with ventilation, water supply and Disposal facilities.

**(f) Utilities**

**The STP site should also have the following provisions:**

**(i) Compound Wall and Gate**

Compound wall of minimum 1.2 m height shall be constructed. It will have 1m high barbed wire fencing above DPC. However the contractor shall be responsible for safeguard of the entire primises of the plant area till the end of O & M period.

**(ii) Storm Water Drainage**

Storm water drains adjacent to the proposed approach road shall be sized for rainfall intensity of 36 mm/hr, allowing for 100% runoff. Drains roads/pathways shall be in RCC NP3 pipe with necessary chambers at appropriate locations. These chambers shall be covered with CI gratings. The storm water drainage system shall be designed and connected to the run-off from the plot and structures, and discharged into the city network nearby storm

drain or nallah.

**(iii) Approach Road & Internal roads**

An access road through the site along with a network of pathway provided to link the existing approach road and permit access to the STP site for necessary maintenance, delivery of consumables and personnel access. All internal roads shall be of WBM with asphalting BM +AC and minimum 6m wide. Vehicular access shall be provided for such plant units that may require frequent access. All roads shall be provided with drainage and constructed to prevent standing water. The approach road shall be 6 m wide with WBM and required asphalt coats.

**(v) Fire Extinguishers**

The portable fire extinguishers with ISI mark of approved make shall be provided at the Admin room, MEP room, chlorine house.

Each building shall be provided with following portable fire extinguishers

1. Dry chemical powder type fire extinguishers of 3.2 kg capacity – 6 cylinders
2. Buckets filled with dry clean sand – 6 Nos.

All buildings shall be provided with manual fire alarm system connected with main control panel.The layout of the fire alarm system shall be in accordance with the relevant IS standards.

**(vi) Yard Lighting**

Effective yard and building lighting systems shall be incorporated within the treatment plant site in order to provide sufficient illumination for operation and maintenance schedules to be carried out during day and night periods. In addition, the entire treatment plant site shall have sufficient street lights and perimeter lights for various operations, safety and security reasons.

**(vii) Landscaping & Gardening**

Landscaping involves beautification of Sewage Treatment Plant site by cultivating Lands, Plants and Trees of environmental value and suitably modifying the appearance of treatment plant site. It shall add scenic value to the treatment plant site to obtain maximum visual impact. Contractor has to develop proper landscaping in the treatment plant site from professional landscaper approved by FSCCL. Area for future expansion shall also be considered for landscaping.

Minimum 10meters wide with three rows of tree plantation of green buffer zone shall be developed allround the treatment plant with in the first phase of 12months of the contract period. About 30 %of the plant area for the total ultimate capacity should be land scaped with various standard species as approved by FSCCL.

**(g) Battery Limits**

The capital works of assignment is having two parts , part " A" have Turnkey scope of works and Part " B" is having Item rate contract.

The scope of work of part A starts from diverting existing sewage lines flow to STP and ends at Tertiary treated treated water reservoir with pumping station with required capacity pumps. It also includes drawing 11 KV power from existing 11 KV line 100 m away from boundary of the plant site and construction of 11 x 0.44 KV sub station including LT system with in plant area as per requirement.

The scope of part "B" starts from drawing Tertiary treated water from outside pump house laying required DI pipe line up to Badkal lake.

# 4. GENERAL SPECIFICATIONS

## 4.1 REFERENCE TO SPECIFICATIONS AND STANDARDS

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'BS') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (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 the latest revision of that Standard at the Tender opening date.

The Contractor may propose the use of any relevant authoritative internationally recognized Reference Standard. The basic guide lines as provided in CPHEEO manual for Sewerage and Sewage Treatment issued by Ministry of Housing shall be adhered.

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.

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 Organisation for Standardisation
- DIN : Deutsche Institute fur Nuremburg
- 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

### 4.1.1 Related Indian Standards to be referred for the project:

| S No | Particulars | BIS Code No |
|---|---|---|
| 1 | National Building Code | SP-7 Part-9 |
| 2 | Code of practice for Plain & Reinforced Concrete | IS - 456 |
| 3 | Code of practice for concrete structures for storage of liquids | IS – 3370 (I-IV) |
| 4 | Criteria for design of RCC staging for over head tanks | IS - 11682 |
| 5 | Code of practice for design loads (Other than Earth quake) for Structures | IS – 875 Part 1 to 5 |
| 6 | Criteria for Earthquake resistant design of structures | IS – 1893 Part 1 to 5 |
| 7 | Electrically welded steel pipes for water gas and sewage | IS - 3589 |
| 8 | Spiral welded pipes | IS - 5504 |
| 9 | Code of practice for cathodic protection of underground pipe lines | IS – 8062 Part -2 |
| 10 | Code of practice for coating and wrapping of under- ground steel pipe lines | IS - 10221 |
| 11 | Code of practice for laying of welded steel pipes for water supply | IS - 5822 |
| 12 | Centrifugally cast (spun) Ductile Iron Pipes for water gas and sewage | IS - 8329 |
| 13 | Ductile Iron fittings | IS - 9523 |
| 14 | EPDM Push – on joint rubber gaskets | IS - 5382 |
| 15 | Code of practice for laying of Ductile Iron pipes | IS - 12288 |
| 23 | Sluice Valves for water works purposes ( 50 to 300 mm) | IS - 780 |
| 24 | Sluice Valves for water works purposes ( 350 to 1200 mm) | IS - 2906 |
| 25 | Single faced sluice gates (200 to 1200 mm) | IS - 3042 |
| 26 | Swing check type reflux valve for water works purposes | IS – 5312 Part 1 and 2 |
| 27 | Foot Valves for water works purposes | IS - 4838 |
| 28 | Horizontal Centrifugal pumps for clear cold fresh water | IS - 1520 |
| 29 | Vertical Turbine pumps for clear cold fresh water | IS - 1710 |
| 30 | Three phase Induction motors | IS - 325 |
| 31 | Code of practice for installation and maintenance of Induction motors | IS - 900 |
| 32 | Specification for Power Transformers | IS – 2026 Part 1 to 4 |
| 33 | Requirements for Settling Tank ( Clarifier Equipment) for Water Treatment Plant | IS - 10313 |
| 34 | Guidelines for Flocculator devices | IS - 7208 |
| 35 | Requirements for Filtration Equipments | IS - 8419 |
| 36 | Allumina Ferric | IS - 299 |
| 37 | Liquid Chlorine | IS - 646 |
| 38 | Bleaching Powder stable | IS - 1065 |
| 39 | Drinking water quality standards | IS - 10500 |
| 40 | Requirements for Chlorination equipments | IS – 10553 Part 1 to 5 |
| 41 | Methods of sampling and microbiological examination of water | IS - 1622 |
| 42 | Methods of sampling and test ( Physical and Chemical) of water and Waste water | IS – 3025 Part 1 to 37 |
| 42 | Water Meter (Domestic type) | IS - 779 |
| 43 | Water Meter (Bulk type) | IS - 2373 |

## 4.2 MATERIALS GENERAL

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the 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 passage of time, exposure to light or any other cause.

### 4.2.1 PIPES AND SPECIALS

***Mild Steel Pipes***

Mild Steel Pipes shall be spiral welded type as per BIS: 5504 (Latest) manufactured with Steel grade Fe-410. The pipes shall be factory lined with inside cement mortar lining or with 2 pack food grade Epoxy lining as per relevant BIS; and outer surface shall be provided with coal tar wrapping & coating as per BIS : 10221.

The laying and jointing shall be in accordance with relevant BIS: 5822 (Latest). For internal fittings it shall be flanged with slip-on-boss flange confirming to IS 6392-1971.

**Manufacture:**

Pipes shall be made from steel plates conforming to relevant IS 2062 grade Fe410 or strips by butt welding longitudinally or spirally. The weld shall be continuous. Prior to welding, edges of plates or strips may be prepared suitably where required by the process of manufacture.

**Outside Diameters and Thickness:**

The outside diameters of pipes shall be as per relevant BIS. The thickness may be designed for Hoop stress, Max. Beam stress, and Maximum stress on saddle support assuming that the allowable stress for combined bending and direct tensile shall be 60% of yield stress and weld efficiency as 80

**Tolerance:**

a) The tolerance on the pipe body shall be + 0.75 % for all sizes of pipes.

b) The tolerance on specified wall thickness shall be - 2% / + 10%

c) Straightness - Finished pipe shall not deviate from straightness by more than 0.2% of the total length. Checking shall be carried out using a taut string or wire from end to end along the side of the pipe to measure the greatest deviation.

d) Length - Straight pipe shall not vary from the specified overall length by +10 mm or -10 mm for length up to and including 6 m.

**Inside / Outside Coating:**

The coating of the pipes shall be smooth, dense and hard. The coating shall be free from excessive surface irregularities. Projection exceeding 3 mm. measured from the general surface shall be removed. For inside coating of epoxy paint, the inside surface of the pipe should be sand or shot blasted. The surface should be thoroughly rubbed down with rough sand paper or wire brush so that surface will be uniformly rough. Mixed paint should be used within 3 to 4 hours of mixing and fresh mixing is taken for every new Bid.

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting. No primer shall be applied without prior approval of the owner. The mix of zinc rich epoxy primer shall be prepared at works site not earlier than 15 min. before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer shall be applied along with 2 coats of epoxy paint. No thinner shall be added to ready mix paints without previous approval of the owner and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at-least 48 hours.

After Bid of zinc rich epoxy primer, the surface should be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

The painting shall be done by cross brushing, i.e. one coat shall be given vertically and another coat shall be given horizontally so as to get required thickness, a good looking surface and also to avoid sagging of paint. Every successive coat of paint shall be given only after 48 hrs. of painting the previous coat. Before applying the next coat, the surface shall be properly cleaned by duster. Each coat of paint shall give a film thickness of 300 micron.

**M.S. Specials:**

Providing, testing, installing and commissioning M. S. Specials suitable to M. S. pipes, valves and other fittings from steel plates at site of work tested to specified test pressure and including providing flanges required, painting complete including freight, loading, unloading, carting, stacking as directed, and including all taxes, insurance etc. The sizes and types of specials shall be as per requirements taking into consideration the tender items like pumps, sluice valves, non return valves, expanders, reducers, dismantling joints etc.

**M.S. Expanders/reducers**

These shall be fabricated from the M.S. plates of the thickness relevant to the O.D. of the pipe (Bigger size). The one side diameter will be equivalent to the diameter of the pump nozzle (Suction/Delivery) where as the other side diameter will be that of valves of pipe & the line suction/delivery.

The expander to be provided on suction side will be of un-equal type with top portion flat horizontal and expansion taking place totally on bottom side to ensure that no air accumulates during suction.

The expander / reducer will be double flanged type and steel flanged as per IS6392:1971 (Slip on boss flanges).

**Steel Flanges:**

The flanges and their dimensions of drilling, wherever not specified, shall be in accordance with IS: 6392 – 1971 or its latest revision. The flanges shall be slip on boss type NP 1N/mm2. Prior to welding flange, the Contractor shall have to obtain approval of Engineer for all sizes and types of flange drawings.

**Jointing Material:**

Each valve shall be supplied with all necessary joint ring, packing, nuts, bolts and washers for completing the joints on all the flanges of valves supplied under this contract including those flanges which will be jointed to pipe system. The cost of all jointing material supplied under the contract shall be included in rates. Joint rings shall be of flat section at least 3 mm. thick. They shall be of rubber in accordance with IS 638-1965.

**Test**

All MS pipes & specials shall be tested at a minimum site test pressure of 26 kg/sqcm.

**Dismantling Joints**

Dismantling joint is to be fabricated by welding steel flanges to the MS pipe of same diameter as that of neighboring sluice valve. Flanges shall be slip on boss type as per IS 6392:1971. The dismantling joint shall be suitable for easy removal/installation of adjoining valves and shall have a minimum axial flexibility of 25mm. The GA drawing shall be submitted with the bid.

***DUCTILE IRON PIPES & SPECIALS:***

**General**

The pipes will be centrifugally cast (spun) Ductile Iron pipes for Water and Sewage confirming to the IS 8329: 2000. The pipes used will be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-7 & K-9.

The pipes shall be outside coated with zinc with a finishing layer of bituminous paint as per appendix A and have factory provided cement mortar lining in the inside as per the provisions of Appendix B of the IS 8329: 2000.

The pipes will be supplied in standard length of 4.00, 5.00, 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. Any change in the stipulated lengths will be approved by the Engineer – in charge. The gaskets will confirm to the IS 5382:1985.

The gaskets should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under it's own supervision and have it tested at his/sub-Contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products. The flanged joints will confirm to the Clause 6.2 of IS 8329. The pipe supply will also include one rubber gaskets for each flange.

**Cement Mortar Lining**

All pipes and fittings shall be internally lined with cement mortar in accordance with ISO 4179 / IS:11906. Cement mortar lining shall be applied at the factory in conformance with the above mentioned standards. No admixtures in the mortar shall be used without the approval of the Engineer.

Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be 3 mm for pipes up to DN 300 mm.

**Coatings**

a) Ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer

b) Zinc Coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m2 as described in Clause 5.2 of ISO 8179.

c) Bitumen Coating

Bitumen coating shall be of normal thickness 75 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

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

2 Surface preparation shall be in accordance with manufacturer's instructions, but as a minimum the pipes shall be abrasive blast cleaned to BS 7079 Grade Sa 2.5 or equivalent to achieve surface roughness profile of 40 – 50 microns. The primer shall be applied within 2 hours of surface preparation, before flash rusting can occur. Two coats of Zinc rich epoxy primer shall be applied by spray equipment on the pipes and fittings.

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

4 Though the priming coats become touch dry in 10 to 15 minutes, the finishing coats with epoxy paints shall be applied after allowing the film to cure at least for 48 hours. The final dry film thickness shall be a minimum of 300 microns. This may be achieved by applying in 2 to 4 coats.

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

**Inspection and Testing:**

The pipes will be subjected to tests provided in IS: 8329 including following tests for acceptance:

1 Visual and dimensional check as per Clause 13 and 15 of IS 8329

2 Mechanical Test as per Clause 10 of IS 8329

3 Hydrostatic Test as per Clause 11 of IS 8329

4 The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5832.

**Marking**

1 All pipes will be marked as per Clause 18 of IS 8329 and as below:

2 Manufacturer name/ stamp

3 Nominal diameter

4 Class reference

5 A white ring line showing length of insertion at spigot end

**Packing and Transport:**

The pipes should preferably be transported by road from the factory and stored as per the manufacturer specifications to protect from damage.

**CI and DI Specials**

The following types of DI fittings shall be of class K-12, manufactured and tested in accordance with IS: 9523 or BS: 4772 and shall be suitable for use with DI pipes of titan jointing type confirming to IS 8329.

1 flanged socket

2 flanged spigot

3 double socket bends (90°, 45°, 22 1/2°, 11 1/4°)

4 double socket branch flanged tee

5 all socket tee

6 double socket taper

7 restrained joints

All the DI fittings shall be supplied with one rubber ring for each socket. The rubber ring shall conform to IS: 12820 and IS: 5382 as described in the following clauses. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts.

**Lubricant for Ductile Iron Pipes and Specials**

Lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in rubber ring joints shall have the following characteristics:

1 must have a paste like consistency and be ready for use

2 has to adhere to wet and dry surfaces of DI pipes and rubber rings

3 to be applied in hot and cold weather; ambient temperature 0 - 50 °C, temperature of exposed pipes up to 70 °C

4 must be non toxic

5 must be water soluble

6 must not affect the properties of the drinking water carried in the pipes

7 must not have an objectionable odour

8 has to inhibit bacterial growth

9 must not be harmful to the skin

10 must have a shelf live not less than 2 years

**Acceptance Tests**

They shall be conducted in line with the provisions of the IS 9523

**Packing**

All the DI fittings shall be properly packed with jute cloth. Rubber rings shall be packed in polyethylene bags. Nuts, bolts etc. shall be supplied in separate jute bags.

The fittings shall also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under it's own supervision and have it tested at his/sub Contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

***CAST IRON PUDDLE COLLARS***

The C.I. Puddle collars shall generally conform to IS 1537 / IS 7181 and IS 1538. The material for fittings shall be of good quality grey cast iron conforming to IS 210 grade FG 220.

The puddle collars shall be of uniform bore and straight in axis. Length of the straight double-flanged puddle collars shall be within a tolerance of +/- 1.5 mm. The flanges of the puddle collars shall be square to its axis. The faces of the flanges shall be parallel. The bolt-hole circle shall be concentrate with the bore and bolt-holes equally spaced. In straight pipes the bolt-holes in one flange shall be located in line with those in other. The bolt-holes on flanged pipes and fittings shall be drilled with the help of drilling jig. Hydrostatic test pressure shall be as per IS: 1537 unless otherwise noted. Puddle flanges shall be required to take thrust resulting from the pipe. Puddle flanges shall be fitted where a water barrier is required.

***SLUICE VALVES***

The design and manufacture of the sluice valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the vendor of this responsibility. Valves shall be conforming to IS 14846:2000 for size 50 to 1200 mm and shall be ISI marked.

**Design Requirements for Sluice Valves:**

a) Valves shall be provided with back seating arrangement.

b) Renewable body and wedge rings shall be provided.

c) Collared drain plugs of gunmetal shall be provided for all valves.

d) Stuffing box gland shall be of bolted type.

e) Valves shall be with non-rising spindle type.

f) Valves shall be flanged and drilling shall conform to the standard as specified in data sheet.

g) Face to face dimension shall be as per IS 14846:2000.

**DATA SHEET FOR SLUICE VALVES IN Pump house**

| | | | |
|---|---|---|---|
| 1.0 | Standard | IS 14846:2000. And ISI marked. | |
| 2.0 | Body, Bonnet, Wedge, Stuffing Box Gland. | CI IS:210 Gr. FG 260 | |
| 3.0 | Spindle | SS AISI 431 | |
| 4.0 | Seat ring, wedge ring | SS ASTM A 743 CF8 | |
| 5.0 | Size range and quantity | As per Appendix to the data sheet | |
| 6.0 | Fluid | Water | |
| 7.0 | Rating | PN : 1.0 & PN : 1.6 | |
| 8.0 | Stem | Non rising | |
| 9.0 | Ends | Flanged, flat faced flanges as per IS-1538 Table IV & VI having off centre bolt holes | |
| 10.0 | Bonnet | Bolted | |
| 11.0 | Disc. | Solid wedge | |
| 12.0 | Operation | Hand wheel | |
| 13.0 | Seat | Body - Renewable | Disc - Renewable |
| 14.0 | Other requirements | Valves shall close in clockwise rotation of the hand wheel. | |
| 15.0 | Body / bonnet | C.I. IS 210 GR 260 | |
| 16.0 | Disc | C.I. IS 210 GR 260 | |
| 17.0 | Stem | S.S. AISI – 410 | |
| 18.0 | Body seat | Bronze IS 318 GR LTB 2 | |
| 19.0 | Channel, Shoe | Bronze IS 318 GR LTB 2 | |

| | | |
|---|---|---|
| 1.0 | Standard | IS 14846:2000. And ISI marked. |
| 20.0 | Back Seat Bush | Bronze IS 318 GR LTB2 |
| 21.0 | Stuffing box | C.I. IS 210 GR 260 |
| 22.0 | Gland | C.I. IS 210 GR 260 |
| 23.0 | Packing | Graphite Asbestos |
| 24.0 | Drain and Air Plug | Bronze IS: 318 Gr LTB2 |
| 25.0 | Fasteners | SS AISI 304 |
| 26.0 | Bolts, studs & nuts | Carbon Steel IS 1367 Class 4.6 / 4 |
| 27.0 | Shell test | 15 Kg / $Cm^2$ |
| 28.0 | Seat test | 10 Kg / $Cm^2$ |
| 29.0 | Back seat test | 10 Kg / $Cm^2$ |

***DUAL PLATE NON RETURN VALVES***

The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the Contractor of his responsibility. The valves shall be confirming to API 594 and API 598. The distance across flanges shall be in accordance to IS: 5312 for flanged valves.

**Design Requirements**

The non-return valves shall be of dual plate type check valve and provided with soft seating for clear and cold water. The valves shall be suitable for mounting on horizontal/vertical pipeline. The valves shall be designed for minimum head loss. The valves shall have lugged ends or flat faced flanged ends as specified. The back side of the flanges shall be fully or spot faced. Hydraulic passage shall be designed to avoid cavitations. The valves shall have non slam characteristic during closing. This is to be achieved by suitably designed springs. Direction of flow shall coincide with the flow direction indicated by arrow cast on the valve body.

**Painting**

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface. The coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or odor to the water.

**Tests and Inspection**

Valves shall be tested as per relevant Indian standards specification, API 594 and API 598 with latest revisions. Valves shall be offered for visual inspection and dimensional checks. The hydrostatic and water tightness testing shall be witnessed by the Engineer.

Valve shall be offered for inspection and following tests will be conducted (before painting):

- Visual inspection with dimensional checks.
- Hydrostatic test.

**DATA SHEET FOR DUAL PLATE NON RETURN VALVES**

| | | |
|---|---|---|
| 1 | Mfg. Standard | API 594 and 598 |
| 2 | Size in mm | 80 - 800 mm |
| 3 | Maximum working pressure | 20 kg /$cm^2$ |
| 4 | Ends | Flanged flat faced flanges as per IS 1538 Table IV and VI having off centre bolt holes or lugged ends |
| 5 | Seat | Body - Renewable<br>Plate - Renewable |
| | **MATERIAL OF CONSTRUCTION** | |
| 6.1 | Body | C.I. IS 210 Grade 260 |
| 6.2 | Plate | ASTM A21 GR WCB |
| 6.3 | Seat Rings | EPDM |
| 6.4 | Spring | S.S. AISC 31 |
| 6.5 | Body Bearing / Plate Bearings | S.S. AISC 31 |

| | | |
|---|---|---|
| 6.6 | Hinge Pins | S.S. AISC 431 |
| 6.7 | Bolts, Studs and Nuts | Carbons Steel IS : 137 Class 4./4 |
| 6.8 | Shell Test | 30 kg /$cm^2$ |
| 6.9 | Seat Test | 20 kg /$cm^2$ |

***C.I. FOOT VALVE WITH STRAINER***

Foot valve shall confirm to IS: 4038. Foot valve shall be capable of maintaining water column in the suction line of the pump and shall be suitable for connection to the suction pipe. Valve shall be provided with strainer.

The shape and the height of the housings shall be such that even when the valve is fitted to the pipe, it should be possible to raise the disc or discs sufficiently to provide, at any cross-section, a passage of area at least equal to the bore area of the pipe. Flange drilling shall be as per IS: 1538

Strainer shall be sufficiently robust so as to withstand the normal forces which may come upon them while in transit or at the time of installation or during operation. The total area of the perforations shall be at least 2.5 times the cross sectional area of the bore area of the pipe. The thickness of the strainer shall not be less than 5 mm. The dimensions of strainer holes shall be as per IS: 4038.

The Foot Valves shall be ISI marked.

**Material of construction**

| | |
|---|---|
| Main body, housing | CI 210 FG 200 |
| Seat discs and disc plates | CI 210 FG 200 |
| Strainer | CI 210 FG 200 |
| Disc faces | Bronze / Natural rubber |

***PRESSURE GAUGE***

The Pressure Gauges shall conform to IS: 3624. Casing for line mounted pressure gauges shall be black finished aluminium alloy with aluminium ring, and shall be weatherproof and dust proof suitable for outdoor service. It shall have nominal size of 150mm. A synthetic rubber blow-out disc shall be furnished on casing. Case drilling for disc shall be 25 mm diameter or larger.

Line mounted gauges shall have bottom connection with 1/2 inch male pipe thread. Thread shall be American Standard Taper Pipe Thread. The stainless steel socket and tip with welded stress relieved joints shall be provided.

Movement shall be the rotary geared type with bushed front and back plates. All parts except the hair spring shall be stainless steel. Set screw or similar device shall be provided to change effective length of sector arm.

Measuring system for line mounted gauges shall be constructed as a unit independent of the case.

Pointer shall be micro meter type. All the parts shall be aluminium or stainless steel.

Dial shall be of the laminated phenolic type with black figures on white background.

Pressure gauges shall be mounted on a board suitably supported on the side of a pipe. Pressure gauges shall be mounted using flexible wire braided tubing's to avoid the effect of vibration on pressure gauges.

| | | |
|---|---|---|
| (i) | Process fluid | Potable water / Air |
| (ii) | Accuracy | +/ - 1% of full scale |
| (iii) | Range | 0 – 50 m (0 – 5 kg/sq.cm.) |
| (iv) | Dial size / Glass | 150 mm / Shatterproof |
| (v) | Standard | IS : 3624 |
| (vi) | Over range Protection | 125% of maximum pressure |
| (vii) | Body Material | Die Cast Aluminium |
| (viii) | Material of sensor and other wetted parts (snubber, valves, fittings, tubings etc.) | SS 316 |
| (ix) | Blow out disc | Required |
| (x) | Material of dial | Aluminium with white back ground and black numerals |
| (xi) | Accessories | 2 valve manifold with drain cock<br>Impulse tubing, fittings<br>Snubber and all other installation hardware |

***LAYING, JOINTING AND TESTING OF PIPE LINE SYSTEM FOR WATER SUPPLY***

**Preparatory Work**

The Contractor will inspect the route along which the pipe line is proposed to be laid. He should observe/ find out the existing underground utilities/ construction and propose an alignment along which the pipeline is to be laid. He should make all efforts to keep the pipe as straight as possible with the help of ranging rods. Wherever there is need for deviation, it should be done with the use of necessary specials or by deflection in pipe joints (limited to 75% of permissible deflection as per manufacturer). The alignment as proposed should be marked on ground with a line of white chalk and got approved from Engineer. The Contractor will than prepare an L-Section along this alignment showing the location of proposed pipe line. The L-section should be got approved from the site Engineer. The position of fittings, valves, should be shown on the plan.

**Alignment and the L-Sections**

The alignments, L-section (depth of laying) and location of specials, valves and chambers may be changed at site in co-operation with and after approval of the Engineer.

**Standards**

Except as otherwise specified in this technical specification, the Indian Standards and Codes of Practice in their latest version, National Building code, PWD specification of the state of Madhya Pradesh and Manual of water supply of GOI shall be adhered to for the supply, handling, laying, installation, and site testing of all material and works. The pipe laying and testing work shall generally conform to relevant BIS.

**Tools and Equipment**

The Contractor has to provide all the tools and equipment required for the timely, efficient and professional implementation of the work as specified in the various sections of the contract and as specified by the instructions of manufacturers of the pipes and other material to be handled under this contract. On demand he shall provide to the Engineer in Charge a detailed list of tools and equipment available. If in the opinion of the Engineer in Charge the progress or the quality of the work cannot be guaranteed by the available quantity and type of tools and equipment the Contractor has to provide additional ones to the satisfaction of the Engineer in Charge. The Contractor will always have a leveling instrument on site.

**Handling and Laying Of Pipes**

The Contractor has to transport the pipes and other materials from manufacturer to the site of laying as indicated by the Engineer in Charge. Pipes should be handled with care to avoid damage to the surface and the socket and spigot ends, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rests uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and un-loaded manually or by suitable mechanical means without causing any damage to the stacked pipes.

The transportation and handling of pipes shall be made as per IS 12288. Handling instructions of the manufacturers of the pipes shall be followed. All precautions set out shall be taken to prevent damage to the protective coating, damage of the jointing surfaces or the ends of the pipes.

Whatever method and means of transportation is used, it is essential that the pipes are carefully placed and firmly secured against uncontrolled movement during transportation to the satisfaction of engineer in charge.

Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. Where using crane hooks at sockets and spigot ends hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying according to the instructions of the pipe manufacturer. Pipes shall not be thrown directly on the ground.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jerking motion and pipe movement should be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

Rolling or dragging pipes along the ground or over other pipes already stacked shall be avoided too.

**Stringing of Pipes along the Alignment**

The pipes shall be laid out properly along the proposed alignment in a manner that they do not create any significant hindrance to the public and that they are not damaged.

Stringing of the pipes end to end along the working width should be done in such a manner that the least interference is caused in the land crossed. Gaps should be left at intervals to permit the passing of equipment across the working area. Pipes shall be laid out that they remain safe where placed and that no damage can occur to the pipes and the coating until incorporated in the pipeline. If necessary, pipes shall be wedged to prevent accidental movement. Precautions shall be made to prevent excessive soil, mud etc. entering the pipe.

Generally, the pipes shall be laid within two weeks from the date of their dispatch from the manufacturer/store.

The joint gaskets shall be kept in wooden boxes or their original packing and stored in cool conditions and not exposed to direct sunlight. Gaskets must not be deformed. They shall be taken out only shortly before they are needed. All PVC pipes when stored shall be protected from sunlight and heat at all stages.

**Trench Excavation**

The trench excavation of pipe line shall be in accordance with IS 12288. Pipe trenches shall be excavated to the lines and levels shown on the drawings or as directed by the Engineer in Charge. The depth of the excavated trench shall be as given in the drawings or as directed by the Engineer in Charge. The width of the trench at bottom between the faces of sheeting shall be such as to provide 200/150 mm clearance on either side of the pipe except where rock excavation is involved. No pipe shall be laid in a trench until the section of trench in which the pipe is to be laid has been approved by the Engineer in Charge.

In agricultural land the depth should be sufficient to provide a cover not less than 900 mm so that the pipe line will not interfere with the cultivation of land. It may be necessary to increase the depth of pipeline to avoid land drains or in the vicinity of roads, railways or other crossings. Care should be taken to avoid the spoil bank causing an accumulation of rainwater.

The bottom of the trench shall be trimmed and leveled to permit even bedding of the pipes. It should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes, so that the pipe is supported along its entire length.

All excavated material shall be stacked in such a distance from the trench edge that it will not endanger the work or workmen and it will avoid obstructing footpaths, roads and drive ways. Hydrants under pressure, surface boxes, fire or other utility controls shall be left unobstructed and accessible during the construction work. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural water-courses shall not be obstructed.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards, as required, shall be placed and maintained during the progress of the work and until it is safe for traffic to use the roadways. All materials, piles equipment and pipes which may serve as obstruction to traffic shall be enclosed by fences or barricades and shall be protected by illuminating proper lights when the visibility is poor.

As far as possible, the pipe line shall be laid below existing services, like water and gas pipes, cables, cable ducts and drains but not below sewers, which are usually laid at greater depth. Where it is unavoidable, pipe line should be suitably protected. A minimum clearance of 150 mm shall be provided between the pipe line and such other services.

Trees, shrubbery fences, poles, and all other property and surface structures shall be protected. Tree roots shall be cut within a distance of 50 cm from pipe joints in order to prevent roots from entering them. Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be provided. The structures, which will be disturbed shall be restored after completion of the work.

Where water forms or accumulates in any trench the Contractor shall maintain the trench free of water during pipe laying.

Wherever necessary to prevent caving, trench excavations in soils such as sand, gravel and sandy soil shall be adequately sheeted and braced. Where sheeting and bracing are used, the net trench width after sheeting shall not be

less than that specified above. The sides of the excavation shall be adequately supported at all times and, except where described as permitted under the Contract, shall be not battered.

The Engineer in Charge in co-operation with the Contractor shall decide about the sheeting/ bracing of the trench according to the soil conditions in a particular stretch and taking into account the safety requirements of the Contractor's and ENGINEER's staff. Generally, safety measures against caving have to be provided for trenches with vertical walls if they are deeper than 2.0 m.

**Trench Excavation to Commensurate with the Laying Progress**

The work of trench excavation should be commensurate with laying and jointing of the pipe line. It should not be dug in advance for a length greater than 500 m ahead of work of laying and jointing of pipeline unless otherwise defined by the Engineer in Charge. The Contractor has to ensure the following:

1. safety protections as mentioned above have to be incorporated in the work process
2. hindrances to the public have to be minimized
3. the trench must not be eroded before the pipes are laid
4. the trench must not be filled with water when the pipes are laid
5. the trench must not be refilled before laying of the pipes

The bed for the laying of the pipes has to be prepared according to the L-Section immediately before laying of the pipes.

**Bedding of the Pipes**

The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may injure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes.

**Laying and Jointing of Pipes**

The pipes will be cleaned in the whole length with special care of the spigot and sockets on the inside/ outside to ensure that they are free from dirt and unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on longitudinal sections. The pipes shall be laid without deflection in a straight alignment between bends and between high and low points. Vertical and horizontal deflections between individual pipes need the approval of the Engineer in Charge. In no case the deflection shall be more than 75 % of those recommended by the manufacturer.

Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes, particularly the spigot end and the socket including the groove for the rubber ring. End caps are removed only just before laying and jointing

Pipes and the related specials shall be laid according to the instructions of the manufacturers and using the tools recommended by them.

Cutting of pipes shall be reduced to a minimum required to conform with the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. Cutting shall be perpendicular to the centre line of the pipe. In case of ductile iron pipes the cut and chamfered end shall be painted with two coats of epoxy paint. If there is no mark for the insertion depth on the spigot end of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.

All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.

When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line.

No pipe shall be laid in wet trench conditions that preclude proper bedding, or when, in the opinion of the Engineer in Charge, the trench conditions or the weather are unsuitable for proper installation.

The pipe line laid should be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.

Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is back filled over the barrel of the pipe.

The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline.

The assembly of the pipes shall be made as recommended by the pipe manufacturer and using the suitable tools.

The socket and spigot ends of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end has to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

The two pipes shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade

Deflection of the pipes -if any- shall be made only after they have fully been assembled. The deflection shall not exceed 75 % of the values indicated by the pipe manufacturer.

