



## **::GUJARAT HIRA BOURSE::**

**Gem & Jewellery Park, Ichchhapore, Surat.**

### **TENDER DOCUMENTS FOR**

**DESIGN, CONSTRUCTION, TESTING AND COMMISSIONING OF 10  
MLD CAPACITY WATER TREATMENT PLANT AT VILLAGE  
ICHCHHAPORE, TALUKA: CHORYASI, DIST: SURAT ON TURNKEY  
BASIS**

### **Volume-II**

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## **CHAPTER - I**

### **SCOPE OF WORK**

#### **1. General :**

The M/s.Gujarat Hira Bourse, SURAT has proposed to install 10 MLD capacity Water Treatment Plant at Ichchhapore, Tal: Choryasi, Dist: SURAT.

The average R.L. of ground level is 49.20 m and T.W.L. of clear water sump is 49.700m shall be consider for hydraulic design of Water Treatment Plant. The distance between filter bed outlet chamber to the clear water sump shall be considered approximately 10m.The plot area and soil investigation report is attached with tender document.

The scope of work will be in general but not limited to civil, mechanical, electrical, instrumentation interconnecting pipes works and the design, construction, testing, trial runs, commissioning and guaranteeing of 10 MLD Capacity Water Treatment Plant on turnkey basis at Ichchhapore, Tal: Choryasi, Dist: SURAT as per detailed technical specifications and data sheets. The provision of additional 10 MLD WTP for future requirement shall be made in the proposed Layout.

#### **2. The brief scope of work for 10 MLD Water Treatment Plant shall be as follows :**

- ❖ Design and detailed engineering of 10 MLD capacity Treatment plant including preparation of Layout plan, Hydraulic Flow Diagram, P & I Diagram & all detailed drawings of civil, mechanical, electrical, instrumentations.
- ❖ Submission of all detailed drawings, structural drawings design calculations etc.
- ❖ Clearing the site :  
The plot is free from debries and is levelled. Only cleaning of shrubbs would require.
- ❖ Making provision for RCC Stilling Chamber of capacity 10 MLD, with drainage arrangement with valves.
- ❖ Ultrasonic LOH/ROF shall be provided on each filter bed to measure loss of head and rate of flow with local indication. The instantaneous and totalized flow of each filter bed shall be displayed at PLC HMI.
- ❖ Ultrasonic insertion type flow meters with local and remote indication shall be provided at raw water inlet pipe and at treated outlet pipe to measure incoming and treated water flow. The instrument shall transmit 4-20 mA signals to PLC panel. The instantaneous and totalized flow shall be displayed on the PLC HMI.
- ❖ Ultrasonic level switches shall be provided on Dirty Water Sump for auto pump operation in interlock with the level of water. High and low alarms shall be annunciated at PLC HMI.

- ❖ Ultrasonic level transmitter shall be provided on Backwash water tank for auto backwash water feed pump operation. The auto ON/OFF of pumps corresponding to the tank level shall be accomplished by PLC and high and low alarms shall be annunciated at PLC HMI.
- ❖ Float Buoyancy type level switch shall be provided on the PAC dosing tank for auto pump operation corresponding to the tank level. The pump shall be operated from PLC Panel automatically depending on the level in the tank.
- ❖ Pressure Switch shall be provided on each air blower for auto ON/OFF operation. The high and low alarm shall be annunciated on the PLC HMI.
- ❖ Provision of 2 Nos.(1 W+1 S) Vacuum type chlorinators for pre and post chlorination purpose. The capacity of Chlorinator shall be 5.0 Kg/hr. The 2 Nos. (1 W + 1 S) Horizontal Centrifugal type Chlorine Booster pumps having material of construction CI with motors of suitable capacity will be provided by the contractor.
- ❖ Two Nos. Sludge Blanket Lamella Clarifier Units with surface loading of  $4.5 \text{ M}^3/\text{M}^2/\text{hr}$  capacity provided for 10 MLD with free board 500 mm. The Material of construction shall be RCC M25. The unit shall be provided with PVC Tube Modules.
- ❖ Chemical House with following facilities shall be provided for total area of 100 M<sup>2</sup> (G.F. + F.F). The chemical house will accommodate Alum Storage and Dosing Tanks, Blowers and Chlorination System.
- ❖ Filter House consisting of 4 Nos. of Filter Beds (Two Twins) each of declining rate type rapid gravity sand filters, having an arrangement of PVC/PP nozzles in false slab along with allied system. The filtration rate shall be  $6 \text{ M}^3/\text{M}^2/\text{hr}$ . The Loss of Head and Rate of Flow Indicator shall be provided for Twin Sets. For Backwash, tank of 350 M<sup>3</sup> shall be provided.
- ❖ Suitable piping shall be provided by the contractor.
- ❖ Two Nos. of PAC Solution Tanks of required size with Inside Epoxy lining to be provided with the necessary piping works and Agitators. The Agitators shall be turbine type its SS-304 MOC and speed of Agitators shall be 30-60 RPM.
- ❖ Drainage system to discharge chemical sludge shall be provided. The sludge as well as filter backwash shall be collected in 200 M<sup>3</sup> capacity RCC Dirty Water Sump from where it will be pumped to Stilling Chamber and bypass line to be connected to the nearest storm water drain. Two Nos.(1 W + 1S) Centrifugal Non-clog Pumps of 20 M<sup>3</sup>/hr capacity with 13 M head with CI in construction shall be provided.
- ❖ All interconnecting piping, channels, launders, valves, specials etc. within water treatment plant battery limits.