**Anchoring of the pipeline**

Thrust blocks shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design of Engineer according to the highest pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

**Backfilling of the pipe trench**

For the purpose of back-filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top:

| | |
|---|---|
| **Zone A:**<br>From the bottom of the trench to the level of the centre line of the pipe | Back-filling by hand with sand, fine gravel or other approved material placed in layers of 150 mm and compacted by tamping. The back-filling material shall be deposited in the trench for its full width of each side of the pipe, specials and appurtenances simultaneously. Special care shall be taken to avoid damage of the pipe and the coating or moving of the pipe. |
| **Zone B:** | Back-filling and compaction shall be done by hand or approved mechanical methods in layers of 150 mm, special care shall be taken to avoid damage of the pipe and the coating or moving |

| | |
|---|---|
| From the level of the centre line of the pipe to a level 300 mm above the top of the pipe | of the pipe. |
| **Zone C:**<br>From a level 300 mm above the top of the pipe to the top of the trench. | Back-filling shall be done by hand or approved mechanical methods in 15 cm layers after compacting and carried to the level necessary to allow for the temporary restoration of road and path surfaces, and also for hard-core (if and where ordered) on roads or to such level as will leave the requisite space for the top soil, road surface etc. to be reinstated as directed by the Engineer in Charge.<br>In case of agricultural or waste land and after approval by the Engineer in Charge back-filling may be made in thicker layers and with less compaction up to 200 - 300 mm above the initial ground level. |

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back-fill to the sub grade of the structures shall be made with sand in accordance with IS 12288.

The excavated material may be used for back-fill in the following cases, provided it complies with IS 12288 Clause 4.11.1:

a) In Zone C: In cases where settlement is unimportant the back-fill shall be neatly rounded over the trench to a sufficient height to allow for settlement to the required level.

b) In any zone, when the type of back-fill material is not indicated or specified, provided that such material consists of loam, clay, sand, fine gravel or other materials which are suitable for back-filling in the opinion of the Engineer In Charge.

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer in Charge, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Engineer in Charge, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

Trenches crossing a road shall be backfilled with selected material placed in layers not exceeding 15 cm in thickness after compacting, wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal of refuse or unsuitable soil.

**Thrust boring for pipe laying under Road Crossing**

Where the pipeline has to cross High way, Trench less laying by thrust pushing method has to be done. The specifications for which are as under:

**Specification for trench less laying of pipe line:**

Providing, lowering in trenches, laying and jointing DI/ MS pipe as per Railway / NH standards with welded joints by hydraulic jacking and smooth controlled pushing method under running traffic condition as per Standards, including carrying out survey work at the job site for determining underground cable trenches like telephone, power cable, water & sanitary lines and resistivity tests for finding the soil strata using necessary equipments for completion of work, mobilizing of machineries and specialized crew at the job site, etc. complete in all respects, including driving in all

types of soils & all types of rock, including excavation of Drive pit and Exit pit with proper protection at the three sides with shoring sheets & ISMB's, Providing and casting MS cutting edges for front shield and constructing thrust bed at designed level as directed by the Engineer, necessary de-watering and providing concrete foundations at the base of the drive pit, crane for handling of pipes, and any other machinery, tool & tackles required, construction of temporary works as per requirement and as approved by Railway / NH authorities and the Engineer, and laying and jointing of MS/ DI K-9 pipes on M20 concrete saddles/beds for resting the MS/ DI K-9 pipes inside the MS pipe, and finally clearing of pipes with water jetting and removal of surplus earth, closing both sides of MS pipe with brick stone masonry in CM 1:6 230m thick with 150mm thick PCC foundation M15 grade and finishing with 18 mm thick cement plaster in single coat on outer face and edges with CM 1:3 to prevent entry of water including all plant machinery, equipments, labour, materials, giving satisfactory hydraulic field testing as per IS: 12288-1987 and Commissioning, etc., complete in every respect for crossing the Railway line / National Road and irrigation canal for 600mm / 450 mm / 400mm / 250 mm diameter of rising main, in all kinds of soils at necessary depth (all depths) with all lead and lifts, as per specifications and as directed by the Engineer.

**Sequence of Works for Ensuring Good Pipe Laying**

a) The required fittings, valves and jointing material should be carefully worked out in beginning. This material should be received in full first of all on site and stored as per directions of manufacturer or as directions given elsewhere in this manual on Standards. The pipes should be received on site only after the above fittings, valves and material for joints has been received and all necessary preparation for laying has been made. The material received should be checked for inspection certification as per contract and damage during transportation. All damaged material should be separated and not used. The pipes received should be stored strictly as per directions of the manufacturer or as mentioned elsewhere in this manual or standards. The pipes and other material should be again inspected for any damage before use in the trench. The fittings and valves should be installed in sequence with the laying of pipes without leaving any gaps. It is desirable to lay the pipe lines from the end from where it can be connected to the water source to enable regular flushing of laid pipes. The entry of dirt or any foreign material in the pipe should be religiously prevented. Each joint should be carefully checked for its completeness before covering up. There should be a commensurate progress in trench excavation, laying and jointing of pipes, fittings, valves etc. and testing of laid pipes in sections so as to complete testing of all pipes laid in quick follow up of completing laying and jointing.

**b) Installation of valves**

The installation of valves shall be made between flanges and shall be according to the instructions of the manufacturer and the Engineer. Valves shall be placed on a support of concrete so that no shear stress occurs in the flanges. In case of axial thrust due to closure of a valve against pressure, the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

**c) Crossing of existing Distribution Pipes, connecting pipes and other underground service components**

Existing transmission and distribution pipes and connecting pipes of standpipes have to be protected during the laying of the pipes. In case of impossibility of deviation, the pipes have to be replaced according to the instructions of the Engineer and in co-operation with the local representative (e.g. Assistant Engineer of PHED). The Contractor shall be fully responsible in case of damage of pipes or any other item due to inattention of his staff. All costs for the reinstatement of the original status to the pipes or any other item in case of damage have to be borne by the Contractor at his cost. Similarly the Contractor shall have to reinstate in the original status, other services damaged by him such as power or telephone cables etc.

d) Poles of electrical or telephone lines, if coming in the alignment, will be got shifted through the respective agencies, as per approval of the Engineer.

**Testing of the pipelines**

**a) Sectional tests**

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Engineer in Charge. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber).At the beginning, the Contractor shall test stretches not exceeding 2 km. After

successful organization and execution of tests the length may be extended to more than 2 km after approval of the Engineer in Charge.

The water required for testing shall be arranged by the Contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test/saturation and test, immediately following the pre-test. Generally, the following steps are required which shall be monitored and recorded in a test protocol if required:

- Complete setting of the thrust blocks.
- partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control
- opening of all intermediate valves (if any)
- fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
- at the lower end with a precision pressure gauge and the connection to the pump for establishing the test pressure
- at the higher end with a valve for air outlet
- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- Slowly filling the pipe from the lowest point(s).
- the water for this purpose shall be reasonably clear and free of solids and suspended matter
- Complete removal of air through air valves along the line.
- Closing all air valves and scour valves.
- Slowly rising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
- Keeping the pipeline under pressure for the duration of the pre-test / saturation of the lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.
- Start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.
- Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches.
- The testing conditions for the pipelines shall be as per the test conditions laid out in relevant IS codes.

The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits. No section of the pipe work shall be accepted by the Engineer in Charge until all requirements of the test have been obtained.

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

**b) Leakage Test**

After the successful completion of the pressure test (i.e. pressure testing at factory/works), Leakage test at site after proper installation of pipeline shall be conducted at a pressure specified above for a duration as specified below :

- Pre test and saturation period with addition of make-up water
- Pressure : Test Pressure
- Duration : 3 hrs for pipes without cement mortar lining / 24 hrs for pipes with cement mortar lining, Pressure test / Leakage Test with addition of make-up water
- Pressure : Test Pressure
- Duration : 3 hrs
- Test criteria for DI/MS : Q = 1.0 liter per km per 10mm of pipe per 30 m Test Pressure per 24 hrs.
- Test criteria for PVC pipes : Q = 1.5 liter per km per 10mm of pipe per 30 m Test Pressure per 24 hrs.

No pipe installation shall be accepted until the leakage is less than the amount 'Q', as determined by the above formula:

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount 'Q', calculated by the above formula. Where any test of pipe laid indicates leakage greater than that specified as per the above formula, the defective pipe(s) or joints(s) shall be repaired/replaced as per the satisfaction of engineer in charge until the leakage is within specified limits. The Contractor has to make his own arrangements for water of approved quality, required for testing pipeline

**The table, hereunder, gives recommended test pressure for DI pipes.**

| **Maximum Continuous Working Pressures and Recommended Test Pressures** | | |
|---|---|---|
| **Class of pipe** | **Working Pressure** | **Recommended Site/ Field Test Pressure** |
| | **Kg/ sq cm** | **Kg/ sq cm** |
| DI Class K-7 | 8.0 | 17.5 |
| DI Class K-9 | 64 for 100 mm dia to 30 for 1000 mm dia pipes | 96 for 100 mm dia to 41 for 1000 mm dia pipes |

Due to the elastic characteristics and relatively high thermal expansion and contraction of PVC, it is advisable to avoid prolonged pressure tests.

If it is required to test a section of a pipe line with a free end, it is necessary to provide temporary support against the considerable end thrust developed by the Bid of the test pressure. The end support can be provided by inserting a wooden beam or similar strong material in a short trench excavated at right angle to the main trench and inserting suitable packing between the support and pipe end.

**c) Failure to pass the test**

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to the unsatisfactory in any way shall be redone by the Contractor.

**Flushing and Disinfection of Pipelines**

After testing the Contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Engineer in Charge.

The pipeline shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small Bids, the solutions may be fed with a hand pump.

In the case of pipeline of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of

chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/I. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'Slug' of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 mg/I. for at least 3 hours. As the chlorinated water flows past tees and crossings, related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid pipeline in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until the chlorine concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or less 1 mg/I.

After final flushing and before the water pipeline is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coli form organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory; the pipeline may be placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works including arrangement and cost of water and other relevant material till the main placed in service other wise specified.

**COMMISSIONING**

**General**

After successful sectional tests and other pre-commissioning tests, flushing, disinfection etc. and after physical completion, the pipeline shall be commissioned by the Contractor. Dynamic commissioning shall be made in conjunction with or after the commissioning of the respective system.

During testing/commissioning, the Contractor shall supply all material and labour to supervise, adjust, test, repair and do all things necessary to maintain the testing/ commissioning. This shall include labour on a 24 hour-a-day basis during the test period and for such other period of continuous operation as the Engineer may consider necessary to establish the efficient operation of the cluster distribution system.

If any test result shows noticeable variation from the specification requirements for the system, the Contractor shall immediately take steps to rectify the deficiency without any extra cost to Engineer.

The Contractor shall test and commission the system for 7 days at a stretch, from the date of commissioning. On expiry of this period the system shall be taken over by the Engineer and a taking-over certificate shall be issued by the Engineer, provided all defects and/or deficiencies noticed are rectified to the satisfaction of the Engineer.

Should the supply of water from the pumping station fail or should any other event beyond the Contractor's control, the commissioning shall be during such a number of operational periods as the Engineer may consider equivalent. Any repairs or replacement required during this period shall be done by the Contractor at his own cost.

The main indicators for the successful commissioning are:

- no leaks in pipes, joints, specials and valves
- all valves are properly installed and operational
- execution of the entire work including finishing according to the drawings and the specifications
- submission of as built drawings

**Dynamic Commissioning**

The dynamic commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer. It shall simulate the design and operation conditions which are as follows:

- All branches into existing lines (if already in position) to be shut off.

- Pump in operation, pump discharging into the transmission main. This is for the commissioning of the transmission pipe only.
- Water being put into the system through overhead tank or direct pumping as the case maybe.
- Closing of the valves against full static or dynamic pressure.
- Operation of all valves including scour valves (open-close-open).
- Operation of all air valves.
- Operation of all locking arrangements of valve chambers.

### 4.2.2 HORIZONTAL SPLIT CASING / BACK PULL OUT / VERTICAL TURBINE TYPE PUMPING SETS

Supply of pumping sets shall be in accordance with IS: 5210, IS: 6595 & IS: 9137 except for the provisions made here under.

**Design Features**

a) The pump shall be capable of developing specified head at the specified rated capacity while operating single or in parallel as specified and be capable of operating continuously at run out capacity condition.

b) The pumps shall be capable of discharging specified discharge at specified head continuously. The total head capacity curve shall be continuously rising towards the shut-off with the highest at shut-off. Pumps of a particular category shall be identical and shall be suitable for parallel operation. Pumps shall run smooth without undue noise and vibration.

c) The velocity of vibration shall be limited to 4.5 mm/sec. The noise level shall be limited to 85 DBA at a distance of 1.86 m from the pump set.

d) The rating of the motor shall be larger of the following :

   a) Maximum power input required by the pump in its entire range of operation

   b) 110% of pump input at design duty point.

e) The pump shall work without cavitations for the worst suction condition existing at the particular pump house.

**Features of Construction**

**a) Casing / Bowl**

Pump casing / bowl shall be axially/vertically split type. The casing shall be of robust construction. Liquid passage in the casing shall be finished smooth. Casing drain and vent connection with valves and automatic vent shall be provided in case of centrifugal pumps.

**b) Impeller**

- The impeller shall be dynamically balanced so as not to cause any vibration during operation.
- Impellers shall be made in one piece and securely keyed to the shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction. Impeller fastening nuts (if provided) shall be of cap type and shall tighten in the direction of normal rotation.
- Impeller shall be of Bronze with smooth surface and without blowholes.

**c) Wearing Rings**

Wearing rings shall be of renewable type. These shall be held in place by screwing against rotation, press fit and locked with pins, flanged and screwed. Opposite wear surface of hard material shall have a hardness difference of at least 50 BHN.

**d) Shaft**

- The shaft shall be of stainless steel AISI – 410 and finished to close tolerance at the impeller, coupling and bearing locations. The shaft design shall be on the basis of maximum combine shear stress. This shear stress shall not exceed 30% of the elastic limit in tension or 18% of ultimate tensile strength whichever is lower.
- The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 30% above/ below the operating speed.
- The shaft shall be statically and dynamically balanced so as not to cause any vibration during operation.

**e) Shaft Sleeves**

Replaceable shaft sleeves of Stainless Steel as specified in the data sheet shall be provided to protect the shaft where it passes through stuffing boxes. The shaft sleeves shall be securely locked or keyed to the shaft and shaft sleeves shall be machine finished and assembled for concentric rotation.

**f) Bearings**

- The bearings shall be ball or roller type and provision shall be made for the axial and radial loads.
- When there is a possibility of liquid entering the bearings, the pumps shall be provided with suitable preventive arrangements such as water deflectors.
- Grease lubricated ball bearings are acceptable, if the pump is specifically designed for grease lubrication and if operating conditions meet the following:
    a) Shaft speed does not exceed the speed limit recommended by the bearing manufacturers
    b) Suction pressure is below 0.7 Kg./sq.cm. and with no other source of high thrust.
    c) Whenever thrust bearings are fitted, suitable arrangement for adjusting clearance shall be provide. Bearing shall be easily accessible without disturbing the alignment of the pumps.

**g) Couplings**

- Pumps shall be complete with flexible coupling. Both halves of the coupling shall be provided by the pump manufacturer. Coupling halves shall be keyed to fit shafts of the pump and the motor by the Contractor. Both halves of the coupling shall be matched. Flexible rubber bushing with carbon steel coupling pins shall be provided with coupling.
- Coupling guards, made of expanded metal bolted to the base plate, shall be provided.

**h) Base Plates**

- The common base plate for pump and drive shall be in one piece and shall be made of welded steel construction. Suitable holes shall be provided for grouting and they shall be so located that the base can be grouted in place without disturbing the pump and motor. All pumps and drives shall be properly aligned, bolted and dowelled to the base plate by Contractor. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 14 mm drain piping. Base plate shall be manufactured by pump manufacturer so that holes and spacers are as required for pump motor alignment perfectly.
- The material of construction of various components for Vertical Turbine pump shall be as under:

| | |
|---|---|
| Discharge casing | Cast Iron Grade FG 220 of IS: 210-1993 |
| Suction casing | Cast Iron Grade FG 220 of IS: 210-1993 |
| Pump bowl | Cast Iron Grade FG 220 of IS: 210-1993 |
| Diffuser | Cast Iron Grade FG 220 of IS: 210-1993 or Glass filled polyphenylene oxide (modified PPO) or Glass filled poly carbonate of IS: 8034-1989 |
| Pump Shaft | Stainless steel 04 Cr 13 or 12 Cr 13 or 20 Cr 13 of IS: 1570 (Part – 5) – 1985 |
| Bearing sleeves | Stainless steel 04 Cr 13 or 12 Cr 13 or 20 Cr 13 of IS: 1570 (Part – 5) – 1985 |
| Impeller | Bronze grade L BT_2 of IS 318-1981 or Norly composite. |
| Casing wear ring (if provided) | Leaded tin bronze grade 4 of IS: 318-1981 |
| Bearing bush | Leaded tin bronze grade 4 of IS: 318-1981 |

**i) Accessories**

a) All accessories required for proper and safe operation shall be furnished with the pumps.

b) Each stage of the pump, unless self venting, shall be provided with a suitable vent connection, complete with valves.

c) Drain connections shall be provided at low points, valve connections shall be provided for drains.

**Inspection and Testing at Manufacturer's Works**

All the pumps shall be separately tested for performance at manufacturer's works. For testing purpose one of the motors to be supplied along with the pump shall be used.

Standard Running Test shall be conducted as per IS: 5120, IS: 9137 at rated speed to measure capacity, total head, efficiency and power. However, no negative tolerance on pump

Efficiency is acceptable. These tests shall form the basis for pump acceptance except for vibration and noise. The pumps shall be tested over the range covering from shut off head to the maximum flow. Minimum seven readings approximately equidistant shall be taken for plotting the performance curve.

- Material Test Certificate : Casing, Impeller and shaft
- Hydrostatic Test : 1.5 times the shut-off head or twice the rated discharge head whichever is greater
- Performance Test : As per IS:5120 & IS:9137 at full speed
- NPSH Test : "Type" test certificate for the offered model
- Mechanical Balancing : As per ISO:1940, Gr. 6.3 or better
- Visual Inspection : Pumps shall be offered for visual inspection before shipment. The pump components shall not be painted before inspection
- Field Tests : Field performance tests required for satisfactory operation

**a) Hydrostatic Test**

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or twice the rated head whichever is higher.
- Unless otherwise stated in Data Sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.

**b) Mechanical Balancing**

- Balancing: The rotating assembly comprising of impeller, shaft with shaft sleeve etc. shall be statically and dynamically balanced as per IS 11723(Part I).
- Necessary test certificates shall be furnished by vendor for purchaser's approval before dispatch of material.

**c) Performance Testing**

- All the tests shall be carried out by the third party inspection agency as per IS – 9137:1978 with its own motor for its entire working range.
- Each pump shall be tested for its full operating range in accordance with the applicable standard.
- Test shall be carried out with minimum NPSH as available at site for rated discharge and maximum discharge. Each pump shall be tested at its rated speed.
- During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the Data Sheet, and cover its full working range from its closed valve condition to when delivery valve is fully opened up. Head, flow and overall efficiency shall be used to determine the capacity of pump sets to meet guaranteed performance at site.

**d) Material Test Certificate**

Material test certificates for the various pump components shall be furnished for purchaser's approval as stated in the Data Sheet.

**e) Visual Inspection**

Pump body shall be painted only after the hydrostatic test has been witnessed by the third party inspection agency.

**f) Field Testing**

After installation pumps will be subjected to testing in field for its satisfactory and trouble free operation for 200 working hours. If the field testing, performance is found not to meet the requirement, the equipment shall be rectified and/ or replaced by the Contractor.

**Drawings and Manuals**

The following drawings shall be submitted by the Bidder along with his bid:

a) Preliminary out line dimensional drawing showing the details of pump, base plate and motor. Suction & discharge nozzle sizes and foundation details.

b) Performance curves for capacity v/s (a) total head, (b) efficiency, (c) NPSHR and (d) KW requirements ranging from run out to pump shut off duly signed by responsible engineer of the manufacturer.

c) Typical cross sectional drawing with material of construction of each pump offered shall be provided with the bid.

d) Installation manual of all types of pump offered shall be submitted at the time of approval of equipment.

**Name Plate**

Each pump shall be provided with a stainless steel name plate of the manufacturer, indicating following details.

a) Rated capacity in m3/hr

b) Total head in meter

c) Speed in RPM

d) Make and Model number

e) Manufacturer's serial number

f) Weight of equipment

### 4.2.3 CHLORINATORS

Chlorinators shall be provided for Pre chlorination and post chlorination before supply to public for potable use. Chlorinators shall be installed in a separate chlorine room adjacent to storage shade. The room shall be reasonably gas tight and shall be provided with a ventilation system delivering into the open space of the chlorine storage area.

The process water for chlorine solution shall be drawn from the pipes coming from the main pumps of the pump house or from Wash water tank.

The chlorinators shall be adjustable within a range of 1:10 according to the chlorine requirements of water. The tolerance of adjustment is not more then +/-4 %; pressure gauges, indicating chlorine gas pressure and injector pressure shall be mounted on the front of the chlorinator and calibrated in metric units.

**Construction Feature**

All parts of the chlorinators and its accessories shall be of suitable material resistant to the chlorine (silver, silver plated Hastelloy C, PVC, Teflon, Borosilicate glass, ebonite lined cast iron). The chlorinators shall be wall mounted with suitable mounting brackets with anchor bolts. All connections, valve sand other pars of the chlorinators shall be easily accessible for cleaning, maintenance and repairs. Pipe connections shall be flexible.

The complete chlorinators shall be piped, and pre-tested as a system with all necessary valves, inlet connections, gauges and orifice control.

**Chlorination and Solution Pipes**

The gas and water piping system shall be designed according to the chlorine and injection water flows and the hydraulics / pressure conditions. The pipes shall be laid as straight as possible on the shortest route from the drums to the chlorinators. They shall be fixed on well-supported trays / brackets and adequately sloped to allow for drainage. All steel supports shall be heavily painted in chlorinated rubber paint.

The connections of the chlorine gas pipe to the cylinders and the chlorinators shall be coiled for flexibility during operation and maintenance. Each connection shall have a valve, a solenoid valve and a pressure gauge. All pipes and valves of the connection shall be placed out of the reach of gas cylinder hanging on the hook during manipulation.

Pipe material for the chlorination dosing plant

| **Medium** | **Construction Material** | **Test pressure** |
|---|---|---|
| Chlorine gas | Soft seamless copper tube with compressed fittings | 25 kg/cm$^2$ |
| Water for chlorine solution feed tower | Galvanized iron pipes and fittings, class C | 10 kg/cm$^2$ |
| Chlorine solution | Rigid PVC pipes and fitting, class 4, not exposed to open sunlight or HDPE pipe | 10 kg/cm$^2$ |

After installation, the chlorine gas piping system shall be cleaned and dried. After drying, the system shall be pressurized with dry air up to the test pressure and tested for leaks by Bid of soapy water to the outside of all joints and connections. Leaking joints shall be repaired, and only when all joints are made leak proof chlorine gas shall be gradually introduced and the system shall again be tested for leaks.

**Chlorination Leakage Control System and Security Equipment**

For the detection of excess concentrations of chlorine in the air of the chlorinator room and the chloride storage area, leak detection devices are to be provided at suitable sites. Two levels of detection are envisaged. The detection, installation site and actions proposed are given below:

| **Detection level** | **Action** | **Installation site and number** |
|---|---|---|
| **A. Chlorine concentration at or below the level of human perception :** Concentration level 1 mg/l, adjustable between 1 and 5 mg/l | Indicator lamp, acoustic alarm at the chlorine plant | 1 for drum storage area<br><br>1 for chlorinator room |
| **B. Abnormally high concentrations which could occur on leakage or failure of the chlorinating equipment:** concentration level 5 mg/l | Indicator lamp, acoustic alarm and stopping of booster pump. | 1 for drum storage area. |

**Safety Equipment:**

The Contractor shall provide following set of safety equipments, as a Minimum with each chlorinator:

a) Canister type respirators with full face coverage masks suitable for chlorine gaseous atmosphere with one spare Canister - 1 no.

b) Chlorine leak detector with two sensors – 1 no.

c) Self contained compressed air breathing apparatus complete with working whistle and two spare air cylinders – 1 no.

d) Emergency Tonner repair kit – 1 no.

e) Protective clothing such as PVC overall and gloves and rubber boots shall be provided – min 2 sets.

f) Safety shower with eye wash – 1 no.

These equipment shall be stored in a glass fronted non-locking steel cabinets so that any deficiency in the equipment shall be apparent. 15 m hoses DN 1" with jet and spray nozzle and valve are provided near the chlorine drum storage area in non-locking steel cabinets. They are connected to the process water system.

**Operation of the Chlorine Dosing Plant**

| **Operation** | **Pre / Post-chlorination** |
|---|---|
| Regulation of the chlorine rate | Manual, according to incoming flow of water |
| Regulation of the process water | Manual, according to incoming flow of water |
| Stop of chlorine gas flow | Manual |
| Stop of water to dispensing tower | Manual. |

Chlorine toners shall conform to all statutory requirements and necessary certificates from the manufacturer and the respective government agency. The certificate to this effect shall be submitted/ furnished. It shall have a capacity of 900kg of liquid chlorine.

### 4.2.4 INSTRUMENTATION AND CONTROLS IN SEWAGE TREATMENT PLANT

***1. Introduction***

Instrumentation and control plays an important role in efficient and effective operation of any water/ Sewage treatment plant. In order to monitor the quality and quantity of water produced and to have trouble free operation of treatment plant, it is desirable to provide proper instrumentation and control system in the plant. The impact of sudden changes in raw sewage quality, peak demands and seasonal variations require quick responses and proper action. This is possible only if the plant is provided proper instrumentation and control systems.

***2. Purpose and Objective:***

The purpose and objective of instrumentation & Control systems for treatment plant are:

a) To treat sewage at a lower cost in lower time;

b) To control certain key functions in order to maintain balance in plant processes.

c) To obtain plant-operating data such as (i) characteristics of raw & treated sewage (ii) flow and quantity measurements including the record of consumables.

d) To guide the operator by providing all related data for efficient functioning of various units of sewage treatment plants.

### 4.2.5 R.C.C. RESERVIORS

Ordinary Portland Cement (OPC) conforming to IS: 8112-1989 mark (Grade 43) shall only be used. Cement manufactured in mini-cement plants shall not be used.

All reinforcement used shall be of Tor steel (Fe 415) ISI mark and shall be clean and free from loose mill scales, rust and coating of oil or other coatings which may destroy or reduce bond. Minimum size of reinforcement bars shall be of 8 mm.

Only steel shuttering shall be used. Shuttering shall be new or in a good condition without holes or dents. It has to be approved by the Engineer in charge. The individual elements of shuttering shall be in the correct shape to ensure a gap free shuttering. Suitable systems have to be provided for keeping the shuttering in place and keeping the correct distance in case of walls. The shuttering for vertical walls of tank shall not be kept in position by removable bolts to leave holes on removable of shuttering.

The construction joints should be minimum and these have to be executed with utmost care. Before concreting on contact on joint loose material has to be removed and they have to be cleaned properly. Honey combing has to be avoided by suitable fixing of shuttering and proper use of vibrators. PVC water stops of 230 mm should be provided at construction joints.

The exposed surfaces of concrete shall be kept continuously in a wet condition by ponding or covering with a layer of sackings, canvas, hessian or similar materials and kept continuously wet for at least 21 days from the date of placing of concrete.

To obtain dense concrete and to reduce chances of honey combing adequate admixture approved by Engineer in Charge shall be used as integral water proofing compound in concrete work. The quantity of the admixture used shall be as prescribed by the manufacturer and as approved by the Engineer.

Approved Water Proofing Compound shall be used, as per manufacturer's recommendation, for all concrete work for water retaining structures, at no additional cost to the FSCCL.

**Construction Joints**

As construction joints are week in shear normally construction joints, if required, shall be provided in location where shear stress is minimum. However, construction joints should be avoided in the bottom slab of any water retaining structure. In the walls of the water retaining structures vertical construction joints should be avoided to the maximum possible extent. In the event the Contractor solely for his convenience proposes construction joints in the bottom slab and or vertical construction joints in the wall of the water retaining structures, then the Contractor shall provide approved PVC water-stop of 230mm width and 8mm thick in all such joints. For the convenience of construction and to avoid segregation of concrete horizontal construction joints shall be provided in a planned way at a height not more than 2.0M in case of approved admixture, at his cost, is used by the Contractor in the concrete to increasing the workability of the concrete without affecting the designed water cement ratio. In case such admixture is not used the height of such cast shall be restricted maximum up to 1.5M.

All such construction joints should be prepared properly like removing of all loose materials by wire brush and soaking with rich cement slurry mixed with approved water-proofing compound in prescribed ratio, before pouring next concrete. Next pour of concrete in any construction joints in water retaining structures should be within 24 hours of last pour.

**Final Finishing**

The Contractor will ensure that the entire structure alongwith all its installations are in a finished and in new and fully operative condition when handed over. He shall have repaired and remove all signs of damage that might have been done during the course of installation and fixing of equipment. He shall also see that all the exterior has been finished properly and the entire site is cleared of all extra construction material, debris, and excavated soil This shall have to be done at his own cost for which he will not be separately paid.

**Water Tightness Test**

In addition to the structural test of structures, the tanks shall also be tested for water tightness test at full supply level as described in 10.1.1,10.1.2 and 10.1.3 of latest revision of IS 3370 (Part I).

On completion of the Reservoir works and before its commissioning, the Contractor shall carry out a water tightness test for the maximum water head condition i.e. with the water standing at Full Supply Level (FSL). This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the construction of Reservoir (i.e. construction of container part in all respect) is done and when it is possible to fill the reservoir and ensure that uniform settlement of the structure as a whole or as directed by the Engineer. Before starting of the filling operations, the reservoir shall be inspected by the Engineer and the Contractor's Representative and the condition of surfaces of walls, contraction joints shall be noted and it shall be ensured that the jointing material filled in the joint is in position and all openings are closed. The Contractor shall make necessary arrangement for ventilation and lighting of the reservoir by way of floodlights, circulators etc. for carrying out proper inspection of the surfaces and inner conditions if so desired by the Engineer. For this purpose, it shall be verified that sluice valves provided on the various pipes connected to the reservoir then shall be carried out gradually at the rate not exceeding 30 cm rise in water level per hour. Records of leakages starting at different levels of water in the reservoir, if any, shall be kept.

The reservoir once filled shall be allowed to remain so for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded against the subsequent intervals of 24 hours over a period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40 mm. Also there shall be no indications of the leakage around the puddle collars or on the walls and bottom of the reservoirs.

If the structure does not satisfy the condition of test and the daily drop in water level is decreasing, the period of test may be extended for a further period of seven days and it the specified limit is then reached the structure may be considered as satisfactory.

The external faces of structure shall not show any signs of leakage and shall remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.

In case the drop in level exceeds the permissible level limit and signs of leakage with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer to reduce the leakage within the permissible limits. The entire rectification work that shall be carried out in this connection shall be at the Contractor's cost. The water required for subsequent testing shall be supplied to the Contractor free of cost, if the same is available near the site. Contractor shall have to make arrangement for filling emptying the reservoir at his own cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the water retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure will be condemned and the Contractor will dismantle and reconstruct the structure, to the original specification, at his own cost.

During testing and during defect liability period the impression marks created due to seepage shall be rectified and made good.

No separate payment shall be made for water tightness test and the cost thereof shall deem to be covered in the rates quoted of different items of work of Service Reservoir.

**Precautions to Keep Reservoir free from Contamination**

As soon as possible after completion of reservoir and after all pipes have been laid the Contractor shall remove all dirt, debris, materials, tools etc. from the reservoir and shall wash and brush down with water the whole of the interior. He shall also if required by the Engineer incorporate a mixture of chloride of lime in the water wash required.

The greatest care shall be taken to keep the entire reservoir free from any contamination. Strict supervision shall be maintained over the workmen entering after first washing down. Provision shall be made to enable workmen to wash their feet or footwear clean and sterilize them before entering.

**Pipes & Specials in Reservoirs**

The Double Flanged CI Pipes shall conform to IS 1536 and CI Double Flanged fitting specials shall be in accordance with IS 1538.

Sizes of different pipes for inlet, Outlet, Overflow and wash out pipes for different locations shall be as per the drawings of the ESRs

Cast Iron spun pipes & Fittings laying, jointing, testing, commissioning etc. shall be as per standard specifications.

CI Double flanged Dismantling joints shall be installed in such a manner that valves can be dismantled without stress to the joints. Dismantling joints shall be suitable for installation with all valves of diameters of more than 200 mm. These shall be for working pressures of 10 kg/ cm2 (1 Mpa) and shall be completely leak proof with proper gasket arrangement. Flange dimensions shall conform to latest relevant IS code. Flanged specials shall be supplied with required nuts, bolts and rubber gaskets. The dismantling joint shall be internally and externally coated for corrosion control.

**Valves**

The sluice valve will confirm to IS: 14846/ IS: 2906 as already specified in this document.

**Ladder**

MS iron ladder with cage 450 mm wide made up of 75mm X 75 mm X 8 mm MS angle iron and 20 mm MS bars welded at 300 mm c/c shall be provided from the last landing to landing at middle ring beam level and also from middle ring beam level to the top dome of the container. Ladder should be fixed at respective concrete sections at top and at bottom. Aluminium ladder 450 mm wide shall be made up of Aluminum rectangular section of 65 x 35 mm (3

mm Thk) and 25 mm bars (as approved by the Engineer) welded at 300 mm c/c. The ladder shall be provided from top dome to the bottom dome inside the container.

**Railing**

Hand railing around the platforms, balcony, stairs and landing shall be on both sides consisting of 32 mm diameter medium class GI pipes in two rows (one at the top and other at middle level) and 900 mm high vertical angle 65 X 65 X 6 with all accessories like elbows, tees etc. including welding, threading and embedding in cement concrete floor with two nos. of angle iron 65 X 65 X 6 mm size hold fasts. Railing shall be protected against corrosion after welding and shall be painted with three coats of approved paint.

The vertical posts shall be spaced at a maximum distance of 1.5 m centers and shall be built into the concrete or bolted to the MS plate embedded in concrete as shown on detailed drawing.

**Water Level Indicator**

Water level indicator shall consist of an approved copper float and iron counter weight and connected by 4 mm dia. Stainless steel flexible stranded wire passing over frictionless aluminium pulleys 7 cm diameter fixed on GI medium class pipe to be installed as indicated in the drawing. The scale shall be calibrated in centimetre and should consist of MS sheet 20 gauge fixed over wooden plank with an MS angle iron frame of 35 mm X 35 mm X 5 mm and painted with white enamel bases, letters in black and red. The scale shall be located and fixed with RCC column at 2.5 m above the ground for OHSR.

**Ventilator**

The ventilator shall be as shown in the drawing, consisting of precast RCC jalli 50 mm thick reinforced with 1.6 mm dia MS wire. It shall be fixed with angle iron frame 25 x 25 x 3 mm and wire gauge 16 mesh 24 gauge including 100 mm square bars at interval of 100 mm welded screwed to frame with metal beading of 20 x 3 mm.

**Lightning Arrestor**

Lightning arrestor shall be copper bar of 25mm dia and 2m long connected by aluminium strip of 25mm width and 3mm thickness and the strip shall be connected to a 600x600x6mm thick copper plate embedded below ground with 40mm dia GI pipe in earthing etc complete. Earthing shall comply to IS: 3043.

## 4.3 ELECTRICAL WORKS

### 4.3.1 11 KV CAPACITOR BANKS AND ASSOCIATED EQUIPMENTS

This specification covers design, manufacture, testing at manufacturers works, supply and destination of 11KV Capacitor Banks, Control Panels, Current Transformers, Residual Voltage Transformers, Isolators, Lightning Arresters, Vacuum Automatic Capacitor Switches their mounting GI structures and other associated materials. (Capacitor bank will be installed in the outdoor hence shall be suitable for 11 KV HT cable termination)

**A) CAPACITOR BANKS**

1. 11KV Capacitor Banks: - The rating of the Capacitor Banks will be as follows: -

   i). 1200 KVAR at 11 KV, 3 Ph 50 HZ neutral solidly grounded systems and to be controlled with suitable vacuum circuit breaker.

   ii) 600 KVAR at 11KV, 3 Ph 50 HZ installed at 33/11 KV S/s to be controlled by Vacuum automatic Capacitor Switches.

   1.1 The three phase capacitor banks shall conform to the IS: 13925:98 (Part-I), 13925:94 (Part-II), IEC 871-2-87 with its latest version/amendments, if any.

   1.2 The normal system frequency is 50 HZ and may vary between + 3% i.e. 48.5 HZ to 51.5 HZ.

   1.3 The capacitor shall be connected to the system with nominal voltage 11KV. The highest voltage of the system shall be 12.1 KV on sustained basis.

   1.4 The 1200KVAr & 600KVAr Capacitor will be installed in the 33/11KV substations where the neutral is solidly grounded in the 11KV system.

1.5 The maximum continuous system rms voltage that may be applied to the capacitor shall be of the order of 10% more than the rated rms voltage of the capacitor. However, the supplier of the equipments, including the breaker shall ensure that under breaker opening conditions, due to current chopping, the maximum dynamic over voltage level does not exceed 2.3 PU value of normal rated rms voltage.

1.6 The increase in current or reactive output of capacitor unit & bank over the rated values may be as per IS: 13925:98 with latest version/amendment, if any.

1.7 The capacitor banks shall have a rated voltage of 12.1 KV, therefore, banks ratings shall be 1200KVAr and 600KVAr at 11 KV. The capacitor bank shall be suitable for outdoor installation. The bank shall be arranged in single layer with capacitor units vertically having their bushings upright. The bank shall be completed with mounting fabricated from galvanized steel sections with protective quality to impart weather resistance and shall be maintenance free and complete with rack insulators and other hardware etc. for assembly into completed banks.

1.8 The standard basic unit rating of capacitors (single phase) shall be 121 KVAr at 6.98 KV and will be suitable for outdoor installation.

1.9 1200 KVAr bank shall consist of 12 single phase capacitor units of 121 KVAr. Each phase shall have 4 units in parallel which are connected then in ungrounded star.

1.10 600 KVAr bank shall consist 6 units of 121 KVAr capacitor unit having two independent star consisting of one unit per phase. Star point of the banks shall not be interconnected, no grounded.

1.11 The power loss in capacitor shall not exceed 0.2 Watt/KVAr.

1.12 Each capacitor unit shall be provided with built in discharge resisters, to permit the capacitor unit to discharge the capacitor to 50V or less in less than 10 minutes after disconnection from supply.

1.13 The container of each capacitor unit shall be provided with suitable earthing terminals clearly marked as with lifting lugs for ease in handling.

1.14 An external fuse of suitable rating shall individually protect each capacitor unit so that the fuse with a visual indication disconnects the faulty unit. The fuse shall be of expulsion type. This would permit disconnecting the defective unit as also equivalent rated capacitor from the other two healthy phases to resume supply with partial un balanced compensation.

1.15 Each capacitor unit shall be built with number of elements comprising of high quality embossed aluminium foil acting as electrodes separated by dielectric of biaxial oriented hazy polypropylene film. Capacitor shall be vacuum impregnated with on PCB oils only.

1.16 The container for the capacitor unit shall be made from sheet steel of thickness not less than 2.00 mm (14 SWG) and shall be hermetically sealed by controlled are welding process. The metal flanges of the bushing should be soldered to the container. Suitable mounting brackets and lifting lugs shall be welded to the container. Outside surface of the containers shall be painted with two coats of weather proof and corrosion resistant paint of light gray shade 631 as per IS:5 over the basic primer coat.

1.17 Set of three fuse barrels with leaf spring & fuse elements per bank i.e. 36 nos. in case of 1200 KVAr and 18 Nos. in case of 600 KVAr shall be supplied free of cost with each set of capacitor bank.

1.18 The capacitor bank shall be designed and capable of withstanding the following power frequency and impulse test voltage :-

| | |
|---|---|
| Nominal System Voltage | 11 KV (rms) |
| Highest System Voltage | 12.1 KV (rms) |
| Power frequency test Voltage | 28 KV (rms) |
| Impulse test Voltage | 75 KV (Peak) |

1.19 Each of the capacitor units as well as banks shall be provided with a rating plate and terminal markings as stipulated in IS: 13925:98. Elevating structures made from suitable solid steel sections

should be provided to fix effective height of the lowest accessible live terminal of the capacitor bank at 3.2 meters above the grounded level inclusive of matching plinth.

**ROUTINE/ACCEPTANCE TESTS**

Each capacitor units will be subjected to following routine/acceptance tests at the manufacturers works as per IS: 13925:98 (Part-I) with its latest version/ amendments, if any and shall be witnessed by our representative at the time of inspection at manufacturer works, if so desired by us :-

i) Visual examination

ii) Measurement of capacitance

iii) Voltage test between terminal

iv) A.C. Voltage test between terminals and container

v) Test of discharge device

vi) Capacitor loss tangent (Tan-delta) measurement

vii) Sealing test

**B) TYPE TESTS**

Following type test reports of offered capacitor units as per IS: 13925:98 (Part-I) 13925:94 (Part-II), ICE 871-2-87 with its latest version/amendments shall be submitted, while submitting drawings of capacitor for our approval :-

i) Thermal stability test

ii) Capacitor loss angle (tan-delta) measurement of elevated temp.

iii) AC Voltage test between terminals and container.

iv) Lightning impulse Voltage test between terminal and containers.

v) Short Circuit discharges test

vi) Endurance Test as per IS:13925:9 (Part-II)

Bus and equipment isolators with earth switches as required for isolation and earthing of the equipment shall be included in the scope of the supply.

Any other equipment and accessories which has not been specifically described but is considered necessary for the purpose of ensuring proper and reliable service from the complete installation should also be included in the scope of supply.

All equipment included in the scope of supply will have to be delivered complete with suitable terminal clamps, inter-connections and mounting structures etc.

Mounting structures for all the equipment should provide minimum phase to ground clearance of 32 meter.

Tools and Accessories

All the tools and accessories required for proper maintenance of the capacitor banks and other associated equipment will be provided free of cost. A detailed list of the tools and accessories to be provided shall be enclosed with the order.

**WORKMANSHIP:**

a) Workmanship shall be of the highest grade and conform to the best modern practice for the manufacture of high grade machinery and electrical equipment.

b) Field welding of the equipment are to be avoided and erection at site shall be kept to a minimum. Sub assemblies erected and tested in the factory are limited only by the transport conditions and handling facilities at site.

**DRAWING AND LITERATURES ETC.:**

The drawings with plan elevation and cross section of the switchgear with complete dimensions and weights of module shall be enclosed. Floor loadings for design of civil structure shall be included in G.A drawings. The drawings shall

include control circuit drawings for circuit breakers etc. Technical literature covering instruction booklet and O&M manuals of the equipment shall be enclosed to the offer. Tenders not accompanied by the above are liable to be rejected. Six sets of these drawings and literature (Instruction booklets and O&M manuals). The photographs (front and side views) of the equipment offered shall be furnished.

**NAME PLATE**

The arresters shall be provided with non-corrosive 2 mm thick metal nameplate embossed and fitted rigidly on arrestor body with indelibly marked with the following information:

1. Manufacturer's name or trademark and Identification (serial) No. of the arrestor.
2. Rated voltage
3. Maximum continuous operating voltage
4. Type
5. Rated frequency
6. Year of manufacture
7. The nameplate should be fitted rigidly so that during life of arrestor, there should not be any possibility of removal of nameplate.
8. Rated KVAR

**Drawings**

- The agency shall furnish two sets of following drawings for owner's approval before commencing the supplies. General outline drawings of the complete arrestor with technical parameters. Drawings showing clearance from ground and other live objects and between adjustment poles of surge arresters required at various heights of surge arrestors.
- Drawings showing details of pressure relief devices. Mounting clamp details of surge arresters.
- Details of the terminal and ground terminals.
- Volt - time characteristics of surge arresters.
- The detailed dimensional drawing of porcelain housing shall indicate ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.

**TEST & TEST CERTIFICATES**

**Type Test Certificates**

The following type tests shall be made in accordance with Clause 71 of IEC 99/4/IS-3070 Part-III latest amendment.

1. Insulation withstand test
2. Residual voltage test
3. Long duration current impulse withstand test
4. Operating duty test
5. Pressure relief test (for 30KV LAs)
6. Test of Arrestor Dis-connectors (for 9KV LAs)
7. Partial discharge test.

The following additional tests are to be made in accordance with IS 3070 (part-II) 1985:-

Temperature cycle test on porcelain housing

Porosity test for porcelain components

Galvanizing test on steel metal parts

**Acceptance Tests**

The following tests as per clause 8.2 of IEC 99/4 and IS-3070 Part-I/Part/III shall be done on the lower whole number of the cube root of the number of arresters to be supplied.

- Power frequency reference voltage test at reference current on complete arresters.
- Lightning impulse residual voltage test at nominal discharge current on complete arresters.
- Porosity test on porcelain
- Partial discharge test
- Galvanizing test on exposed steel parts
- Visual / dimensional examination

**Routine Tests**

The following routine tests as per Clause 8.1 of IEC 9/4 / IS-3070 Part-1/Part-III are to be conducted by the manufacturer on offered lot for pre-dispatch inspection. The lot offered without routine test reports shall not be considered & delay in acceptance of the offer will be on firm's account: -

- Measurement of the reference voltage on the complete arresters.
- Residual voltage test at nominal discharge current on the complete arresters or sections.
- Test to verify the efficiency of sealing.

**INSPECTION**

All tests and inspection shall be made at the place of manufacture unless otherwise specially agreed upon by the manufacturer and the owner. The manufacturer shall offer the inspector (representing the owner) all reasonable testing facilities without charges to satisfy him that the material is supplied in accordance with the Specification.

The owner has the right to have the tests carried out by an independent Agency subject to recovery of testing expenditure in case of failure, whenever there is dispute regarding the quality of supply.

### 4.3.2 11 KV INDOOR CONTROL PANELS

**1. SCOPE**

This section contains the technical specification for the Indoor control, indication, relay and metering panels associated with the outdoor switchgear and equipment associated with 11KV 1200KVAr Capacitor banks for use at various sub-stations. The control and relay panels and other requirements specified under this section shall be complete in themselves with all main and auxiliary relays, fuses, links, switches, wiring, labels, terminal blocks, earthing terminals, foundation bolts, illumination, cable glands etc.

**2. PANEL FINISH AND COLOUR**

The purchaser has standardized that the colour finish shall be **opeline green** as per colour No.275 of BS: 38IC (1948). Equivalent colour as per relevant Indian Standards or any other standard shall be acceptable. This colour finish shall be applied to all the exterior steel work of the panels. The exterior finish shall be semi glossy only and shall not be fully glossy. The interior of the panels shall be painted with **egg shall white.**

**3. PROTECTIVE RELAYS AND INSTRUMENTS**

The protective relays shall be manufactured, tested and supplied with the guaranteed particulars, as per following Indian Standard Specifications with latest amendment thereof :-

| | | |
|---|---|---|
| i | IS: 3842 (Part-I) 1967 | Application guide for electric relays for A.C. Systems over-current relays for Feeders and Transformers |
| ii | IS: 3842 (Part-IV)1967 | Application guide for electric relays for A.C. system thermal protection relays |
| iii | IS: 3231 (1965) | Electric relay for power system protection |
| iv | IS: 1885 (Part-I&II) | Electro-technical vocabulary Electrical relays & Electrical power system protection |
| v | All indicating instruments shall conform to IS: 722 or BS-89 | |

The equipment meeting any other authoritative standard which ensure or equal or better quality than the standards mentioned above shall also be acceptable. Equipment for which Indian Standards are not available, the relevant. British Standards and IEC recommendations will be applicable.

**4. TYPE TEST CERTIFICATES FOR RELAYS**

The supplier shall required o submit all type test reports including following type test certificates in respect of relays offered by them for their control panels at the time of getting approval of drawings of control and relay panel.

i) 5 KV Impulse peak voltage test on the relays. This type test report is essential for over current and earth fault relays.

ii) Type test report for vibration test to prove the stability of relays under vibration normally encountered and also vibration under abnormal conditions.

iii) Type test report for overshoot time for IDMT relays.

NOTE:- Regarding testing of the relays, reference may please be made to BS-142-19.

**5. PANEL CUT OUT AND DIMENSIONS**

i) The panels shall be fabricated from 12 SWG (i.e. 2.6 mm) steel sheet free from all surface defects. The panels shall have sufficient structural re-enforcement to ensure a plain surface to limit vibration and to provide rigidity during dispatch and installation. All control panels and switchgear cubicles shall be made absolutely vermin-proof and subjected to the approval of the purchaser. Pre-treatment & painting of panels shall be done as per the procedure detailed Clause 21.

ii) The panels shall have the following dimensions :-

Height – 1475 mm, Depth – 300 mm, Width – 700 mm

iii) No deviation in height/depth will be permitted. However, width can be increased depending upon the actual requirement, which shall be subjected to approval from the purchaser.

iv) The preferred panel cut out dimensions for mounting of the relays shall be as per Indian Standard Specification IS-4483 (Part – II & II).

v) Design, material selection and workmanship shall be such as to present a neat appearance, outside and inside with no works of welds, revits, screw or bolts head apparent from the exterior surface of the Control Panels.

**6. PANEL LIGHTING**

a) For interior illumination, filament lamp/fluorescent tube with switch shall be providing in each panel. The lamp/tube shall be located at the ceiling and guarded with protective cage. The switch shall be mounted on one of the sidewalls and shall be easily accessible.

b) One 5 amp. 3-pin receptacle with plug and switch shall be provided in each control panel.

**7. AUXILIARY SUPPLY**

a) For each Control Panel, the purchaser will provide the following (at one point):-

i) 415+10%, 3ph-4 wire, 50 C/S neutral grounded A.C. supply.

ii) 30 V, + 10% D.C. supply

b) The supplier shall arrange for providing these power supplies to the different panels of the control board group.

c) H.R.C. fuses shall be provided by the supplier for both the A.C. and D.C. power supplies.

d) All H.R.C. fuses and links shall be with holder; the base of fuse holder shall be mounted on slant support and with identification labels.

**8. CONTROL WIRING**

a) The supplier shall provide complete wiring upto the terminal block for the equipment, instrument devices mounted in the control panel strictly according to the wiring diagram prepared by the supplier based on the purchaser's information and schematic diagram and get approved from the purchaser.

b) The wiring shall be completed in all respects so as to ensure proper functioning of control, protection and metering schemes.

c) All spare contacts of relays and switches shall be wired upto the terminal block.

d) Control Panels shall be supplied completely wired ready for purchaser's external connections at the terminal blocks. All the wiring shall be carried out with 1100 V Grade PVC insulated stranded copper conductor of size 2.5 Sqmm as per IS 694.

e) Colour coded wires should be used to facilitate easy tracing, as under: -

i) Three Phase A.C. Circuit

Red for R Phase, yellow for Y Phase, Blue for B Phase, Black for Neutral

Single Phase A.C. Circuit

Red for Phase, Green for Earthing, Black for Neutral

ii) D.C. Circuit

Red for Positive, Black for Negative

iii) Control Wiring

Gray for annunciation and other control circuits

f) Each wire shall be identified at both ends with wire designation number by plastic ferrules, as per wiring diagram based on latest revision of IS-375 to denote the different circuit functions. The supplier shall take approval for the system of wire numbering.

g) All wire termination shall be made with compression type connectors. Wires shall not be tapped or spliced between terminal points. All wire shall have crimp type termination and direct connection at any place is not at all required.

h) All series connected devices and equipment shall be wired-up in sequence. Loop-in/loop-out system of wiring shall be avoided, as far as possible and the common buses shall normally be made through the terminal block for better reliability of testing and maintenance.

i) Fuses and links shall be provided for isolation of individual circuit from the bus wires without disturbing the other circuits and equipment.

j) The DC trip and DC voltage supplies and wiring to main protective gear shall be segregated from these for back up protection and also for protective apparatus for special purposes. Each such group shall be fed through separate fuses, either direct from main supply fuses or the bus wires.

k) Since a number of wires will run from one point to another, it is desired that the support arrangement should be adequate and neat. The conventional method of bunching of wire should not be adopted, since the same may create problems in case any wire is to be removed. The wires should be accommodated in plastic channel with sliding plastic over mounted inside the panel, suitably. Inspection/removal of wires should be possible by sliding the covers.

l) Blank plastic channels should be provided by the sides of the panel to accommodate the incoming cables from switchyard through the cable glands.

m) The circuit diagram of control circuit along with operating instructions (DOS/DON'T) embossed on metallic plate duly laminated shall be provided on rear side of the door.

## 9. TERMINAL BLOCKS/CONNECTORS

a) Multi-way terminal blocks complete with necessary binding screws and washers for wire connections and marking strips for circuit identification shall be provided for terminating the panel wiring and outgoing cables. The terminal block shall be suitable for receiving at least 2x7/0.737 mm-stranded copper conductor wire per terminal.

b) Terminal blocks shall have shorting and disconnection facilities. The panel-side and outgoing wires should be Des-connectable just by opening the disconnecting links which slide up or down without dislodging the wires from their position. Asea- Kirloskar type sliding links shall be provided. However, Des-connectable type terminal connectors may be limited to CT & PT circuits only.

c) Instrument transformer wires shall be terminated through suitably mounted test terminal blocks for site testing facility.

d) The terminal blocks shall be grouped according to circuit functions and each terminal block group shall have at least 20% spare terminals.

**10. CABLE ENTRY**

i) The control panel shall have provision of cable entry from the bottom. Necessary metallic cable glands should also be provided. The purchaser will arrange for necessary floor opening, below the panels to suit the supplier'' requirement.

ii) The wiring through terminal blocks/connectors shall be such located so that it is convenient for floor opening.

iii) The control panel shall have provisions inside for fixing the multi -Core cable glands, which shall be provided by the supplier. For fixing these cable glands, detachable gland plats of 4 mm thickness shall be mounted at least 200 mm above the floor level.

iv) The cable gland plate and rear door shall be properly gasketted.

v) Rigid supports shall be provided along the terminal block/connectors plastic channel. Suitable clamps may also be provided in plastic channel for holding cables.

**11. GROUNDING**

a) 50 mm x 6 mm galvanized flat ground bus shall be provided extending along with the entire length of the panel and effectively grounding all metal structures.

b) Each continuous length of ground bus shall have provision of two terminals at two separate points for connection to main ground grid of the sub-station.

c) Potential and current transformer neutrals shall be grounded only at the terminal blocks where they enter the control panel from the instrument transformers.

d) Wherever a circuit is shown grounded in the drawings, a single wire for the circuit shall run independently to the ground bus and connected to it.

**12. DOORS**

Each panel shall be completed with end enclosing sheets on both sides and door in the rear. There shall be one door with handle and also turn twist locks at top and bottom. Proper gasket ting shall be provided on the door. A type test report from the recognized Govt. Labouratory on degree of protection test (IP-55) shall also be furnished at the time of getting approval of drawing of control and relay panel.

**13. CONTROL AND RELAY PANELS**

The 11KV control panels required for installation at all the sub-stations shall be mounted in the front. The instruments and relays shall be flush pattern.

The labeling for the circuits shall be provided at the front control panel, as well as on the inside wall. All indicating instruments, meters and important components shall have identification labels from inside also, in addition to outside. The terminal block/connectors shall have identification labels attached to them, clearly indicating phase's

identifications and also circuits and instruments identification. For example, the terminal connector shall have identification indicating that CT circuit for metering, for protection etc.

## 14. CONTROL & INDICATION CIRCUIT

14.1 The following protective relays conforming to relevant Indian Standard with audio alarm & visual indication shall be provided for protection of capacitor bank.

i) 3 pole induction type-IDMT protective relay suitable for 30 V DC and 5 Amp. Rating having two over current element with current coil plug setting 50% to 200% and one earth fault element with current coil plug setting 10% to 40%.

ii) Over voltage relay with setting range of 110% to 170%.

iii) Instantaneous under voltage relay with cut off at 30% voltage.

iv) Neutral voltage displacement relay having variable setting type with timer and system connected for short time alarm and long time trip.

v) 10 minutes time delay relay.

14.2 11KV control relay panel shall also have the following instruments, relays and accessories :-

| | |
|---|---|
| 1 No. | Ammeter 144 Sq.mm flush mounting 5 Amp. Secondary CT with dual Range 0-50-100 A. |
| 1 No. | Volt meter 144 Sq.mm flush mounting 110V secondary PT with Range 0-15 KV |
| 1 No. | Power factor meter 144 Sq.mm flush mounting 5 A/110 V Range 0.5 lead-unity – 0.5 |
| 1 No. | Ammeter selector switch |
| 1 No. | Volt meter selector switch |
| 1 No. | Circuit Breaker Control Switch (Pistol grip type) having trip-neutral-close position |
| 2 Nos. | Push buttons for alarm “Accept” and “Reset” |
| 1 No. | Push button for “trip circuit” Healthy |
| 6 Nos. | Lamps for circuit breaker “ON”, “OFF”, “Trip Circuit Healthy”, “Auto-trip”, Spring charge”. “DC fail” indication |
| 1 No. | Relay test terminal block |
| 1 No. | Illumination Lamp with protective cage & switch |
| 1 No. | Alarm bell |
| 1 No. | Space heater with thermostat and switch |
| 1 No. | 3 pin 5 Amps plug and socket with On Off switch |

Any other accessories, which are not mentioned but may be necessary for function of control & relay panel, shall be deemed to be included.

14.3 A trip circuit healthy lamp shall be provided and connected in such a way as to indicate the healthy condition of the trip circuit. The lamp should have the indication on demand when breaker is ON. Such indication is also necessary when the breaker is OFF, but it should be possible to check the trip circuit condition before closing the circuit breaker. In brief, pre and post close trip supervision facility on demand is required and shall be included.

14.4 The automatic tripping of the circuit breaker due to operation of protective relays shall be indicated by a common audible alarm. The audible alarm shall be cancelled by the flag cancellation of relay, in case of relays of hand reset type.

## 15. RELAYS

15.1 All relays, except where otherwise approved, shall be capable of breaking the maximum current which shall not be affected by vibration or by external magnetic fields. The contacts shall be of silver, platinum or other approved materials and shall be capable of repeated operation, without deterioration. It shall not be possible to operate any relay by hand without opening case.

15.2 All relays shall be so arranged that on opening the case it shall be impossible for any dust which may have collected in or upon the case to fall on the relay mechanism.

15.3 Over current relays shall be of induction type and shall have inverse definite minimum time limit characteristics with separately adjustable time and current settings. Unless otherwise approved, the definite

minimum time shall be continuously variable from 0.2 seconds and current setting range shall be variable between 50% and 200% in six equal steps of 25% each. The relay coil rating shall be 5 Amps.

The scheme incorporated should ensure that flag resetting of relay is "self and operated" type. Thus it should not be necessary to reset he flag, at the time alarm/annunciation is accepted in case of fault. It should be possible to separately reset the flag, after the fault is attended.

15.4 Type test certificate for relays shall be submitted at the time of getting approval of drawing of control and relay panel.

**16. INSTRUMENTS**

16.1 All indicating instruments shall conform to IS-1248 and shall be of type and sizes specified under subsequent section. They shall be capable of carrying their full load currents continuously without heating. They shall have long clearly divided and indelibly marked scales of engraved or enameled metal and the pointers shall be of clean outline. The pointers and scales shall be subject to approval. The marking on the dials shall be restricted to the scale marking. All indicating instruments, shall be provided with non-reflecting glass type fronts. All indicating instruments shall be of class 1.0 accuracy.

16.2 Type test certificate for Ammeter, Voltmeter and Power factor meter shall be submitted.

i) The component of alarm scheme shall be strictly in accordance with the order and shall be explained very clearly.

**17. TESTS**

17.1 Each control panel shall be completely assembled, wired, adjusted and tested at the factory, prior to dispatch.

17.2 The tests shall include wiring continuity tests, insulation tests and functional tests to ensure operation of the control scheme and individual equipment.

17.3 The test procedures shall have prior approval of the purchaser.

17.4 All instruments, meters and relays shall be tested and calibrated in accordance with relevant standards.

17.5 All auxiliary instrument transformer shall be tested in accordance with procedure as laid down in relevant standards.

**18. TEST WITNESSING**

The tests shall be performed in presence of purchaser's representative, if so desired by the purchaser.

**19. TEST CERTIFICATE**

Copies of test certificates for all routine and acceptance tests shall be furnished to the purchaser for approval before despatch of the equipment from the works. Test certificates for important components used shall be furnished along with drawings.

**20. PRE-TREATMENT AND PAINTING PROCESS**

The Sheet steel shall be subjected to pre-treatment process before painting. The process shall be carried out as under. The procedure can broadly be devided as "Metal Treatment" and "painting".

**METAL TREATMENT**

i) Degreasing:- This can be achieved either by immersing in hot alkaline degreasing bath or in-hot dry chlorothelene solution. In case, degreasing is done by alkaline bah, rinse with cold water thoroughly.

ii) Pickling:- This is to remove rust and metal scales by immersing in diluted sulphuric acid (approximately 20%) at nearly 80 degree centigrade until scale and rust are totally removed.

iii) Rinse in cold water in two tanks to remove traces of acids.

iv) Treat with phosphoric acid base neutralizer, for removal of chlorine from the above acid pickling and again wash with running water.

v) Phosphating:- Immerse in gre-nodine Zinc phosphate solution for about 20 minutes at 80 to 90 degree centigrade. The uniform phosphate coating of 4 to 5 gms per sq.metre shall be achieved.

vi) Swill in cold water

vii) Rinse in decxy to bath at 70 to 80 degree centigrade to neutralise any traces of salts.

viii) Seal the above phosphate coating with hot dilute chromate solution.

ix) Dry with compressed air.

**PAINTING**

i) Spray one coat wet on wet specially developed, "High Lusture" Zinc chromate primer and stove at 150 to 160 degree centigrade for 25 to 30 minutes. Alternatively, Red-Oxide primer with chromate content may be used. However, former process is referred.

ii) Rubbing and putting:- Apply putty to fill up the scar, if any, to present smooth surface and stove 15 to 20 minutes. Apply putty several times to get the perfectly smooth finish.

iii) Surfacing: - Sand down with mechanical abrasive and stove for 20 minutes.

iv) Primer: - Spray second coat of primer as per (I) above or grey primer surface wet on wet and stove for 30 to 40 minutes at 150 degree centigrade.

v) Finish Paint: - Rub down dry and spray first coat of synthetic enamel finish paint wet on wet and stove for 30 minutes.

vi) Surfacing: - Sand down or rub dry to prepare for final finish. Spray 2 coats of synthetic enamel finish paint wet on wet and stove it at 150 degree centigrade for 30 minutes.

**NOTE: -**

i) Necessary stiffness may be welded between large cut outs to provide regularly before painting process.

ii) Painting process shall be done within 24 Hrs. of completion of metal treatment.

iii) Small coating shall be supplied along with equipment for touching up at site.

## 3) 11 & 33 kV NOMINAL VOLTAGE HT XLPE POWER CABLES

### 1. SCOPE:

The specification covers design, manufacture, shop testing, packing and delivery of 11, & 33 KV, multi core, cross linked polyethylene insulated power cables. These cables shall be suitable for the 3 phase AC-50 Hz system with the nominal voltage of 11 & 33 KV which may reach maximum of 12/24/36 KV respectively. These cables shall primarily be designed for effectively earthed neutral system.

### 2. SERVICE CONDITIONS:

Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

| | |
|---|---|
| 2.1 | Maximum ambient temperature (deg C) 50 |
| 2.2 | Maximum temperature in shade (deg C) 45 |
| 2.3 | Minimum temperature in air (deg C) in shade 3.5 |
| 2.4 | Relative Humidity (%) 10 to 100 |
| 2.5 | Maximum annual Rainfall (mm) 1450 |
| 2.6 | Maximum Wind Pressure (kg/mm2) 150 |
| 2.7 | Maximum altitude above mean sea level (Meters) 1000 |
| 2.8 | Isoceraunic level (days/year) 50 |
| 2.9 | Seismic level (Horizontal acceleration) 0.3 g. |
| 2.10 | Extremely hot and humid tropical climate, conducive to rust and fungus growth. |

### 3. STANDARDS:

3.1 Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the HT XLPE power cables shall confirm to the latest revisions available at the time of placement of order of all the relevant standards as listed in, but not limited to Annexure-I.

**LIST OF STANDARDS**

**(All amended upto date)**

| S. No. | Standard No. | Title |
|---|---|---|
| 1 | IS: 8130 – 1984 | Conductors for insulated electric cables and flexible cords. |
| 2 | IS: 7098 (Part 2) – 1985 | XLPE PVC sheathed cable for working voltages from 3.3 KV upto and including 33 kV. |
| 3 | IS: 5831 – 1984 | PVC insulation and sheath of electric cables. |
| 4 | IS: 3975 – 1988 | Mild steel wires, Formed wires and Tapes for armouring of cables. |
| 5 | IS: 10462 ( Part I) –1983 | Fictitious calculation method for determination of dimensions of protective coverings of cables. |

**4. GENERAL TECHNICAL REQUIREMENTS:**

4.1 6.35/11 kV, 12.7/22 kV, 19/33 kV earthed, multi core power cables shall normally be with stranded compacted H2/H4 grade aluminum conductor as per IS: 8130 - 1984, provided with conductor screening (of extruded semi-conducting cross link material) and shall be insulated with XLPE of natural colour. Identification of cores shall be by colour, as per provision of clause 13.1 of IS: 7098 (Part 2) - 1985. The insulation (XLPE) screening shall be provided consisting of extruded semi-conducting cross link material in combination with a metallic layer of copper tapes. Three such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of IS: 5831 - 1984.

Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition.

Armouring shall be provided consisting of single galvanized round steel wires (In case of Single core cable armouring shall be of Non-magnetic material) conforming to IS: 3975 - 1988 (amended upto date) and over the armouring a tough outer sheath of PVC compound shall be extruded. The PVC compound for the outer sheath shall conform to type ST-2 of IS: 5831 - 1984 (amended upto date). The colour of the outer sheath shall be black. The cable shall be manufactured strictly conforming to IS: 7098 (Part 2) - 1985 amended upto date and shall bear ISI mark.

**4.2 SEQUENTIAL MARKING OF LENGTH ON CABLE**

Non erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

**4.2.1 Discharge Free Construction:**

- Inner conductor shielding, XLPE insulation and outer core shielding shall be extruded in one operation by special process (viz. Triple Extrusion Process) to ensure that the insulation is free from contamination and voids and perfect bonding of inner and outer shielding with insulation is achieved. The bidders are requested to eLabourate the manufacturing technique adopted by their manufacturers to achieve this motive.
- The Company will order the verification of triple extrusion process at manufacturer's works as a pre qualification if it is technically accepting the bid
- During verification if it is found that the firm is not manufacturing the cable with triple extrusion process the offer shall be rejected.