- ❖ Painting and coloring of pipelines, steel structures operating platforms, ladders, hand railings, rungs etc. with sand blasting, one coat of epoxy primer and 2 coats of epoxy paint.
- ❖ All the lighting system in plant and building of water treatment plant including supply of all the materials.
- ❖ Complete earthing system including supply of all materials.
- ❖ Complete cabling system including supply of cable, cable laying, cable racks, cable trays conduit, pipe and necessary clamping and support hardware. [As far as possible cable shall be laid in underground covered with layer of sand and bricks.
- ❖ Provision of M.C.C. panel located within the chemical house
- ❖ Hydraulic testing of all water retaining structures before applying the plastering. After completion of hydraulic test all R.C.C./ brick works should be plastered (inside and outside).
- ❖ After Mechanical completion the Testing and Commissioning of plant shall be carried out for a period of Three months. Six sets of Operation & Maintenance Manual and all As Built drawings with One set of Reproducible shall be submitted.
- ❖ Providing all Instruments as per design criteria.

The contractor is required to give test report and submit the same to Electrical Inspector for complete Electrical works done by the Contractor. Any other item [s] of work not specifically listed above but required for completeness of the scope envisaged in this tender. All the necessary arrangements for the completion of Electrical, Mechanical, Instrumentation and Interconnecting Piping works along with the civil works shall be carried out.

**3. Preparation of site :**

The site is free from obstacles like trees, old structures or such items. Preliminary cleaning, removing, shrubs etc shall be in Contractor's Scope.

**4. Terminal Points :**

Extension cable up to MCC shall be supplied and laying by M/s.Gujarat Hira Bourse.

**5. Submission by Contractor ;**

The Contractor shall submit the following for approval of M/s.Gujarat Hira Bourse.

- a] Planning (General layout to the scale) of 10 MLD Capacity water treatment.

- b] Hydraulic design and flow diagram.
  - c] Hydraulic design calculation.
  - d] Detailed progress bar chart and report showing physical and financial achievement at every first of calendar month.
  - e] Detailed planning of all units considering the required capacity.
  - f] Detailed Design Calculation, structural detailed drawings, working drawings etc. for all units of treatment scheme.
  - g] Detail piping and instrument or engineering flow diagram for process and utility showing all equipments, machinery piping and instrumentation. All piping should be indicated with diameter material of construction, pipe class, pipe number and fluid flowing through it.
  - h] Detail installation drawing for mechanical equipments and other instruments.
  - i] Electrical design of the system.
  - j] Light fitting layout and wiring diagrams, earthing layout etc.
  - k] Data and guaranteed power consumption for the water treatment plant and treatment scheme units.
  - l] Equipment data sheet.
  - m] Detailed bill of material as per the requirement of the M/s.Gujarat Hira Bourse
  - n] Any other drawing insisted by the Developer.
  - n] Details of plant interconnecting pipe network along with supports etc.
  - o] During commissioning of the plant the contractor shall submit draft copies of Instruction manual for operation and maintenance of the various treatment scheme units giving analytical procedures for various parameters, technical literature, leaflet, wiring diagram etc. On approval and amending the same as per plant conditions, the contractor shall submit ten copies of final Instruction Manual in proper binding, giving details of plant also.
6. M/s.Gujarat Hira Bourse 's Engineer in Charge it's Technical Committee Members or his authorized inspecting agency(TPI) reserves the right to inspect the work of the contractor and satisfy himself about the quality of materials used for the work.