**4.2.2 CONTINUOUS A.C. CURRENT CAPACITY:**

Continuous AC. current capacity shall be as per Table given below.

| Conductor sizes in sq.mm. | Continuous AC current capacity in Amps at maximum conductor temp. of 90 degree C | | |
|---|---|---|---|
| | When laid direct in the ground 30 deg.C | | When laid in air_40 deg.C._ |
| | 11 kV | 33 kV | 11/33 kV |
| 70 sq.mm | 160 | 155 | 165 |
| 95 sq mm | 190 | 175 | 200 |
| 120 sq mm | 215 | 195 | 230 |
| 150 sq mm | 240 | 225 | 265 |
| 185 sq mm | 270 | 255 | 310 |
| 240 sq mm | 315 | 290 | 345 |
| 300 sq mm | 355 | 325 | 396 |
| 400 sq mm | 405 | 385 | 460 |
| 500 sq mm | 450 | 450 | 590 |

**4.2.3 SHORT CIRCUIT CURRENT**

Short circuit current of 11, 22 & 33 kV XLPE cable shall be as per Table given below.

| Duration of Short Circuit in sec | Area of Al. Conductor | Short circuit current in kA |
|---|---|---|
| t | A | I=0.094 x A/sq.rt (t) |
| 1 | 70 sq.mm | 6.58 |
| 1 | 95 sq.mm | 8.93 |
| 1 | 120 sq.mm | 11.28 |
| 1 | 150 sq.mm | 14.1 |
| 1 | 185 sq.mm. | 17.39 |
| 1 | 240 sq.mm. | 22.56 |
| 1 | 300 sq.mm. | 28.2 |
| 1 | 400 sq.mm. | 37.6 |
| 1 | 500 sq.mm | 47 |
| 1 | 630 sq.mm | 59.2 |

**5. TESTS AND TESTING FACILITIES:**

**5.1 Type Tests:**

- All the type tests in accordance with IS: 7098 (Part 2) - 1985, amended upto date, shall be performed on cable samples drawn by purchaser.
- Type tests are required to be carried out from the first lot of supply on a sample of any one size of cable ordered for each voltage grade. In case facilities of any of the type tests are not available at the works of the supplier, then such type test shall be carried out by the supplier at the independent Labouratory at the cost of supplier. Sample for the type test will be drawn by the purchaser's representative and the type test will be witnessed by him.
- Supplier, however, can claim exemption from carrying out type test as above, provided such type tests were already conducted for C.S.E.B.) in the past within five years and the test certificates thereof submitted to our C.E.(Dist). Chief Engineer (Dist) may at his option grant waival from carrying out type tests if the test certificates are acceptable. In case of other Government recognized Labouratories / Test House valid approved Government certificate shall be enclosed along with test.

**5.2 Routine Tests:**

All the Routine tests as per IS: 7098 (Part 2) - 1985 amended upto date shall be carried out on each and every delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, absolutely essential that the manufacturer should have the appropriate type of facility to conduct this test which is routine test. The details of facility available in the manufacturer's works in this connection should be given in the bid.

**5.3 Acceptance Tests:**

All Acceptance tests as per IS:7098 (Part 2) - 1985 as modified upto date including the optional test as per clause no 18.4 and Flammability Test shall be carried out on sample taken from the delivery lot.

**5.4 Short Circuit Test:**

The contractor shall also undertake to arrange for the short circuit test as a type test on any one size of each voltage grade i.e on one size of 11 kV, one size of 22 kV and one size of 33 kV earthed grade shielded XLPE cables ordered at a recognized testing center such as Central Power Research Institute at Bangalore/ Warangal at the cost of supplier. If facilities for carrying out short circuit tests are available at the works of the supplier, and provided the certification procedure is approved by the Purchaser, testing at the supplier's works will be acceptable. Short Circuit test shall be witnessed by the purchaser's representative.

5.4.1 The short circuit test shall be preceded and followed by the following tests so as to ensure that the characteristics of the cable remain within the permissible limits even after it is subjected to the required short circuit rating.

a) Partial Discharge Test.

b) Conductor Resistance Test.

c) High Voltage Test.

5.4.2 The manufactured cable will be acceptable only after such a sample test is successfully carried out at CPRI or at suppliers works and approved by the Purchaser.

5.4.3 The contractor can however claim exemption from carrying out Short Circuit test provided the S.C. Test was carried out by the supplier on same voltage grade for C.S.E.B.) in the past within five years and the test certificates thereof submitted to our C. E. (Dist.).Chief Engineer (Dist.) may at his option grant waival from carrying out Short circuit test if the test certificates are acceptable.

**5.5 Testing Facilities**

The supplier / Bidder shall clearly state as to what testing facilities are available in the works of manufacturer and whether the facilities are adequate to carry out type, routine and acceptance tests mentioned in specified IS. The facilities shall be provided by the bidder to purchaser’s representative for witnessing the tests in the manufacturer’s works. If any test cannot be carried out at manufacturer’s works reason should be clearly stated in the tender.

**4.3.3 CONTROL CABLES**

**6.1 Scope**

This specification calls for design, manufacture, stage testing, inspection and testing before dispatch, packing and delivery of Copper Control Cables for substations in the state of Madhya Pradesh.

It is not the intent to specify completely herein all the details of design and construction of Control. However the material shall conform, in all respect, to the high standards of design and workmanship and be capable of performing the duties specified herein.

The Control Cables shall be ISI marked, 1.1 KV Grade. The cores shall have a size of 2.5 sq.mm, 4 sq.mm. and 10 sq.mm. (for Copper Control Cables) and 150 sq.mm., as called for using solid Copper Conductor and Stranded Aluminium Conductor (for Control cables respectively) with different number of cores as specified below:-

**7. COPPER CONTROL CABLES:**

**7.1 Unarmoured:**

| |
|---|
| 19 Core 2.5 Sq.mm |
| 12 Core 2.5 Sq.mm |
| 08 Core 2.5 Sq.mm |
| 04 Core 2.5 Sq.mm |
| 02 Core 2.5 Sq.mm |

**7.2 Armoured:**

| |
|---|
| 19 Core 2.5 Sq.mm. |
| 12 Core 2.5 Sq.mm. |
| 08 Core 2.5 Sq.mm. |
| 04 Core 2.5 Sq.mm |
| 02 Core 2.5 Sq.mm |
| 02 Core 10 Sq.mm. |
| 04 Core 10 Sq.mm. |
| 04 Core 04 Sq.mm. |

**7.3 Standards**

The Control Cables shall conform to the latest applicable Indian Standards. In case bidders offer Control cables conforming to any other International Standards which shall be equivalent or better than IS, the same is acceptable.

| S. No. | Standard Ref. No. | Title |
|---|---|---|
| 1 | IS: 1554 | PVC insulated (Heavy Duty) Control Cables for working voltage & including 1100 Volts. |
| 2 | IS: 3961 | Recommended current ratings for PVC insulated and PVC sheathed heavy duty cables |
| 3 | IS: 3975 | Mild steel wires, strings and tapes for armouring of cables |
| 4 | IS: 4905 | Methods of random sampling |
| 5 | IS: 5831 | PVC insulation and sheath of electric cables |
| 6 | IS: 8130 | Conductors for insulated electric cables and flexible cords |
| 7 | IS: 10418 | Wooden drums of electric cables |
| 8 | IS: 10810 | Methods of tests for cables |

**7.4 Acceptance of Other Authoritative Standards**

In above paragraph relevant Indian Standard have been mentioned. However, the cables meeting any other authoritative International Standard which ensures equal or better quality than the standards mentioned, shall also be acceptable. Cables for which Indian Standards are not available, the relevant equivalent International Standards will be applicable. Please attach photocopy of all such standards according to which the cables have been offered.

In this bid, the Bidders will have to furnish confirmation in regard to compliance of our entire technical requirement. The bid should clearly describe various technical particulars of the Control Cables as per details given in this specification.

**7.5 Climatic Conditions:**

The Control cables to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions :-

| | | |
|---|---|---|
| 1 | Location | At various substations in the State of Madhya Pradesh |
| 2 | Maximum ambient air temperature | 50°C |
| 3 | Minimum ambient air temperature | 1°C |
| 4 | Maximum Daily average ambient air temperature | 40°C |
| 5 | Maximum Yearly Weighted average temperature | 32°C |
| 6 | Maximum Relative Humidity | 95% (Sometimes approaches saturation) |
| 7 | Maximum altitude above mean sea level | 1000 Metres |
| 8 | Average Annual Rainfall | 125 cm |
| 9 | Maximum Wind Pressure | 150 Kg/Sq. metre |
| 10 | Isoceraunic level (Average Number of thunderstorm days per year) | 50 |
| 11 | Seismic Level (Horizontal acceleration) | 0.3 g |

**7.6 SYSTEM PARTICULARS:** The Cables offered under this specification shall conform to the parameters given below :

| S. No. | Particulars | System Voltage |
|---|---|---|
| 1 | Nominal System Voltage | LT |
| 2 | Highest System Voltage | |
| 3 | Frequency | 50 Hz |
| 4 | Earthing | Effectively Earthed |

**7.7 GENERAL TECHNICAL REQUIREMENTS AND CONSTRUCTIONAL DETAILS:** The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water. Cables shall be designed to withstand mechanical, electrical and thermal stresses developed under steady-state and transient operating conditions as specified elsewhere in this specification.

**7.8 COPPER CONTROL CABLES:** Control cables shall be of 1.1 KV grade, multicore (as specified in Clause 1.3 above), PVC insulated, PVC inner sheathed, armoured/unarmoured, PVC outer sheathed with solid copper conductor conforming to latest version of IS: 1554 or equivalent International Standards.

**7.9 CONDUCTOR:** The conductor shall be made from high conductivity copper rods complying with latest version of IS: 613 or equivalent International Standards. The conductor shall consist of annealed copper wires complying with IS: 8130 with latest amendments or equivalent International Standards.

**7.10 INSULATION:** The conductor shall be provided with PVC insulation applied by extrusion in accordance with latest version of IS: 5831 or equivalent International Standards. The average thickness of insulation shall be in accordance with the IS: 1554 (Part-I) with latest amendments or equivalent International Standards.

The insulation shall be so applied that it fits closely on the conductor and shall be possible to remove it without damages to the conductor.

**7.11 CODE IDENTIFICATION:** Colouring of insulation shall identify cores of the cables of upto 5 cores. Following colour schemes shall be adopted:-

| S. No. | Number of Cores | Colour Scheme |
|---|---|---|
| 1 | 1 Core | Red, Black, Yellow or Blue |
| 2 | 2 Cores | Red and Black |
| 3 | 3 Cores | Red, Yellow and Blue |
| 4 | 4 Cores | Red, Yellow, Black and Blue |

| S. No. | Number of Cores | Colour Scheme |
|---|---|---|
| 5 | 5 Cores | Red, Yellow, Black, Blue and Grey |
| 6 | 6 Cores and above | Two adjacent cores (counting and direction core) in each layer, Blue and Yellow, remaining cores Grey or in accordance with the scheme given in IS: 1554 Clause 10.3 |

For reduced neutral conductors, the insulation colour shall be Black. The cables having more than 5 cores, as an alternate to the provision of (6) above, the core identification may be done by numbers as indicated in latest version of IS: 1554 (PART-I) 10 core identification.

**7.11 LAYING UP OF CORES:** In multi-core cables, the cores shall be laid up together with a suitable lay, the outer most layer shall have right-hand lay and successive layer shall be laid with opposite lay, where necessary, the interstices shall be filled with non hygroscopic materials.

**7.12 INNER SHEATH:** The laid up cores shall be provided with inner sheath applied by extrusion. It shall be ensured that the shape be as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation. The thickness of inner sheath shall be conforming to latest version of IS: 1554 (Part-I) or equivalent International Standards.

**7.13 FILLER AND INNER SHEATH:** The filler and inner sheath shall be of the following:

- Unvulcanised rubber, or
- Thermoplastic materials, or
- Proofed tape (for inner sheath only)

Unvulcanised rubber or thermoplastic material used shall not be harder than PVC used for insulation and outer sheath. The material shall be chosen to be compatible with temperature ratings of the cable and shall have no deterious effect on any other component of the cable.

**7.14 ARMOURING:** Armouring shall be of the following:

- Galvanized roundsteel wires, or
- Galvanized steel strip.

The galvanized steel wires/strips shall comply with the requirements of latest version of IS: 3975 or equivalent International Standards. The armouring shall be of galvanized steel, as follows:-

| S. No. | Calculated nominal size of Cable under Armour | Type of Amour and Size Steel Strip/Round Wire |
|---|---|---|
| 1 | Upto 13 mm | 1.4 mm dia GS Wire |
| 2 | Above 13 upto 25 mm | 0.8 mm thick GS strip/1.6 mm dia GS wire |
| 3 | Above 25 upto 40 mm | 0.8 mm thick GS strip/2.0 mm dia GS wire |
| 4 | Above 40 upto 55 mm | 1.4 mm thick GS strip/2.5 mm dia GS wire |
| 5 | Above 55 upto 70 mm | 1.4 mm thick GS strip/3.15 mm dia GS wire |
| 6 | Above 70 mm | 1.4 mm thick GS strip/4.0 mm dia GS wire |

The gap between armour wire/strip shall not exceed one armour wire/strip space and there shall be no cross over/over-riding of armour wire/ strip. The minimum area of coverage of armour shall be 90%. The breaking load of armour joint shall not be less than 95% of that of wire/strip. Zinc rich paint shall be applied on armour joint surface.

**7.15 OUTER SHEATH:** The outer sheath shall be applied by extrusion. It shall be applied:

- Over the inner sheath in case of unarmoured multicore cables.
- Over the armouring in case of armoured multicore cables.

The outer sheath shall be so applied that it fits closely over insulation / inner sheath / armouring. It shall be possible to remove it without damage to the insulation / inner sheath. The colour of the outer sheath shall be black.

The thickness of outer sheath insulation shall conform to latest version of IS: 1554 Part-I or equivalent International Standards.

**7.16 IDENTIFICATION:** In addition to Manufacurer's identification on cable as per Clause-17.1 of IS: 1554 (Part-I) with latest amendments, following marking shall also be embossed over outer sheath at every three meters:-

- Cable size and voltage grade
- Word " client name" and Name of manufacturer
- ISI marking and sequential marking by means of embossing

The embossing shall be increasive, automatic in line throughout the length of the Cable and shall be legible and indelible.

**7.17 TESTS**: All types and sizes of cable being supplied shall be subjected to Type tests, Additional test, Routine tests and Acceptance tests as specified below at the expense of Agency and according to relevant standards.

**7.18 TYPE TESTS AND ADDITIONAL TESTS:** It is essential to furnish all the type test reports for each type and size of cable as stipulated in latest version of IS: 1554 (Part-I) and following Additional Tests along with the bid :

- Loss of mass test
- Heat shock test
- Thermal stability test
- Accelerated water absorption test
- Dielectric strength retention test

Above tests shallbe conducted in Government / Reputed Testing Labouratories.

**7.19 ACCEPTANCE TEST**

Acceptance test shall be caried out on each type and size of cables on cable drums selected at random as per following plan :-

The following shall constitute acceptance tests :-

- Annealing Test
- Conductor Resistance Test
- Wraping Test
- Tensile Test
- Test for Thickness of Insulation and Sheath
- Tensile Strength and elongation test before ageing and after ageing at break of insulation and sheath

- High Voltage Test (Water Immersion Test)
- High Voltage Test at Room Temperature

**7.20 ROUTINE TESTS:** Routine test shall be carried out for each drum of cables of all types and sizes. Following shall constitute routine tests :

- Conductor Resistance Test
- Resistance Test
- High Voltage Test at Room Temperature

**7.21 INSPECTION:** The owner shall have access at all times to the works and all other places of manufacture, where the Cables are being manufactured and the Bidder shall provide all facilities for unrestricted inspection of Bidder's works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed in the bid document.

The Successful Bidder shall keep the owner informed in advance of the time of starting and of the progress of manufacture of Cables in its various stages, so that arrangement could be made for inspection.

No material shall be dispatched from the point of manufacture unless the material has been satisfactorily inspected and tested.

The acceptance of any quantity of the equipment shall in no way relieve the successful bidder of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

## 8. EARTHING

Earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules 1956 amended from time to time and relevant regulations under Electricity Supply Employer concerned.

In case of high and extra high voltages, the neutral points shall be earthed by not less than two separate distinct connections with earth, each having its own electrodes sub-station and will be earthed at any other point provided no interference is caused by such earthing. If necessary, the neutral may be earthed through suitable impedance.

As far as possible, all earth connections should be visible for inspection. Each earthing system shall be so designed, that, the testing of individual earth electrodes is possible. It is recommended that the value of any earth system resistance shall be such as to conform to the degree of shock protection desired.

It is recommended, that a drawing showing the main earth connections and earth electrodes be prepared for each installation and submitted to STM Division of CLIENT in all three circles.

No addition to the current carrying system, either temporary or permanent, shall be made which will increase the maximum available fault current on its duration until it has been ascertained that the existing arrangement of earth electrodes, earth bus-bar etc., are capable of carrying the new value of earth fault current which may be obtained by this addition.

All materials, fittings etc., used in earthing shall conform to Indian Standard Specifications, wherever they exist.

## 9. GENERAL REQUIREMENTS AND PROCEDURES FOR EARTHING AT SUB-STATIONS:

The ground resistance for sub-stations should not exceed a value 2(two) ohms. The joints/connections in the earthling, system shall be welded only, except the connections, which require opening for testing/maintenance. Such connections should be bolted tightly, using spring and ring washers for proper contact pressure. The G.S. flats to be provided for the horizontally laid earth grid should have overlap welded joints, with length of welding at least twice the width of the flat, e.g., 100 MM for 50x6 MM G.S.

flats. There should not be any dirt, grease, oil, enamel, paint or any such non-conductive coatings on the surfaces being joined/ connected. Only the finished joints/connections above ground may be provided with red-oxide or any other protective coating. Underground earth electrodes and earth grid elements, when laid, should have a clean metallic surface, free from paint, enamel, grease or any such non-conductive coatings.

As far as possible, all earth connections should be accessible for visual inspection. No cut-outs, links or switches, other than linked switches arranged to operate simultaneously on the earthed or earthed neutral conductor and the live wire shall be inserted in the supply system. Earth electrodes or mate should not be installed in close proximity to metal fence to avoid possibility of fence becoming live. Separate earth electrodes, isolated from the earth grid, are to be provided for grounding the fence wires.

Pipes or rods used as electrodes should be in one piece, as far as possible, with a minimum allowable length of 3 mtrs. Except where rock or hard stratum is encountered, the pipe/rod electrodes should be driven into the ground to a minimum depth of 3 metrs. The strip electrodes, forming the horizontal gild, should be buried underground to a minimum depth of 0.5 mtrs. The path of earth wire should be out of normal reach of any person, as far as possible.

For high resistivity soils, above 100 Ohm-Mtrs. Attempts should be made to bring the soil resistivity in the range of 50 to 60 Ohm-mtrs. By digging and treating the soil mass around the earth grid/electrodes with a mixture of salt and charcoal.

In case of rocky top soil and sub-stratum, having very high resistivity, with no scope of improvement by other means, the procedure given below should be followed:

At least two bores of diameter little less than 40 mm, with a minimum distance of 10 mtrs. Between them, should be made in the ground at suitable locations inside the S/S yard. The boring should be done until soil sub-stratum rich in moisture and low in resistivity is encountered. G.I. pipes of 40 MM dia. Should be descended in each bore, such that, the soil mass around the pipes grips them tightly, Back – filling of bores, if required, with wet soil/clay may be done to ensure this condition. The G.I. pipes in these deep bores should be interconnected with the main earthing grid of the S/S through 50x6 mm G.S. flat, with all the joints/connections and terminations being either fully welded, or clamped/bolted and welded simultaneously. The G.I. pipes in the bores should also be interconnected with each other. In extreme cases, the bores may have to be made at remote locations i.e. outside the S/S yard, with inter-connections, through 50x6 MM flats, as explained before.

The procedures to be observed stringently for making connections and joints between various elements of the earthing system are as follows:

a. G.S. flat to Structure/flat – The G.S. flat should be welded to the metallic portion (leg) of the structure after thoroughly cleaning the surfaces to be welded. The length of the welding should be at least twice the width of the G.S. flat, e.g.-minimum 100 mm for 50x6 mm G.S. flat. Exactly similar procedure is to be adopted for joints between two G.S. flats.

b. G.I. wire to structure. The G.I. wire should be bolted to the structure after making an eye formation and kept tight with the help of spring and ring washer. Then, the entire arrangement should be welded.

c. G.I. wire to G.S. flat- The G.I. wire should be bolted and then welded to G.S. flat, as explained above.

d. G.I. rod to G.S. flat- The G.I. rod should be securely clamped to the G.S. flat with the help of bolts and washers and the entire arrangement should then be welded.

e. G.I. wire to G.I. pipe – GI wire should be bolted to the G.I. pipe and then welded, keeping in view the relevant precautions, mentioned before.

G.I. flat to G.I pipe – The GI flat should be bolted tightly to the G.I. pipe and then the connection should be welded.

Before making connections and joints, it should be ensured that, the elements to be joined have a clean metallic contact surface without any non-conductive coating.

**10. EARTH GRID SYSTEM**

Grid system of interconnected conductors forming a closed loop mesh is to be installed using 50x6 mm GS flat for peripheral and branch conductors. Interconnections are made by welding them. This earth grid will be laid at a depth of about 0.5 mtr. Bonded to general mass of the earth by 3 metrs. Long earth electrode of solid GI rod (or pipe) of dia 25mm. The G.I. pipe 40 mm. dia 3 metrs. Long in the earthing pits, driven vertically.

It is to this earth grid that the transformer neutral, apparatus, frame work and other non-current carrying metal work associated like transformer tank, switchgear frame etc. are to be connected. All these connections should be made in such a way that reliable and good electrical connection is ensured. Aluminum/ other paint, enamel, grease and scale should be removed from the point of contact before connections are made. No part of the ground connection leads should be embedded in concrete.

Arrangement of connection of earth connection shall be as follow:

**STRUCTURES:** Structures including frames, metal supports within the substation grid at least two legs, preferably diagonally opposite (where more than two legs are provided) on each metal structure shall be connected to earth grid with GI wire of 4mm dia or 6 mm dia.

**ISOLATORS/ SWITCHES:** The operating handle shall be connected to earth grid independent of the structure earthing or through the steel mounting structure, through 4 mm dia G.I. wire.

**LIGHTNING ARRESTOR:** The bases of lightning arrestors shall be directly connected to the earth electrodes (nods) by 4 or 6 SWG G.I. wires as short and as straight as practicable, to ensure minimum impedance. Separate earth leads should be used for L.A. in each phase. In addition there shall be as direct connections as practicable from the earthed side of the lightning arrestors to the frame of the apparatus being protected. Surge counters, could also be inserted in the circuit where lightning incidences are high, but in such cases, the lightning arrestor should be mounted on insulated base. Invariably, earth connections for lightning arrestors should be separate, and in no case should they be joined looped or meshed with other conductors. For lightning arrestors mounted near transformers, earthing connections shall be done with the earthing pits and earthing leads shall be laid clear of the tank and collars in order to avoid possible oil leakage caused by arcing. The earth connection should not pass through iron pipes, as it would increase the reactive impedance of the connection.

**POWER TRANSFORMER:**

The tank of the transformer shall be directly connected to the main earth grid. In addition there shall be a separate and as direct a connection as practicable from the tank to the earth side of protecting LA using 4 or 6 SWG GI wire.

The earthing of the neutral shall be by two separate, distinct and direct connections of 50x6 mm GS flat to earth pits, which form a part of the earth grid, and shall be run clear of the tank and collars.

The transformer track rails shall be connected to earth

**VCB:**

At least two sides, preferably diagonally opposite of the supporting structure frame work of each circuit breaker unit shall be connected to the earth grid, through 50x6 mm G.S. flats.

**FENCING:**

All metal fencing wire-mesh and fencing poles (if metallic) where provided shall be separately earthed through earth rods isolated from the main earth grid.

Gates shall have each support post (if metallic) earthed by means of through earth rods isolated from the main earth grid.

**CURRENT TRANSFORMERS/ POTENTIAL TRANSFORMERS:**

The bases of the current transformers should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. The base (neutral side) of the P.Ts. should be directly connected to the earth grid through 4 or 6 SWG G.I. wires. Separate earth leads should be used for P.Ts. in each phase. The termination of leads on the P.T. neutral should be bolted/clamped and not welded, to facilitate opening of the earth connection for testing purposes. In addition, all bolted cover plates to which bushings are attached, should be connected to the earth grid, both in case of C.Ts. and P.Ts.

**CABLES AND SUPPORTS:**

Armoring of armored metal-sheathed cables within the station grid area shall be connected to the earth grid.

**Substation L.T. Supply Transformer:** Same as above except that the neutral earthing conductor used shall be 4 or 6 SWG G.I. wire.

**Capacitor Banks:** Same as before.

**Note for drawing of earthing systems for 33/11 kV Substations:**

The earth rods (19 nos.) shall be 3 mtrs. Long 25 mm dia solid GI rods driven into the ground (not to be painted, enameled, greases etc)

The earthing pits (3 nos.) shall consist of 3 metrs. Long 40 mm GI pipes buried vertically inside the ground (not to be painted enameled grease etc.)

All joints in the earthing grid shall be welded only. The GS flats in the earth mat should be joined by overlap welded joints, with welding length at least twice the width (i.e. 100 mm)

The fencing/ gates are to be kept isolated from the main earthing grid and metallic portions of the fences gates (if having metallic support posts) are to be earthed separately. Separate earth pipe as per scope of work to be provided for fence Earthing.

### 4.3.4 GI EARTHING PIPE

Earthing pipe should be made of 40 mm diameter ISI marked B class GI Pipe. 12 mm dia suitable holes on its circumference shall be made as per approved drawing. The pipe should be in one piece. No joints or welding would be allowed on its length. Clamps made of 50x6mm GI flat duly drilled with 12 mm size holes should be welded at the top end for connection of earth conductor. The Earthing pipe should not contain any joints in length.

Pipe used shall be 40mm NB diameter, ISI marked Galvanized Mild Steel Tubes continuously welded Electric Resistance Welded ERW/High Frequency Induction welded (HFIW)/Hot finished welded (HFW) type, conforming to IS-554-1985 with latest amendment of MEDIUM quality (Class B).

**MANUFACTURE:** GI earth pipe (40 mm diameter & 4.5metre long) shall be made of tubes which shall be made from tested quality steel manufactured by any approved process as follows:

a) Electric Resistance Welded (ERW).

b) High Frequency Induction Welded (HFIW) and

c) Hot finished Welded (HFW).

Tubes made by manual welding are not acceptable.

**DIMENSIONS**: The dimensions and weights of tubes shall be in accordance with Table-I and Table-II of IS: 1239 (Part-I)/1990 with latest amendments, subject to tolerance permitted therein. Necessary 12 mm diameter holes across the circumference shall be provided as per approved drawing. Drawings shall be approved by the owner before start of the manufacturing work. The tube, earthing pipe shall be provided with 50x6mm GS clamps on one end, one clamp is to be welded with the pipe and another is removable to enable measurement of earth resistance of the pit. Other end of the earth pipe should be cut half in slop to make it a sharp.

**GALVANIZING**: Tubes shall be galvanized in accordance with IS-4736-1986 with latest amendment for not dip zinc coating of Mild Steel Tubes. The minimum mass of zinc coating on the tubes shall be in accordance with clause 5.1 of IS-4736-1986 (specification for hot dip zinc) and when determined on a 100mm long test piece in accordance with IS: 6745:1972 shall be 400 $g/m^2$. The zinc coating shall be uniform adherent reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust, stains, bulky white deposits and blisters.

**HYDRAULIC TEST:** (Before applying holes) Each tube shall withstand a test pressure of 5 M Pa maintained for at least 3 seconds without showing defects of any kind. The pressure shall be applied by approved means and maintained sufficiently long for proof and inspection. The testing apparatus shall be fitted with an accurate pressure indicator.

**TEST ON FINISHED TUBES AND SOCKETS**: The following tests shall be conducted by the manufacturer of finished tubes and sockets.

1. The tensile strength of length of strip cut from selected tubes when tested in accordance with IS-1894-1972, (Method for tensile testing of steel tubes), shall be at least $320N/mm^2$.
2. The elongation percentage on a gauge length of 5.65/so (where so is the original cross-sectional area of test specimen) shall not be less than 20%.
3. When tested in accordance with IS-2329-1985 (Method for Bend test on Metallic tubes) the finished tube shall be capable of with standing the bend test without showing any sign of fracture or failure. Welded tubes shall be bent with the weld at 90 degree to the plane of bending. The tubes shall not be filled for this test.
4. Galvanized tubes shall be capable of being bent cold without cracking of the steel, through 90 degree round a former having a radius at the bottom of the groove equal to 8 times the outside diameter of tube.
5. Flattening Test on Tubes above 50 mm Nominal Bore: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattered between parallel plates with the weld, if any, at 90 degree (point of maximum bending) in accordance with IS-2328-1983. No opening should occur by fracture in the weld unless the distance between the plate is less than 75 percent of the original outside diameter of the pipe and no cracks or breaks in the metal elsewhere than in the weld shall occur, unless the distance between the plates is less than 60% of the original outside diameter. The test rings may have the inner and outer edges rounded.
6. GALVANISHING TEST:
    - Weight of zinc Coating: For tubes thickness upto 6 mm the minimum weight of zinc coating, when determined on a 100 mm long test piece in accordance with IS-4736-1986 shall be 400 $grm/m^2$.
    - The weight of the coating expressed in $gram/m^2$ shall be calculated by dividing the total weight of the zinc (inside plus outside) by the total area (inside plus outside) of the coated surface.
    - Test specimen for this test shall be cut approximately 100 mm in length from opposite ends of the length of tubes selected for testing. Before cutting the test specimen, 50 mm from both ends of the samples shall be discarded.
7. Free Bore Test: A rod 230mm long and of appropriate diameter shall be passed through relevant nominal bore of the sample tubes to ensure a free bore.
8. Uniformity of Galvanized Coating: The galvanized coating when determined on a 100 mm long test piece [see V (a) (iii)] in accordance with IS-2633-1986 (Method for testing uniformity of coating on zinc coated articles) shall with stand 4 one minute dips.

    WORKMANSHIP: The tubes shall be cleanly finished and reasonably free from injurious defects. They shall be reasonably straight, free from cracks, surface flaws, laminations, and other defects, both internally and

externally. The screw tubes and sockets shall be clean and well-cut. The ends shall be cut cleanly and square with the axis of tube.

GI EARTHING PIPE

Earthing pipe should be made of 40 mm diameter ISI marked B class GI Pipe. 12 mm dia suitable holes on its circumference shall be made as per approved drawing. The pipe should be in one piece. No joints or welding would be allowed on its length. Clamps made of 50x6mm GI flat duly drilled with 12 mm size holes should be welded at the top end for connection of earth conductor. The Earthing pipe should not contain any joints in length.

Pipe used shall be 40mm NB diameter, ISI marked Galvanized Mild Steel Tubes continuously welded Electric Resistance Welded ERW/High Frequency Induction welded (HFIW)/Hot finished welded (HFW) type, conforming to IS-554-1985 with latest amendment of MEDIUM quality (Class B).

MANUFACTURE: GI earth pipe (40 mm diameter & 4.5metre long) shall be made of tubes which shall be made from tested quality steel manufactured by any approved process as follows:

Electric Resistance Welded (ERW).

High Frequency Induction Welded (HFIW) and

Hot finished Welded (HFW).

Tubes made by manual welding are not acceptable.

DIMENSIONS: The dimensions and weights of tubes shall be in accordance with Table-I and Table-II of IS: 1239 (Part-I)/1990 with latest amendments, subject to tolerance permitted therein. Necessary 12 mm diameter holes across the circumference shall be provided as per approved drawing. Drawings shall be approved by the owner before start of the manufacturing work. The tube, earthing pipe shall be provided with 50x6mm GS clamps on one end, one clamp is to be welded with the pipe and another is removable to enable measurement of earth resistance of the pit. Other end of the earth pipe should be cut half in slop to make it a sharp.

GALVANIZING: Tubes shall be galvanized in accordance with IS-4736-1986 with latest amendment for not dip zinc coating of Mild Steel Tubes. The minimum mass of zinc coating on the tubes shall be in accordance with clause 5.1 of IS-4736-1986 (specification for hot dip zinc) and when determined on a 100mm long test piece in accordance with IS: 6745:1972 shall be 400 $g/m^2$. The zinc coating shall be uniform adherent reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rust, stains, bulky white deposits and blisters.

HYDRAULIC TEST: (Before applying holes) Each tube shall withstand a test pressure of 5 M Pa maintained for at least 3 seconds without showing defects of any kind. The pressure shall be applied by approved means and maintained sufficiently long for proof and inspection. The testing apparatus shall be fitted with an accurate pressure indicator.

TEST ON FINISHED TUBES AND SOCKETS: The following tests shall be conducted by the manufacturer of finished tubes and sockets.

9. The tensile strength of length of strip cut from selected tubes when tested in accordance with IS-1894-1972, (Method for tensile testing of steel tubes), shall be at least 320$N/mm^2$.
10. The elongation percentage on a gauge length of 5.65/so (where so is the original cross-sectional area of test specimen) shall not be less than 20%.
11. When tested in accordance with IS-2329-1985 (Method for Bend test on Metallic tubes) the finished tube shall be capable of with standing the bend test without showing any sign of fracture or failure. Welded tubes shall be bent with the weld at 90 degree to the plane of bending. The tubes shall not be filled for this test.
12. Galvanized tubes shall be capable of being bent cold without cracking of the steel, through 90 degree round a former having a radius at the bottom of the groove equal to 8 times the outside diameter of tube.
13. Flattening Test on Tubes above 50 mm Nominal Bore: Rings not less than 40 mm in length cut from the ends of selected tubes shall be flattered between parallel plates with the weld, if any, at 90 degree (point of maximum bending) in accordance with IS-2328-1983. No opening should occur by fracture in the weld unless the distance between the plate is less than 75 percent of the original outside diameter of the pipe and no cracks

or breaks in the metal elsewhere than in the weld shall occur, unless the distance between the plates is less than 60% of the original outside diameter. The test rings may have the inner and outer edges rounded.

### 4.3.5 11/0.433 KV DISTRUBUTION TRANSFORMERS

**SCOPE**

The specification covers oil immersed, Copper wound, naturally air cooled (type ONAN), outdoor type (suitable for HT/LT cable connections), three phase, 50 Hz, 11/0.433 KV step down distribution transformers of capacities 315 & 100 KVA. Transformers should be suitable for service under frequency fluctuation of +/- 4% and voltage fluctuation + 10% / -25% on HV side. The full load rated voltage on HV & LV side of each rating of transformer shall be as under:-

| KVA Rating | Rated Full Load Voltage (in Volts) | |
|---|---|---|
| | High Voltage Side | Low Voltage Side |
| 315 & 100 | 16.53 | 420 |

**APPLICABLE STANDARDS**

Unless otherwise modified in the specification, the transformers shall comply with the requirement of ISS: 1180 (latest issue) 2026 (latest issue) and REC specification 2/1978 and ISS: 2099 (latest issue). The bushings used shall conform to ISS: 2099 & 3347 (latest issue) except as modified herein.

**Type**

(i) The transformers shall be double wound, three phase oil immersed, oil natural air natural cooled (type 'ONAN'), core type suitable for outdoor installation in tropical climate and shall be insulated with DPC insulation on HV & LV windings. Insulation should be of temperature class as per the temperature rise stipulated in this specification.

(ii) The neutral point of the secondary (LV winding) is intended for solidly earthed system and should be brought out to a separate insulated terminal, enabling external insertion of a current transformer in the earth lead to be connected wherever required.

| CLIMATIC CONDITIONS FOR WHICH OUT DOOR TRANSFORMER IS TO BE DESIGNED | | |
|---|---|---|
| i. | Peak Outdoor Temperature | 50ºC (Max.) |
| ii. | Maximum Oil Temperature Attainable | 95ºC (50ºC+45ºC) under max. temp. & max. load conditions |
| iii. | Maximum relative humidity | 95%(sometime approaches saturation point) |
| iv. | Minimum relative humidity | 10% |
| v. | Average no. of thunderstorm days per annum | 40 days |
| vi. | Average number of rainy days per annum | 90 days |
| vii. | No. of months of tropical monsoon conditions | 3 months |
| viii. | Average Annual Rainfall | 100 Cm. |
| ix. | Wind Pressure | 100 Kg/$m^2$ |
| x. | Altitudes not exceeding | 1000 meters |

**12. RATINGS**

| | |
|---|---|
| **Primary Voltage** | **11 KV** |
| **Secondary Voltage** | **0.433 KV** |

The windings of the transformers shall be connected in delta on primary side and star on the secondary side. The neutral of the LT winding shall be brought out to a separate terminal. The vector group shall be Dyn-11.

**13. OVER LOAD CAPACITY**

The transformer shall be suitable for over-load capacity as per IS: 6600 (latest amendment).

**14. TEMPERATURE RISE**

Temperature rise for top oil over an ambient of $50^0$C should be $45^0$C max. (Measured by thermometer as per IS: 2026).

Temperature rise for windings over an ambient $50^0$C should be $50^0$C max. (Measured by resistance in accordance with IS: 2026).

**15. NO LOAD VOLTAGE RATINGS**

The no load voltage ratio shall be 11000/433-250 Volts for all capacities.

**16. OFF LOAD TAPS**

No tapings shall be provided for transformers upto 100 KVA rating. So ratings 200 KVA to 315 KVA tapings shall be provided on the higher voltage winding for variation of HV voltage within range of + 3% to (-) 9% in the steps of 3%.

The changing shall carried out by means of an externally operated self position switch and when the transformer is in reenergized condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 3% in voltage. Provision shall be made for locking the taping switch handle in position. Suitable aluminium anodized plate shall be fixed for tap changing switch to know the position no. of tap.

**18 WINDINGS**

a) Materials:-

For ratings above 200 KVA double paper covered electrolytic copper shall be used.

b) Current Density for HV & LV should not be more than 2.8 A/sq.mm for copper and 1.6 Ampere per sq.mm for aluminium Conductor.

c) HV Cross section shall not be less than:-

- 315 KVA - 3.40 Sq.mm.

d) LV Cross Section shall not be less than:-

- 315 KVA - 156.0 Sq.mm.

**NOTE:**

LV Winding shall be in even layers so that the neutral formation will be at top.

e) HV winding resistance at room temperature 20 C with 5% tolerance should not be more than :

- 315 KVA - 7.07 Ohms.

f) LV winding resistance at room temperature 20 C with 5% tolerance should not be more than

- 315 KVA - 0.00278 Ohms.

**19. LOSSES AND IMPEDENCE**

The losses and impedance for various ratings of transformers should be as shown below subject to tolerance as per IS: 1180/2026 and shall be calculated at 75ºC as per limits specified. For 63 to 100 KVA no tolerance shall be permissible on No Load and Load losses.

| S. No. | Rating in KVA | No Load Loss (Watts) | Load Loss at 75ºC (Watts) | Impedance (%) |
|---|---|---|---|---|
| i | 315 KVA | 580 | 4200 | 5 |

**20. INSULATION MATERIAL AND CLEARANCES**

(a) Materials:-

Electrical grade insulating craft paper of triveni Ballarpur or equivalent make subject to approval of the purchaser. Press Board of Senapaty, whitelay or Raman make or equivalent subject to approval of purchaser. Permswood or Haldiwood blocks shall be used for top and bottom yoke insulation.

(b) Radial clearance of LV coil to core (bare conductor) shall not be less than:-

315 KVA - 4.5 mm

(c) Radial clearance between HV & LV shall not be less than 11 mm for ratings 63 KVA to 315 KVA.

(d) Phase to phase clearance between HV conductors shall not be less than 10 mm with the minimum of 2x1 mm pressboard to cover the rods.

(e) The minimum electrical clearance between the winding and body of the tank (between inside surface of the tank and outside edge of the winding) should be 30 mm.(f) Minimum end insulation to earth shall be 25 mm.

(g) No. of coils HV/Phase (minimum)

i) For 315 KVA - 6 Nos.

(h) Thickness of lacking spacers between HV coils- 10 mm (minimum)

(i) No. of axial wedges between LV and HV winding equipage around LV –12 for 315

(j) Minimum external clearances of Bushing terminals:

| | **Phase to Phase** | **Phase to Earth** |
|---|---|---|
| **HV** | 255 mm | 140 mm |
| **LV** | 75 mm | 40 mm |

**21. TANK**

The transformers tank shall be of robust construction and shall be built of electrically welded M.S. plates. All joints of tank and fittings shall be oil tight and no bulging shall occur during service. The tank design shall be such that the core and winding can be lifted freely. The tank plate shall be such of such strength that the complete transformer when filled with oil may be lifted easily by means of the listing lugs provided. Tank inside shall be painted by varnish/zinc chromate. Top cover shall be slightly sloping (difference of heights should be 20 mm + 10%) towards H.V. bushing and cover the top with end walls. Shape of the tank shall be rectangular only. No other shape will be accepted. The tank shall be fabricated by welding at corners. No Horizontal or vertical joints in tank side and its bottom or top cover will be allowed.

a) i. Side wall plate thickness : 4.0 mm Above 100 KVA

ii. Top and bottom plate thickness : 6.00 mm Above 100 KVA

b) Reinforced by welded angle of size 50x50x6 mm on all the objects walls on the edge of tank to form two equal compartments in case of transformers up to 100 KVA rating and three equal compartments for above KVA rating. One face of reinforcement angle should be continuous welded with the tank surface such that other side of the angle forms inverted "L". The permanent deflection is not more than 5 mm up to 750 mm length & 6 mm up to 1250 mm length, when transformers tank without oil is subjected to a vacuum of 760 mm. of mercury.

c) **Lifting Lug:-**

2 Nos. welded heavy duty lifting lugs of M.S. plate 8 mm. thick suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall, up to the reinforcing angle, for transformers up to 100 KVA rating. For transformers of 200 KVA rating and above No. of such lugs should be 4.

d) **Pulling Lug:-**

4 Nos. of welded heavy duty pulling lugs of M.S. Plates of 8 mm. thick shall be provided on width side to pull the transformers horizontally upto 100 KVA and on length side for above 100 KVA.

e) **Top cover Gasket & Bolts**:-

1. The Gasket provided in between top cover plate and tank shall be of 5 mm and 6 mm thick Neoprene Rubberized Cork sheets confirming to IS: 4352, Part-II for ratings upto 100 KVA and above 100 KVA respectively.
2. G.I. Nut Bolts shall be of size 3/8" x 1.5" with one plain and one spring washer suitably spaced to press the cover for ratings upto 100 KVA. For ratings above 100 KVA GI Nut Bolts of ½" dia with one plain washer shall be used for top cover fixing spaced at 4" apart.

3. The height of the tank shall be such that the minimum clear height upto the top cover plate of 120 mm is achieved form top yoke in case of transformers upto 100 KVA. The above clearance is achieved form the live part of the tap changer in case of transformers above 100 KVA.

   a) Heat dissipation by tank walls excluding top and bottom should be –500 w\m2.

   b) Heat dissipation by fin type radiator 1.25 mm thick will be worked out on the basis of manufacturers data sheet. Supplier should submit the calculation sheet.

   c) For 100 KVA transformer, 2 Nos. Radiators shall be provided only on LV side shall be of fin type. They should be fixed at right angle to the sides and not diagonally for transformers above 100 KVA Radiators shall be provided on both sides.

   d) Arrangement for studs provided for fixing of HV bushings should be in diamond shape so that the arcing horns are positioned vertically.

**22. TOTAL MINIMUM OIL VOLUME**

| S. No. | KVA Rating | Oil in Liters (inclusive of oil absorbed in core oil Assembly) | Permissible oil absorption (Ltrs.) |
|---|---|---|---|
| 1 | 315 KVA | 500 | 19 |

**NOTE: -** If the absorption of oil in core and winding assembly is more than permissible value, first filling of oil volume should be increased accordingly. Detail calculation of absorption should be submitted.

**23. CONSERVATOR**

a) The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity of the total oil will be contained in the conservator. Dimension of the conservator shall be indicated in General arrangement drawing.

b) Die cast oil level indicator shall be provided on the side which will be with fully covered detachable flange with single gasket and tightned with M.S. Nut-Bolts and will be fixed on the side of rating plate and drain valve.

c) The pipe form the conservator tank connecting to main tank shall be of 30 mm internal dia and shall have a slopping plate so that the oil falling form the pipe shall not fall directly on the active job and shall fall on the side walls only. The pipe should project in the conservator. Thus slopping plate should be fitted such that clearance form the yoke/live part of the tap changer is maintained as prescribed i.e. 120 mm.

The conservator shall be provided with the drain plug and a filling hole, with cover. In addition, the cover of the main tank shall be provided with an air release plug.

**24. BREATHER**

Breather joints will be screwed type. It shall have die-cast Aluminum body. Make of breathers shall be subject to purchaser's approval. Volume of breather shall be suitable for 500 gm. Of silica gel for transformers upto 200 KVA and 1 Kg for transformers above 200 KVA.

**25. TERMINALS**

a) Brass rods 12 mm dia for H.T. and L.T. with necessary Nuts, check nuts and plain thick tinned washers for ratings upto 100 KVA.

b) Tinned copper rods 20mm dia for 200 & 315 KVA transformer with necessary nuts ,check nuts and plain thick tinned washers for LT confirming to relevant IS with latest amendment.

c) H.T.\L.T. bimetallic connectors shall be provided with transformers for all ratings.

**26. BUSHINGS**

i) For 11 KV – 12 KV bushing will be used and for 433 volts 1.1 KV terminal bushing will be used. Bushings of the same voltage class shall be interchangeable. Bushings with plain sheds as per IS:

3347 shall be mounted on side of the tank and not on the top cove. Only continuous sheet metal pocket shall be provided for mounting of all H.V./L.V. bushings and the same shall not be fixed on pipes. Sheet metal pocket shall be designed in such a way that all HT bushings shall remain parallel and equidistance all through and inside connections of windings to bushings shall remain within the pocket. Bushings having type tested as per IS: 3347 shall only be acceptable.

ii) Internal Connections:-

In case of HV winding, all jumpers form windings to bushings shall have cross section larger than the winding conductor (normally, 1.5 times). For copper winding, joints will be made by using silver brazing alloy. For aluminum winding, L & T Alkapee Aluminum brazing rods with suitable flux will be used or alternatively joints will be made by using tabular connectors properly crimped at three spots. Aluminum brazing rods to be used ring formed on other end and nut bolting on HV bushing stud.

LT Star connection will be made by using Aluminum/Copper Flat and properly brazed or bolted with the crimped lugs on flat. Other end of the conductor is brazed on "L" shape Aluminum/Copper flat and flat nut bolted with neutral bushing stud. ALTERNATIVELY, for 63 & 100 KVA ratings all the three terminals of LV windings together with terminals for neutral bushing shall be properly brazed and then covered with Aluminum tubular sleeve of suitable length and cross sectional area duly crimped in order to provide sufficient strength to the joint. The star connection should be wrapped with cotton/paper tape.

Firm connection for LV winding to bushings shall be made by adequate size of "L" shape flats nut bolted with LV bushing stud.

For delta formation on HV side, copper wire having cross sectional area 1.5 times the winding area should be used. SRBP tube/insulation paper should be used on delta connection and on the portion of HV winding joining to HV bushing.

**27. ROLLERS**

For transformers of rating 200 KVA and above four Nos. rollers of 150 mm diameter and 50 mm width shall be provided.

**28. TANK BASE CHANNEL**

To be fitted across the length of the transformer.

For 200 &315 KVA Transformers – Two channels of 100mmx 50mm

**29. TERMINAL MARKING PLATES AND RATINGS PLATES**

The transformers shall be provided with a plate showing the relative physical position of the terminal and their markings engraved on it. The transformers shall be provided with non- detachable rating plate of Aluminium anodised material fitted in a visible position, furnishing the informations as specified in IS: 2026. The ratings plate shall be embossed/engraved type but not such printing. The relative position of tapping switch and corresponding voltage may also be shown on the rating plate. Further, MS plate of size 125 x 125 mm be got welded on width side of the transformer on stifner angle. On this plate name of firm, Order No. & date, Rating, Serial Number and date of despatch should be engraved.

**30. FITTINGS**

The fittings on the transformers shall be as under:-

| | | |
|---|---|---|
| 1 | Rating and diagram plate | 1 No. |
| 2 | Earthing terminals with lugs | 2 Nos. |
| 3 | Lifting lugs 8 mm thick | 2 Nos. upto 100KVA and 4 Nos. above 100 KVA |
| 4 | Oil filling hole with cap on conservator | 1 No. |
| 5 | Drain cum sampling valve of 20 mm dia for transformers upto 100 KVA and 32 mm dia for 200 KVA and above (It shall be covered with metallic cover by spot welding) | 1 No. |

| | | |
|---|---|---|
| 6 | Conservator with drain plug | 1 No. |
| 7 | Thermometer pocket | 1 No. |
| 8 | Aluminium die cast silica gel breather (500 gms. Capacity upto 200 KVA and 1000 gms for 315 KVA) | 1No. |
| 9 | Platform mounting channel (with hole suitable for axle of roller for transformers of 200 KVA and above rating) | 2 Nos. |
| 10 | Oil level gauge indicating three position of oil marked as below: | |
| | a) Minimum (-) $5^0$C | |
| | b) $30^0$C | |
| | c) Maximum $98^0$C | |
| 11 | Bushings | |
| | H.T. | 3 Nos. |
| | L.T. | 4 Nos. |
| | Each bushing should be provided with 3 Nos. of brass nuts and 2 plain brass washers for connecting terminals. | |
| 12 | Radiator | Details shall be given as per drawing (to be provided on L.V. side upto 100 KVA) |
| 13 | Arcing horn for H.T. bushing | 6 Nos. |
| 14 | Pulling House | 4 Nos. |
| 15 | Metallic cover spot welded to tank for drain valve shall be provided | |
| 16 | Explosion vent in case of transformers of 200 KVA and above | 1 No. |
| 17 | Rollers for 200 KVA and above (150 mm dia and 50 mm wide) | 4 Nos. |
| 18 | Filter valve-32 mm dia for 200 KVA and above | 1 Nos. |
| 19 | Off circuit tap changing switch with indicator handle and locking device with tap ranging form (+) 3% to (-) 9% in steps of 3% on HV side for HV variation. Direction of rotation marked. | 1 No. |
| 20 | Top cover lifting lugs | 2 Nos. |
| 21 | Bimetallic connectors for all ratings to be fitted on the studs: | |
| | HV | 3 Nos. |
| | LV | 4 Nos. |

All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. This will include stage Inspection during manufacturing stage as well as active part inspection during acceptance tests.

Random sample checking and testing of the transformer selected at random from the supplies made to the area stores shall be done for verification of technical details, design and losses as per approved G.T.P., drawings and technical specification of the order. In case of verification, the lot shall be rejected.

The purchaser has all the rights to conduct the test including type tests, at his own cost by an independent agency whenever there is dispute regarding the quantity of supply or interpretation of test results. In the event of failure of transformers in such test, the expenses incurred in testing shall be to the supplier's account as already mentioned above in case of random testing.

**31. INSPECTION & TESTING OF TRANFORMER OIL**

To ascertain the quantity of the transformer oil, the original manufacturer's test report should be submitted at the time of inspection. Also arrangement should be made for testing mainly, BDV of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative. However, other tests, if required by the Board shall also be arranged to be carried out.

**32. TEST REPORTS ON THE ANALYSIS OF RAW MATERIALS**

The suppliers shall furnish details of source (s) of raw materials, test certificates and report on the analysis of electrolytic Copper/Aluminium used for the winding and the steel used for core, insulation material and also other bought out items from sub-suppliers.

### 4.3.6 L.T. MAIN DISTRIBUTION PILLARS

The specification provides for design, manufacture, testing before dispatch, supply and delivery of distribution boxes with three pole moulded case circuit breakers for protection of distribution transformers and LT feeders.

The MCCBs provided in these boxes shall conform in all respects to the relevant IS: 2516 (Pt-I&II)/1977 and REC specification No.18/1981 (revised) or its latest revision as applicable.

***REQUIREMENT OF MCCBs:***

The moulded case circuit breakers should comprise of a switching mechanism, an effective extinguishing device and a tripping unit contained in a compact moulded case cover made of high strength, heat resistance and flame retardant thermo-insulating materials. They should comprise of a spring assisted quick make/quick break type independent manual trip free mechanism rendering it easy to manually operate the MCCBs and capable of clearly indicating "TRIPPED", "ON" AND "OFF" positions from the position of the operating handle. The contact tips should be made of a suitable alloy having high arc resistance and a long electrical and mechanical life needing no replacement. The breakers should be designed with a common trip bar to break and make all the three phase together even when fault occurs on any of the phases. The breakers should provide protection against sustained overloads and short circuits through thermal-magnetic/fully magnetic releases. These MCCBs along with terminal blocks are intended to be housed in the distribution boxes made out of sheet steel of 2mm gauge. The assembly of the MCCBs and the terminal blocks should be compact, reliable from operation point of view and safe to the operating personnel. As already mentioned earlier, the MCCBs should be fully maintenance free.

**TECHNICAL PARTICULARS OF MCCBs:**

The LT MCCBs should have inverse current/time characteristics suitable for protection of 315KVA 11.0.4KV Distribution Transformers against sustained over-loads and short circuits for following operating conditions:-

| | | |
|---|---|---|
| i | Rated Operating Voltage | 3 Phase 415 Volts AC 50 cycles with neutral solidly grounded system |
| ii | Standard rated current ratings for MCCBs to be used with different sizes of transformers will be as follows:- | |
| | For 315KVA 11/0.4KV Dist. Transformer | 450 Amps |
| iii | No. of Poles | 3 |
| iv | Duty | Un-interrupted |
| v | Maximum ambient temperature | 47$^{o}$C in shade |
| vi | Minimum ambient temperature | 4$^{o}$C in shade |
| vii | Average altitude | A maximum of 1000 meter |
| viii | Maximum humidity | Frequently approaches saturation point |

**TIME/CURRENT CHARACTERISTICS**:

The circuit breakers shall have time/current characteristics suitable for following operating conditions:-

| Multiple of normal current rating | Tripping time |
|---|---|
| 1.1 times | After 4 hours |
| 1.2 times | Less than 50 minutes |

| Multiple of normal current rating | Tripping time |
|---|---|
| 1.3 times | Less than 30 minutes |
| 1.4 times | Less than 10 minutes |
| 2.5 times | Less than 1 minute |
| 6 times | Less than 40 mili-seconds |
| 12 times | Less than 40 mili-seconds |

Time/Current characteristic of the Circuit Breaker (MCCB) shall be tested in accordance with Clause-7.7.2.3 (b) (2) of IS: 2516-(Pt-I&II) Sec.I/1977 and the test shall be made with all the three phases loaded.

For time/current characteristic, the reference calibration temperature of the MCCBs shall be 40°C and durance, if any; upto 50°C operating temperature in the enclosure shall not exceed 10% of the value indicated above in Clause (I) above.

The MCCBs shall be calibrated and adjusted in the factory itself for the desired time/current characteristic

The MCCB should have the following maximum resetting time under overload & short circuit conditions :-

Overload conditions - 3 minutes

Short Circuit conditions - Instantaneous

**RATED SHORT CIRCUIT BREAKING CAPACITY:** The rated short circuit breaking capacity of the MCCBs shall be as follows: -

| Transformer rating(KVA) | Rated short circuit breaking capacity of the breaker in Kilo-Amps |
|---|---|
| 315 KVA | A minimum of 25 Kilo-Amps |

The short circuit breaking capacity test as specified above shall be based on short circuit tests carried out at 0.4 Power Factor (lagging). For the purpose of these tests, the following operating sequence shall be followed: -

Break-3 minutes itnerval-Make-Break-3 minutes interval-Make-Break.

The Distribution Box shall be provided with two nos. 75x 40mm (ISIC) mounting channels welded to the top sheet of the Box. The channel shall have 2 nos. holes (13mmx13mm) for receiving bolts. With such top mounting facility, the Box can be mounted directly under the base channels supporting the distribution transformer. The mounting holes shall be maintained at fixed distance of 225 mm irrespective of box size so that necessary provision of drilled holes can be done.

The Distribution Box shall house a Triple Pole **Isolator** of adequate ratings at incomer and Triple pole MCCBs equal to numbers of outgoing feeder circuits on outgoing side. The ratings of MCCB as incomer and numbers and ratings of MCCBs to be provided at out going circuits are indicated hereunder:-

Light emission diodes shall be provided for all the outgoing phases to indicate the availability of supply and when switched off due to tripping/manual operation of MCCBs to indicate that the same is off. LED are to be provided inside the box.

**Enclosures:**

- The enclosure shall be made of 14 SWG (2mm) steel sheets and shall be suitable for outdoor installation, conforming to IP-20 degree of protection as per IS: 2147/1962.
- The front door shall be having locking facility. The box should be provided with single door in front and having internal locking arrangement with two keys. Extra padlock arrangement shall also be provided. The latches provided inside the door, which are locked in position by the keys, should be such that the door gets locked just by closing (for opening the door, keys will then be required). The backside cover shall be screwed type and should be fixed with 4 nos. 8mm size Allen screws at four corners.
- One box spinner of suitable size for the screw fitted in the box should be provided inside the box with suitable clamps.
- Neoprene rubber gasket shall be used on front door as well as back cover.
- Painting of Box
- All sheet steel surface of the box shall be thoroughly degreased and shall be followed by antacid cleaning so as to produce smooth and clean surface free from scale grease and dust. After cleaning, the surface shall be given phosphate coating followed by two coats of anti rust paint primer (i.e. red zinc chrome primer). After which, 2 coats of synthetic paint of light grey colour (no.631 as specified in

Indian Standard 5 of 1961) shall be applied on internal and external, surface of the steel structure of the box with a spray gun. The box shall be baked in the oven so as to give an elegant and durable finish to the box.

- Leakage Proof: The box shall be vermin proof and weatherproof.
- The assembly, comprising of the enclosure, framework and the circuit breaker shall be provided with earthing terminals readily accessible and of adequate size two earthing studs of 12mm dia size shall be welded to the enclosure on either side as shown in the drawing and shall be provided with locking nuts and washers. All the nuts, bolts and washers should be galvanized iron. The earthing terminal shall be clearly marked.
- Four nos. drainpipes of ½" diameter shall be welded at the bottom of the box at Four Corners. The bottom plate shall be centrally bent to provide slope for drainage of water through the drain pipes.
- Ventilation louvers with wire mesh shall be provided on both the sides as per requirements. In addition to this, louvers with wire mesh of suitable sizes and numbers also required on backside cover of box. Detailed drawing showing size of openings and size of brass mesh shall be submitted by the bidder for approval prior to manufacture.
- **Danger Board:** Specifications are shown in Technical Specifications of the package.
- **Knock-out Holes:**

  Knockout holes for incoming and outgoing cables will be provided. The holes shall be suitable to accommodate single core aluminium conductor LT cable of appropriate size. These holes should be provided direct contact with and gets out by the metal edges.

  The holes should be in alignment with the terminals of incomer and outgoing MCCBs so that the cable may be directly crimped with lugs. Bending of cable inside the box for terminal connection should not be required.

### 4.3.7 BUS BAR AND CABLING:

i) The incoming single core cable shall enter from backside (top) of the enclosure. All outgoing cables shall enter from the sides of the enclosures.

ii) Electrolytic grade aluminium shall be used for bus bar and links used inter-connection of incoming and outgoing MCCBs. The minimum size acceptable are as follows :-

iii) Bimetallic / suitable connectors are required for connecting the MCCBs terminals to Bus Bar.

**BUS BAR DETAILS**

[All dimensions are in mm]

| Item | Main Bus Bar size | Feeder Bar size | Neutral Bar Size | Remarks |
|---|---|---|---|---|
| 315KVA Dist. Box | 10x50 or 5x30 | 6x25 | 10x50 | The sizes of main bus and feeder can suitably be changed for carrying capacity up to 2.5 times of the respective MCCB. Neutral bus may be provided separately at the backside maintaining proper clearance duly isolated from body of Distribution Box through cotton |

iv) The Bus Bar/Links shall be covered with casting of through setting compound to avoid possibility of shorting due to movement of lizards' etc.

a. All the bolts used in the bus bar joints shall be provided with check nuts in addition to spring washers. The size of nut bolts connecting the busses to other bus etc. should be such that the clearance between phase to phase or phase to neutral should not be less than prescribed limit.

v) Crimping type aluminium lugs of suitable size shall be used for all incoming and outgoing cable connection. The size of cable used for incoming and outgoing for various boxes are as follows

| Transformer capacity | Incoming | Outgoing |
|---|---|---|
| 315 KVA | 2X300 Sq.mm, 3.5 C | 3.5CX 150 Sq.mm (4 ckt) |

vi) All bus bar shall be secured by DMC/SMC, (Fiberglass reinforced polystyrene) support depending upto their design and arrangements of bus bars. The support shall have anti tracking barriers between phases.

vii) The minimum clearance of 25mm between phases and 20mm between phase and Neutral/Earth shall be maintained for the bus bars.

viii) DMC/SMC moulded cable support shall (fixed on sides of enclosures) have holes of sizes to suit incoming and outgoing cable of recommended size.

**TESTS & TEST CERTIFICATE:**

The type test certificates from reputed national level labouratories for the distribution box complete with suitable MCCBs (as indicated in technical specification) for incoming and outgoing feeders giving the results of sample tests as per relevant BSS/ISS indicated below are required to be submitted along with the lot offered for inspection before despatch for approval in support of compliance of material to the specification and quality. Make of the MCCBs to be used should be indicated in the offer. Acceptable make of MCCBs are L&T, Siemens, Crompton Greaves, and Alstom.

(a) Type test for Distribution Box as per BS 214/1959.

(b) All type & routine tests, except the Short Circuit Breaking Capacity Test shall be carried out on the MCCBs in accordance with IS: 2516(Pt-I&II Sec.I)/1977 or its latest modification. The short circuit breaking capacity test shall be carried out.

(c) Test Certificate in respect of Type Tests, from standard testing Labouratory like C.P.R.I. etc. should invariably be furnished in support of the quality.

***(G) PVC INSULATED AND PVC / XLPE SHEATHED CABLES 4 Core x 16.0 SQ.MM.***

**1 SCOPE**

The specification covers the design, manufacture and testing and delivery at places CLIENT marked 1100 volt grade, four core 16 $mm^2$. Aluminium conductor, armoured PVC Insulated, PVC sheathed Cable suitable for outdoor use. The cables are intended to be used for service connections in the CLIENT WARANGAL.

**2 APPLICABLE STANDARD**

All the cables shall conform to the requirements of following standards with latest amendments, if any:-

i) IS: 694 -1990 - PVC Insulated Cables for working voltages upto and including 1100 V

ii) IS: 8130 -1984 - Specification for conductors for insulated electric cables.

iii) IS: 5831 -1984 - Specification for PVC Insulation and sheath of electric cables.

iv) IS: 10810-1984 - Methods of test for cables

v) IS: 4905 -1968 - Methods for random sampling

**3 GENERAL TECHNICAL REQUIREMENT**

3.1 Conductor

Aluminium conductor used in cables shall comply to the requirement to IS: 8130-1984 with latest amendments and shall be in accordance with clause 4.2, 9.0, 9.1., 9.1.1. of IS: 694:1990 with latest amendments. The conductor shall be stranded type conforming to Class-2 of IS: 8130-1984 for four core 16.0 Sq.mm. PVC Cables.

3.2 Pvc Insulation

PVC Insulation used shall comply to requirement of IS: 5831-1984 with latest amendments.

3.3 PVC insulation shall be suitable for continuous conductor temperature of 70°C under normal operation Insulation shall be of "Type A" PVC compound. The average thickness of insulation shall be not less than nominal value specified in table 5 of IS: 694:1990. The smallest of the measured values of thickness of insulation shall not fall below te nominal value (ti) specified in table 5 of IS:694-1990 by more than (0.1mm + 0.1 ti). The insulation shall be applied by extrusion so that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

3.4 Sheath

The sheath shall be of type S71 PVC Compound conforming to the requirements of IS: 5831-1984. The sheath shall be applied by extrusion over the insulation in case of Single Core Cables and over the laid up cores in multi-core cables. The Sheath shall be so applied that it fits closely on laid up cores and it shall be possible to remove it without damage to insulation. The colour of sheath shall be black. The thickness of PVC sheath shall not less than the nominal value (ts) specified in table-5 of IS: 694:1990 and the smallest of measured value shall not below the nominal value (ts) specified in Table-5 (of IS:694:1990) by more than 0.2 mm Plus 0.2 ts.

**3.5 Core Identification**

Core shall be identified by different colouring of PVC Insulation in accordance with Clause-11 of IS: 694:1990 by following colouring of PVC Insulation:-

Four Core - Red, Yellow, Blue and Black

**3.5.1 Standard Length**

The standard length of cable shall be 500 mtrs. A maximum of 5% (Five percent) of each consignment in short lengths varying from 100 (Hundred) meters and above shall be accepted. Balance quantity of order shall be supplied in 500 Mtrs. Length only. However, plus minus 1-% tolerance in length shall be permitted. This shall be indicated clearly and on individual coil.

**4. TESTS**

Following type tests, acceptance tests and routine tests are to be carried out in accordance with clause-15 of IS/694 1990 with its least amendments.

**4.3.8 APPLICABLE STANDARDS & MAKE OF EQUEPMENT**

Latest revisions of relevant Indian Standards (IS) & all **International Electro technical** Commission's recommendations (IEC) as well as Indian Electricity Rules shall be applicable.

1) IS-4237 General requirements of switchgear & control gear for voltage not exceeding 1000V.
2) IS-375 Arrangement of bus bars, main connection, auxiliaries & wiring:
3) IS-4047 Specification for heavy duty air break switches & fuses for voltages not exceeding 1000 V.
4) IS-2208 Specification for HRC cartridge fuse links up to 650 V.
5) IS-2507 Indian standards for current transformers (Part - I / II / III / IV)
6) IS-4201 Application guide for current transformers.
7) IS-2959 Specification for contractors of voltage not exceeding 1000 V.
8) IS-5569 Electrical power connectors.
9) IS-1336 Colour code recommendations for push buttons.
10) IS-1248 Electrical indicating lamps.
11) IS-4483 Preferred panel cutout dimensions.
12) IS-2147 Degree of protection provided by enclosures for LV switchgears.

13) IS-3072 Code of practice for installations & maintenance of switchgears for system voltages not exceeding 1000 V.

14) IS-439 Low voltage switchgears & control gear assemblies.

15) IS-2032 Graphic symbols.

16) IS-8623 Factory built assemblies.

17) IS-2675 Distribution Boards.

18) IS-1554 PVC Cables.

19) IS-5133 Steel Boards for enclosure of electrical accessories.

20) IS-4615 Switch socket outlet

21) IS-694 PVC wires.

22) IS-3043 Earthing.

23) IS-732 Electric wiring installations.

24) IS-2309 Lightning protection.

25) IS-8544 Porcelain post insulators (33 KV & above).

26) IS-2834 Capacitors.

27) IS-1318 IEC 56 for VCB'S

28) IS-2026 / 1977 for Transformer.

29) IS-2705 for Potential transformer

30) IS-2062 for Steel/RSJ/angle/channel/MS sheet

31) IS-1651 for Battery

32) IS-1991 for Battery chargers

33) IS: 209-1966 Specification for Zinc

34) IS: 226-1975 Structural Steel (Standard Quality)

35) IS: 229-1976 Ordinary rapid hardening & low heat Portland Cement.