7. Safety :

All the safety and factory rules shall be strictly followed. The contractor is fully responsible for the safety of his staff and workmen and must equip them with safety appliances and tools.

**8. Time Schedule :**

8.1. The work shall be executed strictly as per the time schedule/bar chart submitted and as agreed upon along with offer. The entire project has to be completed within a period of 12 (Twelve) months from the date of commencement of order. The time period of completion shall be reckoned from the date of notification of award of work. The bidder shall have to submit a detailed PERT/BAR chart network, with the time frame consisting adequate number of contractual activities covering key phases of the works such as design, drawing approval procurement, manufacturing, testing, construction and field erection activities.

**8.2. Penalty for delay :**

The Contractor is bound to complete the work as per the sanctioned schedule of work/bar chart. The contractor shall have to submit the progress report with physical and financial achievement at every first of calendar month. If the contractor fails to complete the whole project by the stipulated completion date then penalty shall be applicable against late completion at a rate of half percent per week subject to maximum of 10% of the Contract Value.

**9. Scope of Supply of Material :**

**a] Supply of Material :**

All materials, testing appliances, tools, tackles & spares etc. necessary for the successful execution & completion and till plant handing over to M/s.Gujarat Hira Bourse shall be procured and provided by the tenderer. No material will be supplied by the Developer **except cement and steel.**

**b] Water :**

Contractor shall have to make his own arrangement for water required for construction, testing and for his labour/employees too.

**c] Power :**

Electrical power for construction purpose shall be in Tenderer's scope including energy consumption.

Electrical power of adequate capacity for operation & maintenance at a single point shall be in Developer's scope including energy consumptions.

**d] Cement :**

Cement required for the construction, erection works shall be purchased by the Developer. As per site datas, PPC cement confirming to IS 1489:1991 PI is approved of Ambuja or Ultratech make. A wastage of 3% (max) shall be allowed. Wastage exceeding the above limit, bidder shall be charged as per GC-58.

**e] Steel :**

All reinforcement and structural/mild steel required for construction, erection and other

allied job shall be purchased by the Developer. A wastage of 5% (max) wastage shall be allowed. Scrap steel shall be deposited with Developer at reconciliation stages. Contractor should quote the rates as per price mentioned for cement & steel as per GC-58.

f] Chemical and Consumables :

Only PAC , Chlorine and poly (if required) will be supplied free of charge by M/s.Gujarat Hira Bourse during testing, commissioning and till handing over the system to M/s.Gujarat Hira Bourse All other consumable items and arrangements shall have to be arranged by the contractor at his cost.

10. Construction of Stores and Site Office :

Suitable vacant areas will be allocated by the M/s.Gujarat Hira Bourse to the Contractor to build storages for storing his equipments, plant, materials etc. and also to build his site offices. The contractor will be solely responsible for watching and guarding of his stores, offices etc. The contractor shall cover all his equipments and materials at site with requisite insurance against theft, larceny, dacoit, fire tempest, flood, earthquake etc. It will be the contractor's responsibility till handing over the plant after satisfactory completion of trial run. Even if part/ full payment is released against supply/installation /commissioning. On completion of the works undertaken by the contractor, he shall remove all temporary works erected by him and have the site cleaned as directed by the Engineer. The M/s.Gujarat Hira Bourse reserves the right to ask the contractor any time during the tendency of the Contract to vacate the land by giving 7 day's notice on security reasons or on national interest or otherwise.

11. Labour and Supervisory Camps :

Open land will be provided by the M/s.Gujarat Hira Bourse to the Contractor for constructing his labour and supervisory camps and other service facility. Contractor shall make his own arrangements outside the plant boundary.