36) IS: 278 Specification for barbed wire

37) IS: 383-1970 Coarse sand fine aggregates from natural sources for concrete.

38) IS: 398 Part-II Alum. Condr. galvanized steel reinforced

**1. Part – IV Aluminum Alloy stranded conductors**

39) IS: 406-1964 Methods of Chemical Analysis of Slab Zinc

40) IS: 731-1971 Porcelain Insulators for Overhead Power Lines with a Nominal Voltage

41) IEC:274-1968 greater than 1000 volts

42) IS: 802 Code of practice for use of structural steel in overhead transmission Line.

Part - I: Load and Permissible stresses.

Part - II: Fabrication, Galvanising, Inspection and packing, and packing.

Part – III: Testing

43) IS: 1367-1967 Technical supply conditions for threaded fasteners (First Revision)

44) IS: 1489-1976 Portland Pozzolena Cement

45) IS: 1521-1972 Method of Tensile Testing of Steel wire

46) IS: 1573-1976 Electroplated Coating of Zinc on Iron & Steel

47) IS: 1778-1981 Reels and Drums of Bare wire

48) IS: 2016-1967 Plain Washers

49) IS: 2070-1962 Method of impulse voltage testing

50) IS: 2121-1981 Specification for conductors and Earthwire Accessories for Overhead Power Lines

Part-I Armour Rods

Part-II Mid-span joints & repair sleeves for conductors

51) IS: 2131-1967 Method of Standard penetration tests for soils.

52) IS: 2251-1982 Danger Notice Plates

53) IS: 2486 Specification for Insulator Fittings for overhead Power Lines with a nominal voltage greater than 1000 volts

Part- I: 1971 General Requirements and Tests

Part-II: 1974 Dimensional Requirements

Part-III: 1974 Locking Devices

54) IS: 2629-1966 Recommended practice for hot dip galvanising of iron & steel.

55) IS: 2633-1972 Method of testing uniformity of coating of zinc coated articles.

56) IS: 3043-1972 Code of Practice for earthing (with amendment No. 1 & 2).

57) IS: 3063-1972 Single Coil Rectangular Section spring washers for bolts, nuts, screws.

58) IS: 3138-1966 Hexagonal bolts and nuts

59) IS: 3188-1965 Dimensions for Disc Insulators

60) IS: 4091-1967 Code of practice for design and construction of foundation for transmission line pole and poles.

62) IS: 4218-1967 Metric Screw Threads.

63) IS: 4826-1968 Galvanised coatings on round steel wire

64) IS: 5358-1969 Hot dip galvanised coatings onfasteners

65) IS: 5613 (Part-II) Code of practice for Design, installation & maintenance of overhead power lines (Section 1: Designs.)(Section 2: Installation & Maintenance)

66) IS: 6610-1972 Specification for heavy washers for steel structures.

67) IS: 6639-1972 Hexagonal bolts for structure

68) IS: 6745-1972 Methods for determination of weight of Zinc coated iron and steel articles

69) IS: 7814-1975 Phosphor bronze sheet, strip and foil

70) IS: 8263-1966 Method of Radio Interference tests high voltage insulators

71) IS: 8269-1976 Method of switching impulse test On high voltage insulators

72) IS: 8500-1977 Specification for weld-able structural steel (Medium and High strength

- IEC50 (151) : 1978 International Electro-technical Vocabulary (IEV) -Chapter 151 : Electrical and magnetic devices
- IEC 50 (441) : 1984 International Electro-technical Vocabulary (IEV) - Chapter 441 : Switchgear, control gear and fuses
- IEC 60- 1 : 1989 High-voltage test techniques - Part 1 : General definitions and test requirements
- IEC 71 - 2 : 1976 Insulation coordination - Part 2 : Application guide
- IEC 76 - 1 : 1993 Power transformers - Part 1 : General
- IEC 76 - 2 : 1993 Power transformers - Part 2 : Temperature rise
- IEC 243 - 1 : 1988 Methods of test for electric_ strength of solid insulating materials -Part 1 : Tests at power frequencies
- IS 1885 (Part 17) : 1979 Electro-technical vocabulary : Part 17 Switchgear and control gear (*first revision*)
- IS 2071 (Part 1) : 1993 High voltage test techniques : Part 1 General definitions and test requirements *(second revision)*
- IS 3716 : 1978 Application guide for insulation coordination ( *first revision* )
- IS 2026 ( Part 1 ) : 1977 Power transformers : Part 1 General ( *first revision* )
- IS 2026 ( Part 2 ) : 1977 Power transformers : Part 2 Temperature rise
- IS 2584 : 1963 Method of test for electric strength of solid insulating materials at power frequencies
- IS 5 - Colours for ready mixed paints and enamels.
- IS 3 - Three phase induction motors.
- IS 374 - Electric ceiling type fans and regulators.
- IS 694 - PVC insulated cables for working voltages upped and including 1100V.
- IS 722 - AC electricity meters.
- IS 1248 - Direct acting indicating analogue electrical measuring instruments and their accessories.
- IS 1271 - Thermal evaluation classification of insulating material.
- IS 1293 - Plugs and socket outlets of rated voltage upped and including 250V and rated current upped and including 16A.
- IS 1364 - Hexagon head bolts, screws and nuts of product grades A and B.
- IS 1534 - Ballast's for fluorescent lamps.
- IS 1554 - PVC insulated (heavy duty) electric cables.
- IS 1777 - Industries luminaries with metal reflectors.
- IS 1913 - General and safety requirements for luminaries.
- IS 2086 - Carrier and bases used in rewire able type electric fuses for voltages upped 650V.
- IS 2223 - Dimensions of flange mounted AC induction motor.
- IS 2253 - Designation for type of construction and mounting arrangement of rotating electrical machines.
- IS 2254 - Dimensions of vertical shaft motors for pumps.
- IS 2259 - Methods of tests for determination of insulation resistance of solid insulating materials.
- IS 2419 - Dimensions for panel mounted indication and recording electrical instrument.

- IS 2544 - Porcelain post insulators for system with nominal voltages greater than 1000V.
- IS 2551 - Danger notice plates.
- IS 2667 - Fitting for rigid steel conduits for electrical wiring.
- IS 2705 - Current transformers.
- IS 2713 - Tubular steel poles for overhead power lines.
- IS 2834 - Shunt capacitors for power systems.
- IS 3156 - Voltage transformers.
- IS 3231 - electrical relays for power system protection.
- IS 3725 - Resistance wire, tapes and strips for heating elements.
- IS 3854 - Switches for domestic and similar purposes.
- IS 3961 - Recommended current rating for cables.
- IS 4029 - Guide for testing 3 phase induction motors.
- IS 4691 - Degree of protecting provided by enclosure for rotating electrical machinery.
- IS 4728 - Terminal marking and direction rotation for rotating electrical machinery.
- IS 4889 - Method for determination of efficiency of rotating electrical machines.
- IS 5216 - Guide for safety procedures and practices in electrical works.
- IS 5578 - Guide for marking for insulated conductors.
- IS 6098 - Method of measurement of air borne noise emitted by rotating electrical machinery.
- IS 6875 - Control switches (switching devices for control and auxiliary circuits, including contractor relays) for voltage upped and including 1000V AC and 1200 purpose.
- IS 7098 - Cross – linked polyethylene insulated PVC sheathed cables
- IS 8623 - LV switchgear and control gear assemblies.
- IS 828 - Circuit breakers for over current protection for house hold and similar installations.
- IS 10322 - Luminaries.
- IS 12729 - General requirement of switchgear and controller.
- IS 13032 - MCB boards for voltage upped and including 1000V AC.
- IS 13947 - Low voltage switcher and controller.
- IS 732 - Code of practice for electrical wiring installations.
- IS 3043 - Code of practice for earthing.
- IS 3646 - Code of practice for interior illumination.
- IS 10118 - Code for practice for selection, installation and purpose.
- IS IEC 309 - Plugs, socket outlets and couplers for industrial purpose.
- IS 2026 – Transformers
- IS 13118 - Vacuum circuit breakers.

### 4.3.9 RECOMMENDED MAKES OF ELECTRICAL EQUIPMENTS

All material should be ISI mark / ISO 9000 accredited company or manufactured by Public sector/Govt. owned Companies or of the firms of repute. However Govt. / Public Sector makes are preferred makes. It is necessary to

mention the make of equipment contractor intends to use. If contractor does not mention make, the Owner would be free to mention the make of his choice.

| S.No. | MATERIAL | | MAKE |
|---|---|---|---|
| 1. | 11 KV/ 0.4, 315 KVA Transformers : | | Areva / Crompton / ABB / EMCO/ Vijai |
| 2. | 11 KV Lightning Arrestor | : | GE / Crompton / Lamco/ Elpro / Oblum/ Areva |
| 3 | L.T. Panels | : | CPRI/ ISO 9000 acredited manufacturer/ Schneider |
| 4 | Indicating Lamps | : | L&T / Siemens / Schneider |
| 5 | Push Buttons | : | L&T/ Siemens / Tele mechanic |
| 6 | Timers | : | L&T/ Siemens / Tele mechanic |
| 7 | ACB | : | L & T / Siemens/ Schneider/ABB |
| 8 | SFU | : | GE /L&T/ Schneider/ Siemens/ ABB |
| 9 | Starters/Contactors | : | GE/ L&T/ Schneider |
| 10 | MCCB | : | GE/ L&T/ Schneider/ Siemens |
| 11 | Connectors | : | Elmex/ Connectwell/Raychem |
| 12 | MCB | : | L&T/MDS /ABB/GE/ Schneider |
| 14. | Capacitors | : | Epcos/ Siemens/ PUCAT / Areva / |
| 15. | Wires | : | Finolex / Polycab / RR Cables / Gloster |
| 16. | HRC | : | L&T/GE / Schneider/ Standard |
| 17. | Power Switch (upto 32A) | : | L&T/GE / Schneider/ Siemens |
| 18. | Cable Accessories: | | |
| | Gland | : | Comet/ Meat Craft Industries/Raychem |
| | Lugs | : | Dowells/ Meat Craft Industries/RayChem |
| 19. | Exhaust Fan/ Light Fitting T-5 | : | GE /Crompton /Bajaj/Orient/Usha |
| 20. | 11/33 KV Vacuum Circuit Breaker | : | BHEL/Crompton/Siemens/ Schneider/ABB/ Bicco lawrie/Areva |
| 21. | 33, 11 KV HT cable | : | Finolex/ Universal/ Polycab/ Prime-cab/Gloster/CCI |
| 22. | Light Fittings & Lamps | : | Philips/WIPRO/BAJAJ/SCHREDER |
| 23. | Octagonal Poles | : | Jindal/ Balaj/ Schreder |
| 24. | LT Cable | : | Finolex/ Universal/ Polycab/ Prime-cab/Gloster/CCI |
| 25. | SCADA system | : | CMS/ Siemens / Westing house/Alstom/ Fox bro/ |
| 26. | Computer | : | LENOVO/ HCL / IBM / HP-Compaq/DELL/ |
| 27. | Steel | : | SAIL / TATA/ JINDAL |
| 28. | Power transformers 33/11 KV | : | Areva/ Crompton/ BHEL/EMCO/ Vijai |
| 29. | Ring Main units 11 KV | : | Areva/ Crompton/ BHEL/ Siemens/ ABB/Schneider/ |
| 30. | Cement | : | Ultra Tech/ACC/Guj.Ambuja/Lafraj |
| 31. | Load break switch | : | Areva, Crompton , BHEL, L& T, Siemens,ABB, Schneider |
| 32. | Pre-fibracate steel building system | : | Kerby , Vardhaman, Nesha, National |

### 4.3.10 Motors

The motors for water pumps shall be of Suitable HP, 1500 rpm synchronous speed, horizontal solid shaft TEFC –IP55 protection squirrel cage induction motors continuous rated with "F" class insulation conforming to latest IS: 325 suitable for operation on 3 phase 50 Hz, 415 V AC supply.

The motor for Dewatering pump shall be horizontal solid shaft TEFC –IP55 suitable for 3phase, 50Hz, 415V AC supply.

**Energy efficient motors:**

- More than 75 % of the industrial energy consumption is by poly-phase induction motors, using energy saving high efficiency motors would result in considerable contribution towards energy and fossil fuel conservation.
- The superior design and higher quality of materials used in energy efficient motors results in lower heat generation. This leads to lengthened insulation life, longer uptime, reduced maintenance and enhanced reliability and higher productivity.
- All motors up to 15 KW shall conform to IS: 12615:2004 .As per this standard all motors shall be designed for an ambient temperature of 40 degree Celsius. The nominal efficiency values listed for EFF2 and EFF1 classification in tables 1 to 4 of this standard are subject to motor operation at 40 degree Celsius, with rated voltage and frequency being available at motor terminals and altitude not exceeding 1000 meters. These values are subject to tolerance as per IS :325.
- The clause 4.3 of IS 12615:2004 makes it clear that when operated at extreme conditions of voltage and frequency the performance may not be in accordance with the standard.
- The clause 17.1.2 of this new standard makes provision for calculation of efficiency of motors, when motors conforming to this standard are operated at ambient temperatures exceeding 40 degree Celsius but up to 55 degree Celsius.
- The clause 6 of this standard requires that motors classified as per EFF1 or EFF2 shall have a method of cooling as per IC 411 as per IS 6362.
- This standard has a correlation of output to frame size for motors up to 315M.
- The standard in its clause 8 also requires that the motors covered shall be rated for S1 (Continuous duty)as specified in 9.2 of IS :325.
- This is the only EEM standard which also gives the limiting values of full load speed, full load current ,starting current and starting torque.
- The motors shall be suitable for the duty conditions and as per bid specifications and site requirements.

**Specifications**

This specifications covers the requirements of 3 phase 415V, 50cycles, F class insulation, continuous rating induction motors of suitable HP, totally enclosed fan cooled (TEFC) IP -55 for indoor /outdoor Bids The motors shall be suitable for installation at an altitude of 268 m above MSL and 45o ambient temperature.

**Codes and Standards**

- The design, manufacture and performance of the equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.
- Unless otherwise specified the motors shall conform to the latest applicable Indian Standards, or equivalent international standards some of which are listed below :
- IS 325: Induction Motors
- IS 4691: Degrees of protection provided by enclosures for rotating electrical machinery.
- IS 4029: Measurement and evaluation of vibration of rotating electrical machines. Guide for testing 3 phase induction motors.
- IS 900: Code of practice for installation and maintenance of induction motors.
- IS 1231: Dimension of 3 phase foot mounted induction motors

**Performance**

- The motors shall be suitable for the method starting specified. All motors up to and inclusive of 22KW only shall be started using Direct online starters, up to 90 KW only shall be started using automatic Star/Delta starters while motors above 90 KW shall be started using automatic Auto transformer starters/soft starters.
- The operation of the motors shall be possible with variable voltage drives at voltages up to and including 500 V/11kV/33kV.
- The motors shall be designed to allow the required no of consecutive starts as per IS :325.
- The Bidder shall furnish the efficiency and P.F. at no load, 50%, 75% and full load.
- The motor shall have at least 10% power margin on the maximum power absorbed by the pumps over the entire working range or 15% over the power required at duty point whichever is higher, based on the ultimate duty conditions.
- Motors shall be capable of giving rated output without reduction in the expected life span when operated continuous under either of the following cases of supply conditions.
- Variation of supply voltage from the rated voltage  10%
- Variation in supply frequency from the rated frequency  5%
- Combined Voltage and frequency variation + 10% absolute
- Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding acceptable winding temperature when the supply voltage is 85% of the rated voltage.
- The locked rotor current of squirrel cage motors shall not exceed 600% rated current.
- Overload capacity: The motors shall be capable of withstanding 1.5 times the rated current at rated voltage and rated frequency for 2 minutes.

**Construction:**

- Terminal box for outdoor Bids shall be of weatherproof construction. Gaskets shall be provided at joints as per IS 4691.
- Terminal box shall be suitable for top and bottom entry of cable. Further it shall be capable of being turned through 360o in steps of 90 0
- When TEFC type of enclosure is specified, fans mounted on the motor shaft shall be provided as per IS 1231 and IS 2253.
- Motors shall have grease lubricated ball or roller bearings. Bearings shall be adequate to absorb axial thrust from the driven load together with any thrust produced by the motor itself.
- Bearings shall be capable of grease injection from outside without removal of covers with motor in running condition. The bearing boxes shall be provided with labyrinth seal to prevent loss of grease or entry of dust.

**Degree of Protection: The degree of protection of TEFC motors shall be IP-55 as per IS 4691.**

- All TEFC motors shall be self-ventilated fan cooled. The fans shall be manufactured from die cast aluminium or polypropylene. The fans shall be corrosion resistant. They shall be suitable for rotation in either direction without affecting the performance of the motor.
- The motors shall be complete with all other standard fittings.

- Two earth terminals shall be provided for each motor. These shall be located outside the terminal box. These terminals shall preferably be on diametrically opposite points. A separate earth terminal shall be provided inside the terminal box.

**Bearing**

The motor shall be provided with roller bearings at bottom and 2 nos. of angular contact bearing at top to take care of the thrust due to self weight of the rotor and provided with labyrinth ring seal in the bearing housing to prevent the entry of dust or water as per ISS 4691 standards.

**Balance and Vibration:**

The rotor shall be dynamically balanced. The no-load vibration level of motor would be Normal" as per IS: 12075.

**Noise level:**

The No-load noise level for motors shall be in accordance with IS: 12065.

**Winding connection:**

The motors up to 1.5 KW shall be star connected and for 415V,50 Hz supply and 6 leads shall be brought out to the terminal box. The motors rated 2.2 KW and above shall have 6 leads of the winding brought out in the terminal box.

**Testing**

The motors shall be subject to testing as per IS 325 and third party inspection as per "Thirt Party Inspection Conditions" in Sec 3 of the bidding document.

**Rating Plate**

All motors shall have a stainless steel Rating plate on the body.

**Painting**

- External parts shall be finished and painted to produce a neat and durable surface, which will prevent rusting and corrosion. The surface shall be degreased and all rust, sharp edges, scales be removed and treated with two coats of primer and finished with two coats of epoxy based final paint.
- The motors shall be painted with shade 631 of IS5.Otherwise if agreed it shall be shade RAL 7037(Dusty Grey).

### 4.3.11 LT MOTOR STARTER

***Star Delta Starter***

The Star Delta starter shall be oil immersed, fully automatic suitable for 415 Volts +/- 10 %, 3 phase, 50 Hz squirrel cage induction motor. The Star Delta starter shall comply with IS 8544 and BS 587 and regulations of Rajasthan state electricity utility/board.

Housing or enclosure shall be dust proof and splash proof sheet steel clad, floor mounting type.

The oil chambers shall be separate so that carbonization of oil in starter does not make any depositions on auto transformers.

The tapings shall be brought out on terminal board for easy accessibility and change.

The parts subject to wear such as contact shall be easily accessible for the purpose of inspection, maintenance and replacement.

The Star Delta starter shall be suitable for at least 2 starts per hour equally spread.

Suitable overload protection, under voltage protection, emergency stop, interlocks and earthing terminals shall be provided.

The contacts shall be made from electrolyte grade high purity copper with silver coating.

The Star Delta starter shall comprise the following components .The list of components is indicative only.

3 Nos.- Air Break power contactors of suitable rating one for STAR ,RUN and MAIN connections

1 No- Bimetallic overload relay of suitable rating for overload protection.

2 Nos.- Sets of ON and OFF delay timer on delay of 0-30 seconds mounted on STAR contactor.

2 Nos.- Push buttons for motor Start and Motor Stop conditions.

3 Nos. - Suitably rated CT's having 5 A secondary for Ammeter.

1 No. – stem type thermostat range 0-90 degree Celsius for protection of starter overheating.

1 No. –Ammeter of suitable rating

1No.- Voltmeter of suitable rating.

***Auto Transformer Starter:***

The Auto transformer starter shall be oil immersed, fully automatic suitable for 415 Volts +/- 10 %, 3 phase, 50 Hz squirrel cage induction motor. The auto transformer starter shall comply with IS 8544 and BS 587 and regulations of Telangana state electricity board.

Housing or enclosure shall be dust proof and splash proof with steel clad sheet, floor mounting type.

The oil chamber shall be separate so that carbonization of oil in starter does not make any depositions on auto transformers.

The tapings shall be brought out on terminal board for easy accessibility and change.

The parts subject to wear such as contact shall be easily accessible for the purpose of inspection, maintenance and replacement.

The contacts shall be made from electrolyte grade high purity copper with silver coating.

It shall be the Contractors responsibility to have a suitable tappings available on the auto transformer so that the motor develops the required starting torque.

Suitable overload protection, under voltage protection, emergency stop, interlocks and earthing terminals shall be provided.

The auto transformer shall comprise the following components .The list of components is indicative only.

3 Nos.- Air Break power contactors of suitable rating one for AUTO ,RUN and MAIN connections

1 No- Bimetallic overload relay of suitable rating for overload protection.

2 Nos.- Sets of ON and OFF delay timer on delay of 0-30 seconds mounted on AUTO contactor.

2 Nos.- Push buttons for motor Start and Motor Stop conditions.

3 Nos.- Suitably rated CT's having 5 A secondary for Ammeter.

1 No. – stem type thermostat range 0-90 degree Celsius for protection of transformer overheating.

1 No. –Ammeter of suitable rating

1 No.- Voltmeter of suitable rating.

1 No. – Oil immersed auto transformer without oil, with 50 %,65 %,80 % tapings of the line voltages to be applied to the motor while starting.

The motor shall never be disconnected from the power supply during starting to arrest transient phenomena.

### 4.3.12 HT & LT SWITCHGEAR AND DISTRIBUTION BOARD

**Sheet Metal Work**

- Sheet steel used for fabrication of distribution boards, switchgear cubicles shall be cold rolled.
- All cubicles, starter panel and boards shall comprise rigid welded structural frame made of structural steel sections or of pressed and formed sheet steel of not less than 3 mm thickness. The frames shall be enclosed by steel sheets of thickness at least 2 mm cold rolled or 2.5 mm hot rolled smoothly finished, levelled and free from flaws. Stiffeners shall be provided wherever necessary. The fabricated structure shall undergo seven tank painting process and shall two coats of epoxy based final paint shade of approved colour follow applied two coats of primer.
- All doors, panels, removable covers, gland plates etc. shall have gasket all around the perimeter.
- All panel edges shall be reinforced against distortion by rolling, bending, or by the addition of welded reinforcing members.
- All doors shall be supported by strong hinges of the disappearing or internal type and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.
- All floor mounting panels / boards shall be provided with 50 mm high channel base frame. Total height of all floor mounting cubicles / panels shall be 2500 mm (maximum).
- Components coming on door shall not be mounted at a height less than 300mm from floor level.
- Components except indication lamps coming on doors shall not be mounted at a height more than 1800mm from floor level.

**Distribution Boards**

- Distribution boards shall comprise an incoming isolating switch and requisite number of feeder circuits protected by HRC fuses/MCB. Three phase and neutral bus bars, as well as an earth bus bar shall be provided in the distribution board.
- Distribution boards shall be provided with a hinged front door. The incoming switch of the door shall be mounted in such a way as to facilitate operation from the front, without opening the door.
- Distribution boards shall be wall/floor mounted.

**Metal clad Switchgear**

- Separate, segregated compartments shall be provided for circuit breakers, bus bars, cable boxes, voltage transformers, wire ways, relays, instruments and control devices. Cable boxes shall be mounted inside the switchgear cubicle. Metal clad switchgear cubicles/modules shall be provided with hinged doors in the front, with facility for padlocking door handles.
- Switchgear shall be extensible on both sides.
- Switchgear enclosures shall be provided with a degree of protection not less than IPH-3 for HT switchgear, and IP52 if mounted indoors and IP55 if mounted outdoors for LT Switchgear in accordance with IS: 13947.
- Vent openings shall be covered with grills so arranged that gases cannot be discharged through them in a manner that can injure the operating personnel.
- Instruments, relays, and control devices shall be mounted flush on hinged door of the metering compartment located in the front portion of the cubicles.
- Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchgear shall also be fitted with a label indicating the switchgear rating and duty.

- Each relay, instrument, switch, fuse and Contractor shall be provided with a separate label.

- Wording of all labels shall be approved by the FSCCL.
- Switch gear shall be complete with inter panel wiring.
- High voltage metal clad switchgear shall comprise separate vertical sections for each circuit.
- Medium voltage metal clad switchgear shall comprise separate, segregated modules for each circuit. More than one module may be arranged in the same vertical section. Medium voltage switchgear circuits not controlled by circuit breakers shall be of the fixed type, semi draw out or draw out type as specified in the `Equipment Parameters'.
- The fixed type module shall have all the circuit components mounted in the compartment, with bolted type of power and control connections and the component fixing bolts.
- The semi-draw out modules shall have the circuit components mounted on with drawable type steel chassis. be of the draw out type. All control circuits shall be wired to terminal blocks mounted on the fixed portion of the switchgear. It shall be possible to completely withdraw the chassis-mounted circuit components after disconnecting the control circuits.
- The fully draw out modules shall comprise all the circuit components mounted on withdraw able type steel chassis. All power and control connections shall be of the drawout type. It shall be possible to withdraw the chassis-mounted circuit components without disconnecting any connections.
- Bus ways, cableways and wire ways in medium voltage switchgear shall be run in separate segregated compartments.

**Bus Bars**

- Switchgear shall be provided with three phase or three phase and neutral bus-bars as required.
- Bus-bars shall be of aluminium alloy, E91E.
- Bus-bar joints shall be of the bolted type and shall be insulated. Spring washers shall be provided to ensure good contact at the joints.
- Bus-bars shall be located in air insulated enclosures. Direct access to or accidental contact with bus bars and primary connections shall not be possible. All aperture and slots shall be protected by baffles to prevent accidental shorting of bus bars by the entry of maintenance tools. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

***Circuit Breakers***

**Medium Voltage Circuit Breakers**

- Medium voltage circuit breakers shall be of the air break type.
- Air break circuit breakers shall be of either the vertical or horizontal isolating pattern with horizontal draw out facilities.

**Circuit Breaker Operating Mechanism**

- The circuit breakers shall be manually closing type.
- The tripping spring shall be charged by the closing action, to enable quick tripping. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.

- Means shall be provided to manually open and close the breakers slowly when the operating power is not available, for maintenance and adjustments.
- All operating mechanisms shall be provided with `ON'-`OFF' mechanical indicators.
- A local manual trip device shall be provided on the operating mechanism.
- The breaker shall be provided with all protection devices as specified.
- All auxiliary devices shall operate satisfactorily at all voltages between 80-110% of the control voltage. Trip coils shall operate satisfactorily between 50-110% of the rated control voltage.

**Interlocks**

- Interlocks for metal clad switchgear shall comply with the requirements mentioned in the relevant Indian/International standards.
- Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

**Contacts**

- The circuit breaker main contacts shall be made of silver faced copper. The contacts shall be adjustable for wear and tear, and shall be easily replaceable. Main contacts shall be first to open and last to close to minimize contact burning and wear.
- Arcing contacts shall be first to close and last to open to take care of arcing. Arcing contacts shall be accessible for replacement. Tips of arcing contacts shall be silver plated or shall have a tungsten alloy tipping.
- If multi break interrupters are used they shall be so designed as to uniformly distribute the voltage among them.
- Where circuit breakers are used to control circuits, the contacts shall be designed for minimum wear due to frequent operation of the circuit breakers. The number of operations determining the necessity of contact inspection shall be as high as possible, and anyhow not less than 250 operations for oil circuit breakers and 500 operations for air circuit breakers.

### 4.3.13 INTERNAL AND EXTERNAL LIGHTING AND STREET LIGHTING

- Internal and External Lighting of all the Buildings, Units, Office, Store, premises in concealed PVC conduits with suitable sizes of PVC copper conductor wires, including fixtures and fittings to give the level of illumination given in the detailed specifications including providing Ceiling / Exhaust fans .
- Street Lighting with suitable LED lamp fittings on 7.5 m long stepped steel tubular poles to give the level of illumination.
- Emergency lantern with in-built battery backup rated for min 3hrs shall be provided at Switchgear rooms, pump house and walkway and shall be minimum required a total of min 4 points.

**Specifications for Internal and External Lighting and Street Lighting**

- The Bidder shall include under the contract various lighting works in all the buildings / premises. The internal lighting shall be in recessed conduit system using 2.5 sq.mm / PVC copper conductor wires drawn in 19 mm / 20 mm, 2mm thick heavy gauge PVC/GI conduit. 15 Amps plug points wiring shall be done with 2.5 sq.mm wires as per Indian Electricity Rules. Wiring should be carried out by providing 8 to 10 fitting per circuit, each controlled with SP piano type switch for lighting and 15 amps. SP piano plate made out of good engineering plastic type switch for power points.

- Distribution / Sub distribution boards to be provided at various location. On some of them, some spare switch units / MCBs shall be provided. It may be noted that the capacity of such fuses etc. will be taken into account while designing the size of the cable / bus-bars as if was a connected load.
- The Bidder shall carry out supply and erection of all fixtures falling under his sub-head so as to complete the installation including wiring. The actual position of the fittings, poles, switches etc. and the wiring layout cable routes shall however be submitted by the Bidder and got approved by Engineer. The drawing shall also show the position of sub-main distribution board, recessed conduit route in case of internal lighting and cable routes for external electrification. All conduit fittings and accessories shall be painted with weather proof paint of original shade. Cables for power and lighting should not be done or carried out together in the same conduits. The Bidder should give detailed description of fixtures and fittings they are offering along with manufactures leaflets etc. The approval for the type of fitting shall be given by the Engineer. The internal lighting shall conform to the illumination level as per the specification enclosed.
- The internal / External lighting in and around all the buildings shall be done by the Bidder who shall also lay suitable size cables with necessary power margins from the respective control switches adopting loop in, loop out system of wiring.

### 6.23.2 Lighting System Specification

- The lighting system shall consist of lighting switches, power receptacles, distribution boards, sub-distribution boards, complete with switch fuses, junction boxes, pull boxes, terminal blocks, glands, conduits and accessories (elbows, tees, crosses, bends, etc.) and supporting and anchoring materials, lighting fixtures complete with fluorescent tubes / incandescent lamps/HPSV lamps/ LED lamps and lighting cables. All materials, fittings and appliances used in the electrical installation shall conform to the relevant IS specifications and shall be anticorrosive painted for pump house area.
- It shall be the responsibility of the Bidder to work out a detailed layout for the lighting fixtures offered by him in order to provide the specified level of illumination. The Bidder shall be responsible for measuring the levels of illumination after installation and establish compliance with the Specifications. The final layout of the lighting fixtures shall be furnished for the approval of the Employer / Engineer, before commencement of installation. Control of lighting switches should be with suitable circuit breakers.

**Lighting Equipment**

Equipment shall include lighting distribution boards, lighting fixtures, poles, switches, receptacles, conduits, wires cables and miscellaneous hardware necessary for complete lighting work.

**Illumination Levels**

The following minimum levels of illumination shall be provided in the respective areas:

| | Area | Illumination level |
|---|---|---|
| a) | Pump House Area | 100 lux |
| b) | Offices | 250 lux |
| c) | Generator room | 150 lux |
| d) | Switchgear rooms | 250 lux |
| e) | Toilet, Staircase | 100 lux |

| | | | |
|---|---|---|---|
| f) | Outdoor area, Road | | 100 lux |
| g) | Substation - Transformer area | | 100 lux |
| h) | Passage entrance | 100 lux | |
| i) | Laboratory | | 300 lux |

For calculating the no of fixtures required to be provided to achieve above illumination levels, the maintenance factor shall not be taken more than 0.7 in general and 0.8 for air-conditioned rooms.

- Lighting Fixtures
- The lighting fixtures offered shall comply with the following requirements:
- The fixtures shall be suitable for operation on a nominal supply of 240 volts, single phase, 50 Hz A-C with a voltage variation of ± 10%.
- All fixtures shall be designed for minimum glare. The finish of all parts of the fixtures shall be such that no bright spots are produced, either by direct light source or by reflection.
- The lighting fixture ballasts shall have a long service life and low power loss.
- The ballast shall be of the inductive and heavy-duty type, filled with polyester or equivalent. They shall be free from hum and protected from the atmosphere. HPSV lamp ballasts shall be provided with taps.
- For multi lamp fittings, a separate choke shall be provided for each lamp.
- Lighting fixture starters shall be of the safety type (i.e. if the lamps fail to ignite at the first start, no further starting must be possible without attending to the tube light). Starters shall have bimetal electrodes and high mechanical strength.
- Lighting fixture for outdoor lighting shall be of the flood light type. Street lighting shall be carried out with pole mounted fixtures. Building periphery lighting shall be carried out using wall mounted type light fixtures complete with suitable LED lamps. Office areas shall have decorative type and others shall have industrial type fixtures. However the areas likely to encounter corrosive atmosphere shall be provided corrosion resistant fixtures only.
- All lighting fixtures shall be supplied complete with lamps and all necessary accessories for their satisfactory operation.
- Lighting fixtures shall also comply with the following requirements:
- Outdoor lighting fixtures shall be of dustproof and weather proof, decorative, post top lantern type, suitable for accommodating a colour corrected high pressure sodium vapour lamp/ LED lamp and shall be complete with stove enamelled aluminium canopy, opal acrylic Perspex bowl and all necessary accessories. The pole shall be stepped and erected in cement concrete work (1:3:6). The height of poles shall be 7.5 meter.
- The poles shall be provided with two coats of red oxide paint and finished with two coats of epoxy-based paint of approved colour. An M.S base plate of size 300mmx300mmx6mm thick welded at the bottom of the pole.
- Lighting fixtures shall be equipped with all components required for their satisfactory performance. Fluorescent lighting fixtures shall be of high power factor type and shall be supplied complete with lamps, control gear and accessories. All lighting fixtures shall be complete with necessary mounting accessories.

**Miscellaneous Equipment**

- Each electrical panel shall be provided with rubber matting of thickness not less than 12.5mm in front and shall have dielectric strength suitable for the panel as per IE/statutory Employer of the area.

- Firefighting Equipment, as per the approved specifications of Fire Service Department, indulging fire extinguishers of suitable capacity and fire buckets with sand and necessary stand shall be provided in all the installations such as Substations, L.T. rooms, Pump House. Necessary safety charts and Danger/No admission boards, First Aid box will also be provided in the various units as per the direction of the FSCCL.

## 4.4 CIVIL WORKS GENERAL

### 4.4.1 Primary Specifications for Building Works

The Contractor shall ensure that all design, materials and workmanship for civil works are in accordance with the relevant BIS / IRC Codes, manuals including CPHEEO manual and suitable specifications / standard as directed by the Engineer. All building works shall be in accordance with National Building Code.

The detailed specifications for Civil works for the proposed buildings have been given in following para:

### 4.4.2 BASIC SPECIFICATIONS FOR CIVIL WORKS:

| S No | Particulars | Suggested specification |
|---|---|---|
| 1 | Minimum Plinth level above finished GL | 750 mm |
| 2 | Min. Roof Ht. | 3.30 meters or as per GAD for particular Building |
| 3 | Brick Walls | Brick masonry in Class-I bricks, 225 mm thick in CS mortar 1:6 |
| 4 | Partition walls | 100 mm thick in class-I bricks with CS Mortar 1: 4. |
| 5 | Stone masonry walls | Minimum 300 mm thick in CS mortar 1:6. |
| 6 | Inner Walls & Ceiling Plaster | Cement Plaster (1:4) 20 mm thick, with white cement putty lining over it |
| 7 | Outer walls plaster | Cement Plaster (1:4) 20 mm thick, with white cement putty over it |
| 8 | Wall finishing (Internal) and ceiling | Painted with plastic emulsion paint grade-1 |
| 9 | Wall finishing (Outer) | Painted with cement paint. |
| 10 | Floor finish other than Kitchen and toilet | Anti corrosive ceramic tiles 300 x 300 x 20 mm |
| 11 | Floor finish for Kitchen and toilet | Non slip ceramic tiles 200 x 200 x 20 mm |
| 12 | Doors | Laminated factory made Single leaf shutters 35 mm with Teak wood frame |
| 13 | Windows | Anodized Aluminium window frame with fully glazed shutters |

### 4.4.3 EARTH WORK:

- Excavation where required shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident.
- The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.
- Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer.
- Any damages done by the Contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, over-head wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the Contractor. The Contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

**SITE CLEARANCE**

- Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one meter above

ground level and rubbish removed up to a distance of 50 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

- The trees of girth above 30 cm measured at a height of one meter above ground shall be cut only after permission of the Engineer is obtained in writing. The roots of trees shall also be removed as specified.
- Existing structures and services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer.
- In case of archaeological monuments within or adjacent to the area, the Contractor shall provide necessary fencing around such monuments as per the directions of the Engineer and protect the same properly during execution of works. Payment for providing fencing shall be made separately.
- Disposal of Earth shall be disposed off at the specified location or as decided by the Engineer-in-Charge. The Contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer.

**SETTING OUT AND MAKING PROFILES**

A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be connected with the standard bench mark as approved by the Engineer. Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The Contractor shall supply Labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or 'Burjis' and the bench mark shall be maintained by the Contractor at his own cost during the excavation to check the profiles.

The ground levels shall be taken at 5 to 15 meters intervals (as directed by the Engineer ) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in Existing structures and services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer.

**BLASTING**

- Where hard rock is met with and blasting operations are considered necessary, the Contractor shall obtain the approval of the Engineer in writing for resorting to blasting operation. In ordinary rock, blasting operations shall not be generally adopted. However, the Contractor may resort to blasting with the permission of the Engineer.

  The Contractor shall obtain license from the competent Employer for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, 1884 as amended up to date and the Explosive Rules, 1983. The Contractor shall purchase the explosives fuses, detonators, etc. only from a licensed dealer. The Contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer or his authorized representative shall have the right to check the Contractor's store and account of explosives. The Contractor shall provide necessary facilities for this.
- The Contractor shall be responsible for any damage arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation. Blasting operations shall be carried out under the supervision of a responsible authorized agent of the Contractor (referred subsequently as agent only), during specified hours as approved in writing.
- The agent shall be conversant with the rules of blasting. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the Contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked

locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular nitch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the nitch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

- The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited. Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

  (a) The Contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or

  (b) The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one. Before leaving the site of work, the agent of one shift shall inform the other agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

The Engineer shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

**GENERAL PRECAUTIONS**

- For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 meters from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.
- Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done within 200 meters of an existing structure, unless specifically permitted by the Engineer in writing.
- All procedures and safety precautions for the use of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the Contractor as detailed in IS 4081, safety code for blasting and related drilling operation.

**Precautions against Misfire**

The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose. If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material. The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer or his authorized representative before resuming the blasting or returning the consignment.

**EXCAVATION IN ALL KINDS OF SOILS**

- All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.
- During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.
- In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 meters from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer. It shall be the responsibility of the Contractor to take complete instructions in writing from the Engineer regarding the stepping, sloping or shoring to be done for excavation deeper than 2 meters.
- The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer. In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer the excess depth shall be made good by the Contractor at his own cost with the concrete of the mix used for levelling / bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer.
- While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer, the excess depth shall be made good by the Contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required is to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.
- In all other cases where the excavation is taken deeper by the Contractor, it shall be brought to the required level by the Contractor at his own cost by filling in with earth duly watered, consolidated and rammed.
- In case the excavation is done wider than that shown on the drawings or as required by the Engineer, additional filling wherever required on the account shall be done by the Contractor.
- The excavation shall be done manually or by mechanical means as directed by Engineer considering feasibility, urgency of work, availability of Labour /mechanical equipment and other factors involved. Contractor shall ensure every safety measures for the workers

**EXCAVATION IN ORDINARY/HARD ROCK**

- All excavation operations shall include excavation and 'getting out' the excavated matter. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead.

- During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.
- Where hard rock is met with and blasting operations are considered necessary, the Contractor shall obtain the approval of the Engineer in writing for resorting to the blasting operations. Blasting operations shall be done as specified in previous Para and chiselling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer and nothing extra shall be payable for chiselling.
- Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiselling.
- In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, Contractor may do so with the permission of the Engineer in writing.
- If the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer. The excess depth shall be made good by the Contractor with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete as directed by the Engineer
- In all other cases where the excavation is taken deeper by the Contractor, it shall be brought to the required level by the Contractor at his own cost by filling with earth duly watered, consolidated and rammed.
- In case the excavation is done wider than that shown on the drawings or as required by the Engineer, filling wherever required on this account shall be done by the Contractor.

### 4.4.4 CEMENT CONCRETE / REINFORCED CEMENT CONCRETE

**GENERAL**

- The aggregates and cement shall be proportioned by weight only. The mixing shall always be carried out in a mechanically operated mixer in such a way so as to avoid any loss of water or cement. The drum of the mixer should be free from holes to avoid any loss of water or cement. No hand mixed concrete will be allowed. The concrete so prepared, shall be carefully conveyed, placed in position and compacted using suitable type of mechanical vibrator, as rapidly as practicable, but in no case the time required till compaction shall exceed 30 minutes after mixing. During concreting, standby concrete mixer and vibrator shall be kept available at site.
- Ordinary Portland Cement (OPC) conforming to IS: 8112-1989 mark (grade-43) shall only be used. Cement manufactured in mini-cement plants shall not be used.
- All reinforcement used shall be of Tor Steel (Fe-415) having ISI mark and shall be clean and free from loose mill scales, rust and coating of oil or other coatings which may destroy or reduce bond. Minimum size of reinforcement bars shall be of 8 mm.
- Only steel shuttering shall be used. Shuttering shall be new or in a good condition without holes or dents and the Contractor shall get the same approval by the Engineer, before its use. The individual elements of shuttering shall correctly match with the required shape of structural member to ensure a gap-free shuttering. Suitable systems have to be provided for keeping the shuttering in place and in case of walls, maintaining the supports at an appropriate distance.
- The construction joints should be predetermined by the Engineer and these have to be executed with utmost care. Before commencing concreting for subsequent lifts/ panels, surface previously concreted member shall be thoroughly cleaned to remove all loose materials in contact with it. Honeycombing has to be avoided by suitably fixing of shuttering, preparation of surface of joints and proper use of vibrators.
- The exposed surfaces of concrete shall be kept continuously in a wet condition by ponding or covering with a layer of sackings, canvas, Hessian or similar materials and kept continuously wet for at least 21 days from the date of placing of concrete.
- To obtain a dense concrete and to reduce chances of honeycombing, adequate admixture approved by Engineer shall be used as integral water proofing compound in concrete work. The quantity of the admixture to be used shall be as prescribed by the manufacturer and approved by the Engineer.

**TESTING OF RAW MATERIAL**

Materials and workmanship shall comply with the relevant specifications described in subsequent clauses as prescribed in Standard Specifications (Civil Works).

**TESTS ON CONCRETE**

- During the progress of construction sampling, preparation of test specimens, curing and testing of concrete cubes shall be conducted in accordance with IS: 1199 and IS: 516, to determine whether the concrete being produced complies with the strength requirements as specified.
- At least one slump test shall be carried out for every compressive strength test carried out or as directed by the Engineer. Six cubes of 15 cm size shall be made for each cubic meter or portion thereof or for each pour per grade of concrete. This number may be increased at the discretion of the Engineer. Six specimens shall preferably be prepared from different batches, three to be tested after 7 days and the remaining three to be tested after 28 days. The Contractor shall provide at his own expense, all apparatus, labour and arrange for testing at a Laboratory approved by the Engineer.

**ACCEPTANCE OF CONCRETE**

The concrete tested in accordance with 'Testing of Concrete' clause above, shall meet the criteria for acceptance of concrete as per IS:456-2000. The strength of concrete shall be the average strength of three specimens tested at 28 days and conform to strength requirements for different grades of concrete. If 7 days tests show crushing strengths that are too low than required, corrective measures shall be taken at once, at the Engineers direction, without waiting for the results of the 28 days test.

**FAILURE TO MEET STRENGTH REQUIREMENTS**

In case where concrete tested fails to meet the test requirements, the Engineer shall have the right to require any one or all the following additional tests. The Contractor, at his own expense, shall carry out such tests. The Engineer shall be the final Employer for interpreting the results and shall decide upon the acceptance or otherwise.

Curing and load testing of the concrete member concerned represented by the test, which failed.

**Replacement of any such portions of the structure.**

No payment shall be made for the dismantling of the concrete, relevant formwork, or reinforcement. The Contractor at his own expenses shall make good embedded parts and/ or reinforcement that may get damaged during dismantling.

**Extended curing of concrete represented by the specimen.**

Collecting and testing of a core specimen from the hardened concrete. The location number and size of such specimen shall be taken as directed by the Engineer.

Any other test such as, ultrasonic and/ or rebound hammer test, etc. as decided by the Engineer.

**CHECK FOR REINFORCEMENT AND CONCRETING**

- All reinforcement shall be got checked and recorded prior to pouring of concrete, by a representative of the Engineer.
- Minimum Requirement for all Reinforced or Plain Concrete Structures
- All blinding and levelling concrete shall be minimum 100 mm thick in concrete M10 grade.
- All structural reinforced concrete other than for water retaining structures shall at least be of M20 grade with maximum 20mm size downgraded coarse aggregates.
- The minimum grade of concrete for water retaining structures shall be M25, having minimum cement content of 360 kg/m3 with maximum 20mm size downgraded coarse aggregates.
- Minimum cover to reinforcement for all water retaining structures shall be 40mm including the bottom of the roof. For other structures the minimum clear cover shall be as specified in IS: 456 – 2000.

- Approved quality water proofing compound (chloride free) shall be added during concreting of all water retaining structure, in the proportion specified by the manufacturer/as per design mix or up to 2% (percent) by weight of cement.
- The minimum thickness required for different reinforced concrete members shall be as per the working structural drawings to be provided to him within 15 days of award of the work.
- The aggregates and cement shall be proportioned by weight only. The mixing shall always be carried out in mechanical mixer and in such a way so as to avoid any loss of water or cement. No hand mixed concrete will be allowed. It should be conveyed, placed in position and compacted by suitable type of mechanical vibrator as rapidly as practicable but in no case the time of compaction after mixing shall increase 30 minutes. Standby concrete mixer and vibrator shall be available at site.

### 4.4.5 BRICK WORK

**Classification**

The brick work shall be classified according to the class designation of bricks used.

**Mortar**

The mortar for the brick work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

**Soaking of Bricks**

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I: The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II : If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

**Laying**

- Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.
- Note: Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.
- All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow spaces are left inside the joints.
- The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

  (a) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

(b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(c) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

(d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

(e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

- The brick work shall be built in uniform layers. No part of the wall during its construction shall rise more than one meter above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.
- All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer.
- Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to form cut (maru) corners. Where bricks cannot be cut to the required shape to form cut (maru) corners, cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks. Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.
- In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.
- To facilitate taking service lines later without excessive cutting of completed work, sleeves shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.
- Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throttling shall be provided where indicated.
- Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer.
- Vertical reinforcement in the form of bars (MS or high strength deformed bars or thermo-mechanically treated bars as per direction of Engineer, considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 (1 cement : 4 coarse sand), or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The dia. of bars shall not be less than 8 mm and concrete grade shall be minimum 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size).
- In retaining walls and the like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

- Work of cutting chases, wherever required to be made in the walls for housing G.I. pipe, CI pipe or any other fixtures shall be carried out in various locations as per guidelines given below :
- (a) Cutting of chases in one brick thick and above load bearing walls.

  (i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

  (ii) The depths of vertical chases and horizontal chases shall not exceed one-third and one-sixth of the thickness of the masonry respectively.

  (iii) When narrow stretches of masonry (or short length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength bricks in mortar or concrete walls provided, if required.

  (iv) Horizontal chases when unavoidable should be located in the upper or lower one-third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one meter in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

  (v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

  (vi) Masonry directly above a recess, if wider than 30 cm horizontal dimension) should be supported on lintel. Holes in masonry may be provided up to 30 cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes up to 40 cm in diameter.

(b) Cutting of chases in half brick load bearing walls.

No chase shall be permitted in half brick load bearing walls and as such no recessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.

(c) Cutting of chases in half brick non-load bearing wall:

Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

**Finishing of Joints:**

The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are ‘flush’, ‘weathered’, ruled, etc.

**Curing**

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period

### 4.4.6 SCAFFOLDING

- Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.
- Single Scaffolding: Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the

put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one meter in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.

- Double Scaffolding: Where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.6.2.4.1 Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.
- Note: Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.
- All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints.

### 4.4.7 CEMENT PLASTER

- The cement plaster shall be minimum 20 mm thick.
- For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.
- For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose.
- Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one meter in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.
- Note: In case of special type of brick work, scaffolding shall be got approved from Engineer in advance.

**Preparation of Surface**

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface if a chemical retarder 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 retarders is left on the surface.

**Mortar**

The mortar of the specified mix using the type of sand prescribed shall be used. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

**Bid of Plaster**

Ceiling plaster shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 × 15 cm shall be first applied, horizontally and vertically, at not more than 2 meters intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall,

between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and side-ways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive towelling or over working 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. Rounding or chamfering corners, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry 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 wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

**Thickness**

Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

**Curing**

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the Contractor's expense by such means as the Engineer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

**Finish**

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

**Precaution**

Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer

(i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6 mm drawn with any suitable method with the wall while the plaster is green.

(ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150 mm wide chicken wire mesh should be fixed with U nails 150 mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire-mesh with U nails payment shall be made separately.

## 4.5 WORKMANSHIP

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

b. 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.

c. Parts, which are likely 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. The Contractor shall supply all necessary accessories required for satisfactory and safe operation of the Plant, 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.

d. If, after installation, the operation or use of the materials or equipment furnished by the Contractor proves to be unsatisfactory. The FSCCL 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.

### 4.5.1 WELDING

- Welding shall comply with the latest revision of the BS 5135 Code.
- Welders shall be adequately qualified to carry out the welding works. If Engineer in charge experience that welder is not able to produce work satisfactorily Engineer in charge shall have the right to call for another welder. Each welder shall be assigned a number and letter. Engineer shall disqualify the welder whose work requires a disproportionate amount of repairs.
- 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.
- 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.
- 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 diameter, welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.
- 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.
- 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.
- Qualified welders in accordance with the design details and materials specifications shall also do all attachments such as lugs, brackets and other non- pressure parts. 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.

- All tack welds shall be made using qualified 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 either by using 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.
- 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.

### 4.5.2 PAINTING

**General**

- The Contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the Plant at the place of manufacture prior to packing. The colour of paint for various parts of the plant shall be subject to approval of FSCCL.
- 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. Painting is to be done only after successful completion of inspection.
- 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 Bid, and addition of thinners or any other material shall be prohibited.
- Oil, grease, dirt shall be thoroughly removed by emulsion cleaning.
- Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- Phosphate coating shall be sealed by the Bid of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be flash dried while the second coat shall be stoved.
- After Bid of the primer, two coats of finishing synthetic enamel paint shall be applied, with each coat followed by stoving. The second finishing coat shall be applied after completion of tests. The colour for the finishing paint shall be as specified.
- Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- The final finished thickness of paint film on steel shall not be less than 100 microns, and shall not be more than 150 microns.
- Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.
- Materials not complying with the foregoing requirements are liable to be rejected.

**Painting at Place of Manufacture**

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 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.

**Painting at Site**

- Immediately on arrival at the site, all items of Plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.
- After erection, items which are not finish painted at place of manufacture shall be done so, 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.
- The dry paint film thickness shall be measured by Electrometer or other instruments approved by the FSCCL. In order to obtain the dry film thickness specified, the Contractor to 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/sq.cm. 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.

**NOISE AND VIBRATION**

The Contractor shall provide a quiet installation. All items of Plant and equipment shall be carefully chosen with a view to minimizing sound levels.

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 units, compressors, and other motive Plant shall be mounted on resilient mountings.

## 4.6 LIST OF APPROVED MAKES

The bidder should take approval of makes from the Engineer and Employer prior to procurement process, confirming to IS/BS Standards.

If the prescribed makes of materials are not available in the market due to any reasons, the Contractor shall apply in writing to the Engineer with all documentation, who in turn shall approve the equivalent make confirming to IS/BS Standards.

| S. No | Equipment | Suggestive list of Vendors |
|---|---|---|
| 1 | a) Vertical Turbine Pump | Mather & Platt. Pvt. Ltd. (M&P)<br>Worthington Pump India Ltd. (WPIL)<br>Kirloskar Brothers Ltd. (KBL)<br>JYOTI Ltd Vadodra |
| | b) Centrifugal Pump | Mather & Platt Pvt Ltd. (M&P)<br>Kirloskar Bros. Ltd. KBL<br>Worthington Pumps India Ltd.<br>JYOTI Ltd<br>Batliboi and Company Ltd |
| 2 | High Voltage (HT) Motor | Siemens India Ltd. (SIEMENS) Crompton Greaves Ltd. (CROMPTON) Bharat Heavy Electrical Ltd.(BHEL) Kirloskar Electric CO. General Electric |
| 3 | Sluice Valves, Air Valves, Butter fly Valves, Foot valves, Non Return valves : Motor Operated, & Manually operated | Indian Valve Company (IVC),<br>Kirloskar Brothers Ltd,<br>Geeta Valves & Engg Pvt. Ltd. |
| 4 | Actuators for Motorised valve | Rotork<br>Limitork<br>Auma India<br>Emtork |
| 5 | EOT Crane | HITECH<br>INDEF<br>ROCKWELL |
| 6 | Transformer | Siemens India Ltd.<br>Bharat Heavy Electrical Ltd.<br>General Electrical<br>CROMPTON |

| S. No | Equipment | Suggestive list of Vendors |
|---|---|---|
| 7 | Electric Switch Gears (Isolators / Starters etc) | Bhartiya Cutler Hammer,<br>L&T,<br>ENERCO Energy Solutions (Soft starters), Schnader Electric Soft Starter,<br>Emtron Soft Starters (Tangent Technologies) |
| 8 | Air Blowers | Air Equipment Works Calcutta,<br>Candy Filters (India) Ltd, Bombay<br>Kay Engineering Works Delhi<br>Greaves Cotton & Company Ltd Bombay |
| 9 | Chlorinators and Water Treatment Equipments | Hindustan water Engineering Company (HWE)<br>Candy Filters (India) Pvt Ltd<br>Geo- Millers & Co Pvt Ltd<br>Chloro Control Equipment Company, Bombay<br>Babubhai Narottam Das & Co. Bombay |
| 10 | Water Hammer Control devices | Sure Seal (India), Bombay |
| 11 | Ductile Iron Pipes and Fittings | Electro Steel Castings Pvt Ltd.<br>Jindal Saw Ltd |
| 12 | Mild Steel Pipes | Steel Employer of India Ltd<br>Jindal Pipes Ltd<br>Welspun Pipes Ltd<br>Indian Tube Company Secunderabad |
| 14 | HDPE | Gauthami Pipes Pvt Ltd, Hyderabad<br>Modern Plastic Co. Ahmedabad<br>Arihant Evergreen Agro Plast Pvt Ltd Jaipur<br>Dolphin Hydro Engineers Pune |
| 15 | Pressure Gauge | Bourdon<br>WIKA<br>FIEBIG |

| S. No. | Equipment | Make |
|---|---|---|
| 1. | 11 KV/ 0.4,Transformers | Areva / Crompton / ABB / EMCO/ Vijai |
| 2. | 11 KV Lightning Arrestor | GE / Crompton / Lamco/ Elpro / Oblum/ Areva |
| 3 | L.T. Panels | CPRI/ ISO 9000 acredited manufacturer/ Schneider |
| 4 | Indicating Lamps | L&T / Siemens / Schneider |
| 5 | Push Buttons | L&T/ Siemens / Tele mechanic |
| 6 | Timers | L&T/ Siemens / Tele mechanic |
| 7 | ACB | L & T / Siemens/ Schneider/ABB |
| 8 | SFU | GE /L&T/ Schneider/ Siemens/ ABB |
| 9 | Starters/Contactors | GE/ L&T/ Schneider |
| 10 | MCCB | GE/ L&T/ Schneider/ Siemens |
| 11 | Connectors | Elmex/ Connectwell/Raychem |
| 12 | MCB | L&T/MDS /ABB/GE/ Schneider |
| 14. | Capacitors | Epcos/ Siemens/ PUCAT / Areva / |
| 15. | Wires | Finolex / Polycab / RR Cables / Gloster |
| 16. | HRC | L&T/GE / Schneider/ Standard |
| 17. | Power Switch (upto 32A) | L&T/GE / Schneider/ Siemens |
| 18. | Cable Accessories: | |
| | Gland | Comet/ Meat Craft Industries/Raychem |
| | Lugs | Dowells/ Meat Craft Industries/RayChem |
| 19. | Exhaust Fan/ Light Fitting T-5 | GE /Crompton /Bajaj/Orient/Usha |
| 20. | 11/33 KV Vacuum Circuit Breaker | BHEL/Crompton/Siemens/ Schneider/ABB/ Bicco lawrie/Areva |
| 21. | 33, 11 KV HT cable | Finolex/ Universal/ Polycab/ Prime-cab/Gloster/CCI |
| 22. | Light Fittings & Lamps | Philips/WIPRO/BAJAJ/SCHREDER |
| 23. | Octagonal Poles | Jindal/ Balaj/ Schreder |
| 24. | LT Cable | Finolex/ Universal/ Polycab/ Prime-cab/Gloster/CCI |
| 25. | SCADA system | CMS/ Siemens / Westing house/Alstom/ Fox bro/ |
| 26. | Computer | LENOVO/ HCL / IBM / HP-Compaq/DELL/ |
| 27. | Steel | SAIL / TATA/ JINDAL |

| S. No. | Equipment | Make |
|---|---|---|
| 28. | Power transformers | Areva/ Crompton/ BHEL/EMCO/ Vijai |
| 29. | Ring Main units 11 KV | Areva/ Crompton/ BHEL/ Siemens/ ABB/Schneider/ |
| 30. | Cement | Ultra Tech/ACC/Guj.Ambuja/Lafraj |
| 31. | Load break switch | Areva, Crompton , BHEL, L& T, Siemens,ABB, Schneider |
| 32. | Pre-fabricated steel building system | Kerby , Vardhaman, Nesha, National |

**COMMISSIONING**

After the completion of project final checks and preparations necessary for start-up of the plant shall be carried out. The Contractor shall submit to the ENGINEER a written Notice of Mechanical Completion, which shall include:

- Identity of a part of the Plant considered mechanically complete,
- Copy of all relevant completed test reports,
- Date on which the completion of the tests was achieved,
- Check list, and
- A request for issuance of a Mechanical Completion Certificate in respect of that part.
- Within fourteen (14) days from the date of receipt of the Contractor's written Notice, the ENGINEER shall:
    - In the case of acceptance, issue a Mechanical Completion Certificate.
    - 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 the ENGINEER rejects the Contractor's Notice the Contractor shall take any necessary action to complete or correct the items marked and give the ENGINEER a second Notice of Mechanical Completion.

- After the issuance by the ENGINEER 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:
- Commissioning Procedure shall be carried out in a methodical sequence as follows
    - Warming up,
    - Start-up,
    - Initial running,
    - Operability adjustment,
    - Stable operation
    - Final adjustment

At all stages of commissioning sequence, the Plant shall be operated at optimum operating conditions. To ensure this, the Contractor may make minor adjustment to the conditions indicated in the Operation and Maintenance Manual as necessary.

The Contractor shall check the operating conditions of the Plant by constantly monitoring operating data.

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.

The ENGINEER on the forms to be mutually agreed shall record all the operating data. The ENGINEER shall make a copy of the operating log and analytical data initial operation through to the completion of Performance Test available to the Contractor for evaluation.

The Contractor shall carry out commissioning tests in the presence of the Engineer's representative. The evaluation of test results and decision passed by the Engineer's representative regarding the test results will be final and binding on the Contractor. Additional test or repetition of test to establish satisfactory operation of any equipment shall be carried out by the Contractor, if instructed by the Engineer's representative at no extra cost.

The Contractor shall carry out commissioning tests of the system in the presence of the Engineer's representative and run the equipment at its specified duties for the period of 15 successful days. These tests will be carried out after installation of all the new equipments in the pumping station. The evaluation of test results and decision passed by the Engineer regarding the test results will be final and binding on the Contractor. Additional test or repetition of test to establish satisfactory operation of any equipment shall be carried out by the Contractor at no extra cost, if instructed by the Engineer. During Commissions the Contractor shall supply all labour to supervise, operate, test and do all things necessary to keep the plant running. This shall include for provision of such labour on a 24 hour a day basis during testing period of continuous operation as Engineer may consider necessary to establish the efficient operation of the plant.

The completion checks and commissioning tests to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment/system.

All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and commissioning checklists described in subsequent paragraphs.

**General**

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

- Name plate details according to approved drawings/ specifications
- Any physical damage or defect and cleanliness
- Tightness of all bolts, clamps and connections
- Oil leakages and oil level
- Condition of accessories and their completeness
- Clearances
- Earthing connections
- Correctness of installation with respect to approved drawings/specifications
- Lubrication of moving parts
- Alignment
- Correctness and condition of connections

**Spare Parts**

Spares during pre-commissioning trials, commissioning tests / maintenance, guarantee etc. shall be provided by the Contractor. The spares also include the consumable such as bulbs, fuses, wires, lubricating oil, gaskets, packing seals, etc. 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.

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements. Spares shall be packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labelled 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.

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 ENGINEER before such withdrawal so that the ENGINEER can take timely alternative steps.

## 4.7 SAFETY PROCEDURE AND PRACTICE

**General**

Following safety procedure and practice should be provided by Contractor in switchboard room/substation as per latest edition of I.S. 5216.

Rubber matting of 11kV test grade in front of LV switchboard and other panels in switchboard room

One shock treatment chart in LV switchboard room

- Caution/Danger Board
- 415 V switchgear : 1 No.
- Sub distribution board : 1 No.
- Three sand bucket in switchboard room
- Two fire extinguisher in switchboard room
- One set of 11kV grade hand gloves in switchboard room

**Fire Safety**

The requirement of hand appliance in switchboard room, electrical equipment room shall be as per the latest edition of Fire Protection Manual by Regional Tariff Committee.

**Contractor's Licence**

The Contractor shall obtain the necessary License / Authorization 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/recognized 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 electrical system from the appropriate Employer such as MPEB, CEIG etc. which is relevant for electrical installation work.

**2. OPERATION AND MAINTENANCE WORKS:**

**2.1 General**

This section applies to the specifications for operation and maintenance of complete sewerage treatment plants, and secondary treated water supply system for reuse in parks along with related ancillary buildings, roads campus etc. It illustrates for the workmanship, period for routine maintenance, specifications for the acceptable quality of treated water to satisfy the standards of CPHEEO, maintenance of records, and responsibilities during operation and maintenance period. **The period of Operation and Maintenance and defect liability shall be 60 months after 3 months of trial run period.**

**2.3 O & M for Pumping station and treatment plant**

Operation and maintenance of the pumping station and' treatment plant is essential for the sustainability of the entire system and to achieve discharge standards. The operational aspects include regular checking of the units (which include the electrical and mechanical equipment), to identify any non-functionality of the units and to evolve the strategic measures to be taken, so as to run the plant efficiently.

The Plant Manager will look after the operation and maintenance of the pumping station, treatment plant and treated water supply system. All the activities of the pumping station and treatment plant are scheduled and coordinated by the Plant Manager his/her assistant along with the concerned technical staff who will execute the instructions. The Plant Manager will also be responsible for taking steps like shutting down the pumping station and treatment plant or to bypass the wastewater in case of floods / heavy flow.

**2.4 Specifications**

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during construction shall be approved by the

Employer's Representative prior to commencement of the operation and maintenance period and must be incorporated in the O&M manual. Without being limited by this clause, during O&M period the Contractor shall use appropriate material for repairs even if material required for such repairs has not been approved earlier, and no delay in making such repairs shall be subjected to such limitation. However, subsequent to use of such material the Contractor shall submit proposals for the approval of specifications of such material. The approved material will subsequently form a part of the O&M manual.

The Contractor shall be responsible for operation and maintenance of the entire system for the period of 60months after successful completion. Notwithstanding the above, the Contractor will be required to rectify any deficiencies which are attributable to defects in the workmanship or quality of materials, Plant or equipment during the Contract Period.

The operation & Maintenance cost approved by the Department shall be payable on monthly basis on completion of every month on submission of bill by the contractor. The contractor shall maintain the attendance record of the staff employed by him, which can be checked by the Employer / Engineer at any time. The contractor will also submit copy of all the data sheets every month for evaluation.

All sorts of Tool & Plant and spare parts required for proper operation & Maintenance of the Pipeline work, Treatment Plant, Reservoirs, Electrical and Mechanical system and SCADA System shall be arranged by the contractor at his own cost.

The scope of work is given below but is not limited to, The scope may include other incidental items of work connected with the regular operation & maintenance of the treatment plant as required or decided by Employer / Engineer from time to time.

(i) The contractor shall ensure proper running of the plant to give the desired effluent standards as defined in design parameters. The contractor shall also be responsible for overall maintenance of the plant i.e. civil, electrical, and mechanical system. The contractor shall also be responsible for all repairs of equipment/machinery.

(ii) The contractor shall monitor the quality of raw and treated sewage. The contractor shall intimate and take adequate action to ensure smooth and satisfactory running of the plant. The raw and treated sewage analysis for pH, SS, BOD, COD oil & grease shall be carried out on daily basis and keep record of it. The soft copy of the test results shall be mailed to Engineer on daily basis at a pre decided time. If required the Engineer may ask to perform the tests in his / her presence.

(iii) The contractor shall prepare and implement an effective plant maintenance programme in consultation with Engineer. It shall absolutely be the contractor's responsibility to look after all sorts of maintenance whether preventive or break down. The contractor shall maintain the operational activity record as prescribed in this volume.

(iv) The contractor shall be responsible for keeping updated record of documents including History-Card for equipment and maintaining every day logbook relating to running of machinery, consumption of energy, and other consumables and various analysis performed. In addition to above the contractor shall maintain the operation and maintenance data for the following.

(a) Daily status record of STP

(b) Daily flow record

(c) Daily sewage and secondary treated sewage analysis record

(d) Operation records of mechanical screens

(e) Operation record of grit channel

(f) Operation record of all the components of wet wells, Pumping station and treatment units

(g) Operation record of chlorination system

(h) Record of quantity of sludge generation

(i) Operation record of Centrifuge unit

(j) Performance data of aeration system.

(k) Performance data of Chlorination system

(l) Daily record of treated water supply to each park.

(m) Daily record of performance and data analysis of SCADA system.

(n) Any other allied works required by EIC during O&M.

(v) The Contractor shall submit a monthly report to FSCCL, about the operation and maintenance indicating the manpower, electric power, chemicals and other consumables consumed, problems faced and rectified along with various analysis performed for raw and treated sewage.

(vi) The contractor shall be responsible to carry out day to day as well as periodic maintenance necessary to ensure smooth and efficient performance/running of all equipment/instruments installed at the Sewage Treatment Plant. The contractor shall hand over the machinery & site to the department after expiry of the contract period in good running condition.

(vii) The contractor shall maintain all treatment plant, pumping stations, pipe lines, reservoirs and all building and other units including STP premises and boundary wall in sturdy manner to complete its natural / designed life. He should paint all MS / CI / GI structures at least once in a year to prevent rusting as and where required and as directed by Engineer.

(viii) The contractor shall also be responsible for proper upkeep of administrative block of the Sewage Treatment Plant.

(ix) He shall be responsible for proper maintenance of all the pumps and allied items including mechanical screens, gates, Aerators, sludge pumps, chlorinator etc.

(x) He shall be responsible for timely removal and safe disposal of the dried sludge including transportation, loading and unloading etc. He should get approval for the location of the disposal of the dried sludge from FSCCL.

(xi) He shall be responsible for maintenance of Electric sub-station, HT and LT system including streetlight, poles & fixtures.

(xii) The pipe line system in the STP premises, roads and pathways provided for supply of treated sewage to parks shall be maintained properly.

(xiii) Round the Clock watch and ward of the entire premises including plants/machinery etc. will also be the responsibility of the contractor.

(xiv) The entire STP premises including Administration building will be kept neat and clean.

(xv) The records maintained by the contractors shall be produced periodically to the Engineer for proper monitoring as desired by him.

(xvi) Operation & maintenance of boundary wall of STP, Landscaping and Forestation done in the Sewage Treatment Plant premises etc. shall be carried out.

**2.5 General Terms and Conditions**

1. FSCCL shall bear the required power charges for complete O & M period of 60 months. The power bills shall first be paid by the contractor and shall be reimbursed by FSCCL along with the monthly O & M charges.

2. During O & M period the contractor is to keep their staff engaged continuously without any break for Operation, Maintenance and Monitoring of the system.

3. The contractor will supply all consumable and reagents including POL of DG set. FSCCL will not bear any cost on operation and maintenance of the complete system except the power charges.

4. The contractor will employ its own staff for monitoring quality of sewerage and effluent, however the department will be at liberty to get random sampling & testing done on its own or from any other agency, to the entire satisfaction of Engineer. In case of testing from other agency, charges will be borne by FSCCL.

5. Contractor’s labourers and supervisors shall have to normally observe office timings in the

general shift.

6. Plant and equipment covered under this contract shall be totally attended to by the contractor including any "Trouble Shooting" to ensure smooth and trouble free operation.

7. For effective maintenance of STP, the contractor shall employ sufficient staff with proper qualification. For his guidance the pattern and no. of minimum staff to be engaged is described in this chapter.

8. The contractor shall take operational measures that there shall be no flooding of STP area.

9. The contractor shall abide by all central/state govt. /Semi govt. /Local Bodies rules regulations, pertaining to this contract, without any extra cost.

10. In the event of any damage/loss of life/theft of property, due to negligence on the part of contractor, the contractor shall be solely responsible and liable for compensation and damages, regarding negligence and the decision of Engineer shall be final.

11. The contractor should maintain all kinds of securities in the premises round the clock for that he should arrange manpower to prevent theft, robberies and malpractice. No unauthorised person shall be allowed to enter the STP premises, except authorised staff, officials of FSCCL. Educational study visits of the students shall be allowed only on written permission from FSCCL.

12. The site will be open for inspection by the designated officers/official of FSCCL at all times during the contract period.

13. The contractor should observe all safety rules and regulations corresponding to electricity act, factory act, bio-chem process and fire safety act as per building codes. Any accident caused by over sighting the rules, shall be at the contractor own cost and risk and shall be handled by him at all levels.

14. Insurance of the entire staff working for O & M of the system is compulsory. The copy of the cover note should be submitted to FSCCL.

## 2.6 Experience and qualification of staff

For all operation and maintenance works, the Contractor shall provide skilled staff, which has adequate qualifications and sufficient experience of similar works. CV of key staffs will have to be got approved from the Employer. The Contractor will arrange extra work force, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations. The Contractor shall make appropriate arrangements for maintenance of items like road work, buildings, arboriculture, patrolling and maintenance of civil structures, vehicle operations and other activities to fulfill its obligations under O&M Contract.

## 2.7 Operation and maintenance manual

The comprehensive manual shall be submitted before the operation and maintenance period, as specified. It shall be periodically updated to incorporate the "best practices" experience gained while carrying out the O&M activities, broadly on the principals listed below:

(i) Up-dating any changes in the procedures set out in the O&M manual, as deemed necessary based on any limitations observed during the maintenance period, including incorporating additional procedures for maintenance of other repairs/break downs not incorporated in the maintenance manual but faced during O&M period.

(ii) Procedures for repair of leaks/burst in different types of pipes must be provided, with supporting drawings. The O&M manual must be updated if any differences are observed during O&M period.

(iii) Records of locations and type of damages observed during maintenance of road which are of recurring nature must be used in updating the manual.

(iv) Records of Inventory used must be maintained and the relevant portion of O&M manual must be updated to list out the inventory requirements for maintaining the system for 12 months.

(v) Records of the sewage and treated water quality, shall be kept intact for complete period of O&M, and shall be handed over to FSCCL, after the expiry of Contract period.

(vi) The chemical requirement for the plant on monthly basis must be estimated and incorporated in the manual. Record keeping must be sufficient so as to assist in forming a relationship between the chemical dosages required for treatment with respect to the raw water input quality.

(vii) The provisions in the manual must incorporate every aspect of good industrial practices even if not elaborated here or in other parts of the bid document. The provisions in the approved operation and maintenance document shall be valid and binding for both the parties during operation and maintenance along with the additions and deletions made.

(viii) The manual so prepared must be updated after the end of every year of operation and maintenance, giving effect to the experience gained and the observations made by the Department during the maintenance period.

(ix) At the time of handing over after completion of O&M period, all the equipment, including standby equipment, must be in good working order as were taken over before commencement of O&M period.

### 2.8 Penalties for failure to achieve the functional guarantees for part "A" part "B" of this document

In case of failure to deliver the required quality of work, liquidated damages shall be imposed for such failure to meet the performance criteria, as described. The Employer will be entitled to recover any such damages from the monthly progress payments to be made to the Contractor in the month in which the failure occurred, or at any time thereafter from the subsequent monthly progress payments.

However, the contractor shall be allowed to take up routine / periodical, maintenance / repair with prior permission of the Employer.

a. Failure to achieve the specified quality of effluent from STP: Rs. 5000.00 for each time and each parameter.

b. For each breakdown of any unit of plant for more than 1 hour: Rs. 2000.00 each time

c. For complete break-down / non operation of plant for more than 15 minutes : Rs. 10,000 each break down of maximum 30 minute time. If break down exceeds 30 minutes second slot of penalty shall be leviable for each slot of 30 minutes.

e. Non redressel of any complaint within 24 hours : Rs. 1000.00 for each such complaint.

f. Penalties for absence of Supervisory / Operating staff shall be as follows:

**Each treatment plant should have the minimum Supervisory / Operating staff**

| Sl. No. | Staff Category | Penalty for absence |
|---|---|---|
| 1 | Plant Manager | Rs. 2000.00 per day |
| 2 | Chemist | Rs. 1000.00 per day |
| 3 | SCADA Specialist | Rs. 2000.00 per day |
| 4 | Plant operators | Rs. 700.00 per day |
| 5 | Electrician | Rs. 700.00 per day |
| 6 | Mechanic | Rs. 700.00 per day |
| 7 | Helper | Rs. 500.00 per day |
| 8 | Watchman | Rs. 500.00 per day |

### 2.9 Facilities to contractor

The Contractor will be permitted to use the premise and quarters developed under the Contract for use by his staff during operation and maintenance to the extent agreed and approved by the Employer's Representative.

## I. Quality Assurance and Quality Control

## 5. GENERAL

Some of the tests and procedures related to the specific works related to this Contract are laid out here and shall be applicable for this Contract. They shall be in general as an additional stipulation to the QA/QC manual and will not reduce the requirements stipulated in the Manual. The various tests stipulated below will be conducted on the following frequencies and the test report format and other details will be followed as per the QA/QC Manual.

### 5.1 Civil Engineering Works

### 5.1.1. Supply of Material

The tests on the construction material received on site shall be carried out as follows:

**Procedures for Testing Materials on Site**

| CEMENT | | | QC-M-01 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Normal consistency | TC-M-01-01 | One for each source and when called for by the Engineer | On receipt of material at site and before using as directed by the Engineer. Test certificate to be produced to the Engineer before use. |
| 2 | Fineness | TC-M-01-01 | | |
| 3 | Setting time – Initial / final | TC-M-01-01 | | |
| 4 | Compressive strength - 72 hrs, 168 hrs, 672 hrs. | TC-M-01-01 | | |
| For sulphate resistant cement as per IS-12330 OPC 43/53 shall conform to IS 8112/ 12269 and both 56 and 90 days strength shall be tested. | | | | |

| SAND | | | QC-M-02 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Sieve analysis | TC-M-02-01 | One test for 15 $m^3$ | On receipt at site and test certificate to be produced to the Engineer before use. |
| 2 | Fineness modulus | TC-M-02-01 | One test for 15 $m^3$ | |
| 3 | Deleterious constituents | TC-M-02-01 | One test for 15 $m^3$ | |
| 4 | Bulking test | TC-M-02-01 | One test per Source | |

| WATER FOR CONSTRUCTION WORKS | | | QC-M-03 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Alkalinity and acidity as per IS-3025 | TC-M-03-01 | Once per source of supply and when called for by the Engineer | Before use of water from that source |
| 2 | Solids | TC-M-03-01 | | |

| BRICKS | | | QC-M-04 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Compressive strength | TC-M-04-01 | One test per 50,000 bricks or part thereof | On receipt at site |
| 2 | Physical properties | TC-M-04-01 | | |
| 3 | Water absorption test | TC-M-04-01 | | |

| STONE | | | QC-M-05 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Water absorption test | TC-M-05-01 | One test per source and when called for | On receipt at site |

| | | | | |
|---|---|---|---|---|
| 2 | Dimension check | Lab format | As directed by the Engineer | |
| 3 | Type of rock | Lab format | | |

| COARSE AGGREGATE FOR CONCRETE | | | QC-M-06 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Aggregate Impact or Los Angeles Abrasion Value as per IS-2386 Part-IV | TC-M-06-01/1<br>TC-M-06-01/2 | One for each source of supply and when called for by the Engineer | On receipt of material at site |
| 2 | Soundness as per IS-2386 Part-V | TC-M-06-02 | | |
| 3 | Alkali Aggregate Reactivity as per IS-2386 Part-IV | Lab Format | | |
| 4 | Flakiness Index | TC-M-06-03 | | |
| 5 | Gradation by wet sieve analysis | TC-M-06-04 | | |
| 6 | Water Absorption | TC-M-05-01 | | |
| When required, the Contractor shall furnish the mix design along with material properties at least 15 days in advance. | | | | |

### 5.1.2. General Civil Engineering Works

The general civil engineering works will be subjected to a check frequency as follows:

**Table 1: Procedures for Testing General Civil and Structural Works**

| Embankment Formation | | | QC-G-01 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Moisture content as per IS-2720 | TC-M-09-03 | One test for each 250 $m^3$ of soil | In-process |
| 2 | Field density test as per IS-2720 | TC-M-09-03 | 5-10 density tests for each 1000 $m^2$ compacted area, or as directed by Engineer | |
| 3 | Compaction | Daily log | As per required number of passes | While compacting |

| Excavation/Backfilling | | | QC-G-02 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Layout, slopes of excavation, benching and over-burden | Daily log | As directed by the Engineer | After excavation |
| 2 | Sub-soil water, shoring and strutting | Daily log | | |
| 3 | Bottom levels and compaction | Daily log | | |
| 4 | Soil classification | Daily log | | |
| 5 | Backfilling and compaction | Daily log | | After backfilling |

| Concreting | | | QC-G-03 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Compressive strength as per IS-516 | TC-G-01-01 | One test for 1-5 $m^3$ of concrete<br>Two tests for 6-15 $m^3$ of concrete<br>Three tests for 16-30 $m^3$ of concrete<br>Four tests for 31-50 m3 + one set every 50 $m^3$ of | Test samples to be taken while pouring. Testing to be done as specified in Contract. |

| | | | | |
|---|---|---|---|---|
| | | | additional concrete work. | |
| 2 | Slump test per IS-1199 | TC-G-01-02 | Random checks throughout concreting as directed by the Engineer | Before pouring concrete |
| 3 | Inspection of steel reinforcement placement and bending, and formwork | Daily log | Before pouring concrete | Before pouring concrete |
| 4 | Concrete Pour Report | TC-G-01-03 | When pouring is done | Immediately after pouring |

| **Mortar** | | | **QC-G-04** | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Compressive strength as per IS-2250 | TC-G-01-01 | One sample for every 2 $m^3$ of mortar subject to a minimum of three samples for a day's work | Test samples to be taken while before mortaring. Testing to be done as specified in Contract. |
| 2 | Consistency as per IS-2250 | TC-G-02-01 | | |

### 5.1.3. Pipe Line and Water Retaining Works

The general pipe line works and water retaining works will be tested as follows:

**Table 3: Procedures for Testing Pipeline Works and Liquid Retaining Structures**

| **Earth Bedding** | | | **QC-P-01** | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Moisture content as per IS-2720 | TC-M-09-03 | One test for each 250 m3 of soil | In-process |
| 2 | Field density test as per IS-2720 | TC-M-09-03 | One test for each 100 $m^2$ of compacted area | |

| **Concreting** | | | **QC-P-02** | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Compressive strength as per IS-516 | TC-G-01-01 | One test for 1-5 $m^3$ of concrete<br>Two tests for 6-15 $m^3$ of concrete<br>Three tests for 16-30 $m^3$ of concrete<br>Four tests for 31-50 m3 of concrete + one set every 50 $m^3$ of additional concrete work. | Test samples to be taken while pouring. Tests to be done as specified in the Contract. |
| 2 | Slump test per IS-1199 | TC-G-01-02 | Random checks throughout concreting period as directed by the Engineer | Before pouring concrete |
| 3 | Steel reinforcement placement and bending | Daily log | Before pouring concrete | Before pouring concrete |
| 4 | Concrete Pour Report | TC-G-01-03 | When pouring is done | Immediately after pouring |

| **Mortar** | | | **QC-P-03** | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Compressive strength as per IS-2250 | TC-G-01-01 | One sample for every 2 $m^3$ of mortar subject to a minimum of three samples for a day's work | Test samples to be taken while placing. Tests to be done as specified in the Contract. |
| 2 | Consistency as per IS-2250 | TC-G-01-02 | | |

| Completion of Pipeline Laying and Jointing | | | QC-P-04 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Hydrostatic test for NP pipes | TC-P-04-01 | One test for defined stretch | On completion of stage |
| 2 | Hydrostatic test for pressure pipes | TC-P-04-02 | One test for defined stretch | On completion of stage |

| Completion of Manhole/Valve Chamber | | | QC-P-05 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Leakage Test | TC-P-05-01 | 100% inspection | On completion of stage |

| Completion of Liquid Retaining Structures | | | QC-P-06 | |
|---|---|---|---|---|
| **Sl. No.** | **Type of Test** | **Test Report Format No.** | **Frequency of Test** | **Timing of Test/ Inspection** |
| 1 | Water tightness for underground structures | TC-P-06-01 | One test per structure | On completion of stage |
| 2 | Water tightness for elevated structures | TC-P-06-02 | One test per structure | |

## 6. MATERIALS, PLANT AND EQUIPMENT

### 6.1. Extent and Procedure for Submission for Pre Construction Testing and Review Data

All goods and materials to be incorporated into the Works shall be new, unused, of the most recent or current models, and shall incorporate all recent improvements in design and materials.

The Contractor shall place orders for the material and the equipment only after approval of the Employer's Representative. The Contractor shall submit the detailed drawings from the approved manufacturer and the procedure of submission, review and revision shall be as specified in clause 4.1.8 of Sub section 1.

### 6.1.1. Works Tests

These shall be as per applicable standards unless otherwise detailed in the technical requirements. The results of all works tests shall be recorded and submitted to the Employer's Representative.

### 6.1.2. Scope of Inspection

The test equipment, meters, instruments, etc. used for testing shall be calibrated at recognized test laboratories at regular intervals and valid certificates shall be made available to the Employer's representative at the time of testing. The calibrating instruments used as standards shall be traceable to International standards.

All type (as applicable), routine and acceptance tests shall be conducted in the presence of Employer/ Employer's Representative / Third Party Inspector on all the equipment as per latest applicable BIS at no extra cost. Any modification / revision in the equipment as required by the Inspector shall be carried out by the Contractor without any extra cost. All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply of equipment as quoted by the Contractor. Typical type test reports for other equipment shall be submitted by the Contractor for approval by Employer.

### 6.1.3. Dispatch

The Plant / accessories shall not be shipped / dispatched unless shipping release from Employer / Employer's Representative is issued subsequent to acceptance of test results.

### 6.1.4. Packing and Shipping

Any items liable to be damaged in transit shall be effectively protected and securely fixed in their cases. All cases shall be marked to show where slings should be placed.

All cases shall be clearly identified giving particulars of manufacturer's name and type of equipment. All identification marks on the outside of cases shall be waterproof and permanent. All electrical equipment shall be adequately sealed and desiccating agents shall be used where necessary to prevent damage from condensation. All equipment shall be packed and protected, bearing in mind that it will be shipped to a harsh environment, that a considerable period may elapse between its arrival on site and it's unpacking and that covered storage may not always be possible.

All wood and other materials used in packing cases shall be insect free. Adequate protection and precautions shall be taken to exclude termites and other vermin, noxious insects, larvae or fungus from the packing materials or plant. All contents shall be clearly marked for easy identification against the packing list.

The Contractor shall protect all steelwork before shipment, to prevent corrosion and / or damage. Bundles of steel sections shall be properly tied together by an approved method and care shall be taken to ensure that they are robust and that they can be handled easily during shipment.

Bolts and nuts shall be double bagged and crated for shipment. Crating of dissimilar metals is not acceptable.

Packing cases where used, shall be strongly constructed and in no case shall timber less than 25 mm in thickness be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood, but shall be supported by cleats secured from inside.

### 6.1.5. Labels

All equipment / components / parts shall be provided with labels or name plates, giving a description of the equipment, together with information regarding the rating, nominal voltage, nominal current and the like under which the item of plant in question has been designed to operate. The labels shall be permanently attached in a conspicuous position. Where this is not practicable, such labeling shall be provided on packaging to the Employer's Representative approval.

Labels shall be made of non-rusting metal. Labels shall have white letters on black or dark blue background. The lettering size shall be 6 mm for panel designation and minimum 3 mm for device labels. The label inscriptions shall be subject to the Employer's approval.

Each item shall be clearly and permanently labeled on the outside of its container with its description and purpose. When several items are packed in one case, a general description of the contents shall be given on the outside of the case. Spare parts shall not be shipped in the same cases as components, which are used for erection. The cases shall be clearly labeled to indicate that they contain spare parts or tools and each spare part tool or appliance shall be clearly marked with its size and purpose.

## 6.2. Quality Assurance

The Bidder shall submit in the bid an outline of the quality assurance practices that will be applied to all aspects of the manufacturing, installation and commissioning process.

The Contractor shall submit a detailed Quality Assurance Manual, which conforms generally to the requirements of ISO 9002. Approval to proceed with manufacture of equipment within this Contract will not be given until this Quality Assurance Manual and drawings of the equipment / systems has been received and approved by the Employer's Representative. Delays to the Contract completion date due to non-compliance with this requirement will be the Contractor's responsibility.

Major features of the Quality Assurance Scheme practiced by the Contractor and detailed in his Quality Assurance Manual shall include:

(a) The Contractor has defined all staff responsibilities and the QA systems operating within the organization for the purpose of ensuring adequate quality of the end product.

(b) Regular and systematic programs of testing are carried out for all incoming raw materials.

(c) Regular calibration checks are carried out on all measuring equipment used in the manufacturing operations.

(d) All production operations and test functions are properly documented and available to any relevant member of the Contractor's workforce.

(e) All checking activities, test results, etc. are recorded on appropriate standardized forms and these are verified, certified, recorded and filed in a systematic manner.

(f) A detailed inspection and test plan is prepared for the whole manufacturing operation.

(g) Statistical analyses are carried out regularly on appropriate test results to confirm that all processes are performing within the specified tolerances.

(h) Adequate procedures are planned for corrective action in the event that quality checks show that performance is not satisfactory.

(i) The Contractor has a senior officer with the Employer to resolve matters of quality to the satisfaction of the Employer's Representative.

(j) The Contractor has adequate facilities under the control of properly trained staff to perform the quality control duties.

The Contractor shall inform the Employer's Representative about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The Contractor shall notify the Employer's Representative for inspection and testing, at least twenty-eight (28) days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates. The Employer's Representative will decide whether he or his representative will inspect and test the material / equipment or whether he will approve it on the basis of the manufacture's certificate.

The following inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of the equipment:

**Category A:** The drawing has to be approved by the Employer's Representative before manufacture and testing. The material has to be inspected by the Employer's Representative or a third party inspecting agency approved by the Employer's Representative at the manufacturer's premise before packing and dispatching. The inspection charges of the agency will be borne by the Employer. Initially the Contractor will deposit the inspection charges and same shall be reimbursed by the Employer's Representative. The Contractor shall provide the necessary equipment and facilities for tests and the cost thereof shall be borne by the Contractor.

**Category B:** The drawings of the equipment have to be submitted and approved by the Employer's Representative prior to manufacture. The material has to be tested by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Employer's Representative before dispatching of the equipment. Notwithstanding the above, the Employer's Representative, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of the Contractor's representative.

**Category C:** Samples of the materials and/or equipment shall be submitted to the Employer's Representative for pre-construction review. Following approval by the Employer's Representative, the material may be manufactured as per the approved standards and delivered to the Site.

### 6.3. Conditions for Supply and Inspections

For material/equipment under Category "A" and "B", the Employer's Representative will provide an authorization for packing and shipping after inspection.

The testing and approval for dispatching shall not relieve the Contractor from his obligations for satisfactory performance of the System.

The Employer or his duly authorized representative shall have access to the Contractor/Manufacturer's premises at suitable time to inspect and examine inspections (including testing for chemical analysis and physical properties) the material and workmanship of the material, plant and equipment during manufacture.

The Contractor will be responsible for obtaining permission for it at the manufacture's premise. The testing will be carried out by the Contractor/Manufacturer and certificates submitted to the Employer's Representative, who will have the right to witness or inspect the above mentioned inspection/testing at any stage desired by him. The Contractor shall forward to the Employer 3 Nos. duly certified copies of the Test Certificates and Characteristics Performance Curves for all Equipment.

If any material or any part of the works fails to pass any inspection/test, the Contractor shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice. Any fault or short coming found during any inspection or test shall be rectified to the satisfaction of the Employer's Representative without any extra cost before proceeding with further inspection or wiring of that item. Any circuit previously tested, which may have been affected by the rectifications work shall be retested.

Where the Plant and Equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit at the Maker's works.

Neither the Inspection / Testing of the material or any part of the works, nor the attendance by the Employer's Representative(s), nor the issue of any Inspection Test Certificate shall relieve the Contractor from the responsibilities under the Contract.

The Test Equipment, Meters, Instruments etc., used for testing shall be calibrated at Recognized Test Laboratories at regular intervals and valid certificates shall be made available to the Employer's

## 6.4. Category of Inspection

The categorization of the various material, equipment and plant for purpose of inspections is as below. However this list can be altered and additions or subtractions done or categories changed in due course during the implementation of the Contract by the Employer's Representative.

### 6.4.1. Mechanical and Instrumentation Work

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| **A)** | **Mechanical Works** | |
| 1. | Sewage pumps | Category A |
| 2. | Sluice Valves with / without Actuators | Category A |
| 3. | Butterfly valve with the actuator | Category A |
| 4. | Non-Return Valves | Category A |
| 5. | Pipes / specials above 300mm | Category A |
| 6. | Sluice gates | Category A |
| 7. | E.O.T Crane | Category A |
| 8. | Air vessel | Category A |
| 9. | Air compressor | Category A |
| 10. | Chlorinator | Category A |
| 11. | Motor above 75 kW | Category A |
| 12. | Motor below 75 kW | Category B |
| 13. | Cooling water pumps | Category B |
| 14. | Lubricating water pumps | Category B |
| 15. | M.O.T Crane | Category B |
| 16. | Blower | Category B |
| 17. | Metallic bellows, Expansion Joints and Dismantling joints | Category A |
| 18. | Air washers | Category B |
| 19. | Air Valves | Category B |
| 20. | Drain and dewatering Pump sets | Category B |
| 21. | Pipe Work 300mm and below | Category B |
| 22. | Exhaust Fans | Category B |
| 23. | Portable Fire Extinguisher | Category B |

| | | |
|---|---|---|
| 24. | Air Conditioners | Category B |
| **B)** | **Instrumentation Works** | |
| 1. | Instrument Control Panel comprising of PLC system, digital indicators, digital flow indicator and integrator, alarm annunciator, pushbuttons etc. | Category A |
| 2. | Local SCADA Systems (Integrated testing with PLC system) for Raw Sewage Pumping Stations and Treated Water Pumping Stations | Category A |
| 3. | Temperature scanners | Category A |
| 4. | Flow switches | Category A |
| 5. | Digital panel meters | Category A |
| 6. | Conductivity level switches | Category A |
| 7. | Control panel for surge protection system | Category A |
| 8. | Filter consoles | Category A |
| 9. | Full Bore Electromagnetic Flow meters | Category A |
| 10. | Dosing control panel | Category A |
| 11. | Pressure Switches | Category B |
| 12. | Differential pressure switches | Category B |
| 13. | Ultrasonic level measuring systems | Category B |
| 14. | Ultrasonic flow meter | Category B |
| 15. | Float type Level Switches | Category B |
| 16. | Instrumentation and Control câbles | Category B |
| 17. | Battery and Battery Charger Panel | Category B |
| 18. | Surge Protection Devices | Category B |
| 19. | Radar type level meter | Category B |
| 20. | Pressure transmitter | Category B |
| 21. | Flow indicator and integrator | Category B |
| 22. | Alarm Annunciator | Category B |
| 23. | Motorised Actuators for valves | Category B |
| 24. | Chlorine dosing control panel | Category B |
| 25. | Open channel flow meter | Category B |
| 26. | Turbidity meters | Category B |
| 27. | Residual chlorine meter | Category B |
| 28. | PH meter | Category B |
| 29. | Laboratory instruments and equipment | Category B |
| 30. | Pressure Gauges | Category B |
| 31. | Portable temperature monitor | Category B |
| 32. | Portable sound level meter | Category B |
| 33. | Portable vibration meter | Category B |

### 6.4.2. Electrical Works

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| 1. | HV Outdoor Current Transformer | Category A |
| 2. | HV Outdoor Switch Disconnector / Isolator | Category A |
| 3. | HV Outdoor Lightning Arrester | Category A |
| 4. | Gantry/ Structure for Switchyard/ Transmission Line | Category A |
| 5. | Transformer (including OLTC, RTCC panel) | Category A |
| 6. | MV and LV Capacitors | Category A |
| 7. | HV, MV and LV switchboards | Category A |
| 8. | LV Variable Frequency Drive | Category A |
| 9. | Reactance Starter for MV motors | Category A |
| 10. | Battery and Battery Charger and DCDB | Category A |
| 11. | EPABX System | Category A |

| | | |
|---|---|---|
| 12. | Cathodic protection- Transformer/ Rectifier (T/ R) units | Category A |
| 13. | Outdoor 33kV accessories for substation (i.e. Fuse, ACSR Conductor, Clamps and connectors, hardwares, | Category B |
| 14. | Cathodic Protection equipment other than T/ R units | Category B |
| 15. | Neutral Grounding Resistor | Category B |
| 16. | Sub-Distribution Boards, Lighting Panels | Category B |
| 17. | Lighting System | Category B |
| 18. | VHF Communication System | Category B |
| 19. | UPS System | Category B |
| 20. | HV, MV and LV Power and Control Cables | Category B |
| 21. | MV/LV Cable Termination | Category B |
| 22. | Laptop Computers | Category B |
| 23. | Printers | Category B |
| 24. | Earthing System | Category B |
| 25. | Local Push Buttons | Category C |
| 26. | Cable tray and accessories | Category B |

### 6.5. Manufacturer's Works Acceptance Tests

The Contractor shall carry out following minimum specified tests of Equipment prior to acceptance of the instrument / materials and as indicated in corresponding sub sections:

Material Certificates for all the specified material.
Welding Qualifications
Dimension Checking
Stage Inspections (in process inspection)
Dynamic balancing for all rotating parts
Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable
Operation check
Liquid penetrant tests or magnetic particle tests for all machined surfaces of pressure parts.
Ultrasonic test for forging materials viz.,
Plates of thickness 20mm and above for pressed / formed parts such as heads, etc.
Plates, flanges and bars of thickness / diameter 40mm and above used for fabrication of pressure and load bearing members and rotating parts.
Radiographic testing for all but welded parts, as per applicable codes.
Hardness tests for all Hardened surfaces.
Type, routine and acceptance test, as applicable

The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

Testing and Inspection shall be carried out at the manufacturer's works in accordance with the Specifications as prescribed in relevant BIS. The Contractor shall in addition to any obligations under the Conditions of Contract inform the Employer's duly appointed designated representative of the date when the Plant and Equipment will be ready for inspection and to witness the testing.

## 7. LABORATORY

The Contractor is required to establish a field laboratory for ensuring the timely inspection of the material and works. The laboratory will be equipped with testing facilities sufficient to cope with the requirements of the tests to be conducted on site. It should have at least the following equipment which may be supplemented with additional equipment as may be found necessary by the Employer's Representative/Contractor.

The Test Equipment, meters, instruments etc., used for testing shall be calibrated at Recognized Test Laboratories at regular intervals and valid certificates shall be made available to the Employer's

Representative. The calibration certificates should be produced in advance for the approval of the Employer's Representative and if necessary they shall be got recalibrated or substituted before commencement of the tests.

**List of Minimum Laboratory Equipment during Construction**

| S.No. | General |
|---|---|
| 1. | Oven -Electrically operated, thermostatically controlled, range up to 2000°C sensitivity 1°C |
| 2. | Platform balance 300 kg capacity |
| 3. | Balance 20 kg capacity-self indicating type |
| 4. | Electronic Balance 5 kg capacity accuracy 0.5 gm |
| 5. | Water bath-electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1°C |
| 6. | Thermometers: Mercury-in-glass thermometer range 0° to 250°C<br>Mercury-in-steel thermometer with 30 cm stem, range upto 300°C |
| 7. | Kerosene or gas stove or electric hot plate |
| 8. | Glasswares, spatulas, wire gauzes, steel scales, measuring tape, casseroles, karahis, enamelled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools like pickaxes, shovels etc. |
| 9. | Set of IS sieves with lid and pan: 450 mm diameter:<br>63 mm, 53 mm, 37.5 mm, 26.5 mm, 13.2 mm, 9.5 .mm, 6.7 mm and 4.75 mm size |
| 10. | Set of IS sieves with lid and pan: 200 mm diameter: 2.36 mm, 2.0 mm, 1.18 mm, 600 micron, 425 micron, 300 micron, 150 micron, and 75 micron |
| 11. | Water testing kit |
| 12. | Hydrometer |
| 13. | Gauges to measure diameter of pipe |
| 14. | Total station equipment |
| 15. | Measuring tape, Vernier scale, Concrete cubes, vibrating platform, tools and tackles |
| 16. | Core drilling equipment |
| 17. | First aid box |
| | **For soils and aggregates** |
| 1. | Riffle Box |
| 2. | Liquid and plastic limits determination apparatus |
| 3. | Compaction Test Equipment both 2.5 kg and 4.5 kg rammers with light and heavy compaction arrangement |
| 4. | Dry Bulk Density Test apparatus (sand pouring cylinder, tray, can etc.) complete |
| 5. | Speedy Moisture Meter complete with chemicals |
| 6. | Post -hole Auger with extensions |
| 7. | Core cutter apparatus 10 cm dia, 10/15 cm height, complete with dolly, rammer etc. |
| 8. | Aggregate Impact Value Test apparatus/Los Angeles Abrasion Test apparatus |
| 9. | Flakiness and Elongation Test Gauges |
| 10. | Standard measures of 30, 15 and 3 liters capacity along with standard tamping rod |
| 11. | California Bearing Ratio test apparatus |
| 12. | Unconfined compression test apparatus |
| | **For Cement and cement concrete** |
| 1. | Apparatus for testing setting times |
| 2. | Slump testing apparatus |
| 3. | Needle Vibrator and plate vibrators |
| 4. | Vibrating hammer for vibrating dry mix as for Dry Lean Cement concrete sub-base |
| | **For Pumps** |
| 1. | Portable Temperature Measuring Equipment |
| 2. | Portable Sound Measuring Equipment |
| 3. | Portable Vibration Measuring Equipment |
| 4. | Illumination Measuring Equipment |
| 5. | Portable Tachometer |
| | **For Electrical Works** |
| 1. | Earth Megger (Electrically Operated) |
| 2. | Digital Multi-meter |
| 3. | Tongue Tester (with current and voltage measurement provisions) |
| 4. | Insulating Oil tester |
| 5. | Electronic Stop Watch |
| | **For bitumen and bituminous mixes** |
| 1. | Penetrometer with standard needles |
| 2. | Centrifuge type bitumen extractor, hand operated, complete with petrol/commercial benzene |
| 3. | Marshall stability test apparatus, complete with all accessories |
| 4. | Field density bottle along with cutting tray, chisel, hammer and standard sand |

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|---|---|
| 5. | 3 m straight edge |
| 6. | Camber board |
| 7. | Core cutting machine with 10 cm dia diamond cutting edge |
| 8. | Vacuum pump and 3 specific gravity bottles |