12. Construction Equipment :

The Contractor shall make his own arrangement to procure all constructional plant and equipments for his own. He shall also state the type and number of different equipments with their capacities in good working conditions which he will use on the site to ensure completion of the work in the specified time. All materials, construction plants and equipments once brought by the contractor to the site are not to be removed from there without the written permission of the Engineer-in-charge. Also, the Contractor shall have adequate stock of spare parts for the equipment on the site and work shall not be delayed on this account. Similarly all temporary works built by the Contractor for the main construction undertaken by him, are not to be dismantled and removed without the written authority of the Engineer-in-charge.

13. Co-operation with other Contractors :

The contractor shall execute his work in phased manner as directed by the Engineer from time to time so as not to obstruct or retard the work being executed simultaneously by other agencies.

**14. Safety :**

14.1. The Contractor shall be responsible for provision of safety arrangements & protective clothing for all persons/employees on the site whether or not engaged in actual operation or supervision. The Contractor shall also be responsible for safety arrangements of all equipment used for construction and shall employ trained workmen conversant with safety regulation. The contractor shall use only tested equipment and tools and shall periodically renew tests to the satisfaction of the

Engineer. All test certificates shall be made available to the Engineer at the site of the work. If at any time, in the opinion of the Engineer, this provision is not complied with, the contractor shall forthwith replace such equipment and tools.

14.2. The contractor shall display notices and arrange proper fencing at such places where hazardous work is being carried out. The contractor shall provide at his own expense on the works to the satisfaction of the Engineer at such places, proper and sufficient fire fighting, first aid appliances etc. which shall at all times be available for use.

**15. Coverage of Contractor :**

The Contract for the work is a complete one for labour, material and workmanship with contractor's overhead and profit including all temporary works and the provision and use of all construction equipments, tools, tackles, etc.

The contractor shall make his own arrangements for all the materials and equipments required for the due performance of the contract. Except where it is explicitly provided that the cost will be borne by M/s.Gujarat Hira Bourse, the various obligations of the contractor under contract shall be at the cost of the contractor.

**16. Plant Guarantee/Warranty :**

The contractor shall guarantee the performance of the complete water treatment plant as per the scheme shown in Hydraulic flow diagram & layout. The equipments supplied under this tender shall be guaranteed for a period of 12 months from the date of successful completion of three months trial run, commissioning and performance test, against defects in civil, mechanical, electrical & instrumentation with regard to design, materials and workmanship. Any defects found within the guarantee period shall be made good by the Contractor at his cost immediately on receipt of intimation from M/s.Gujarat Hira Bourse in writing.

**17. Mechanical Guarantee :**

Mechanical Guarantee for the entire equipment part shall be for the period as stipulated above.

a] In the event of failure of any particular part of the equipment (excluding fast wearing parts)



more than two times during the guarantee period, it shall not be repaired but the complete part shall be replaced by the tenderer and the guarantee for the particular part shall be extended by one year from the date of last replacement.

b] In case it is found that above mentioned failure is due to some connected part of the equipment, that part shall also be rectified or replaced by the tenderer to avoid such failure in future and similar guarantee shall be offered by the tenderer for this also. c] In the event of failure of any particular equipment which fails more than two times during the guarantee period, the tenderer shall have to replace this equipment with another equivalent make as approved by the M/s.Gujarat Hira Bourse and manufacturer's guarantee shall be kept valid.

**18. Performance Guarantee :**

The tenderer shall give a guarantee for a period of one year from the date of successful completion of commissioning after completion of 3 months trial run period for the treatment plant against defective materials and or workmanship. Any defects found in the workmanship or materials used supplied by the tenderer will be rectified by the contractor at his own expenses, within the time specified by the Engineer-in-charge.

The tenderer shall start and commission the plant and prove that it is giving satisfactory service and desired characteristics of treated water continuously for three months before handing over the plant to Developer at his own cost. During this start up and commissioning period, the tenderer shall also have to give guarantee for the standard quality of the treated water to meet all the applicable requirements given in the tender documents. If contractor fails to achieve the performance of the plant with respect to quality of treated water and power as well as chemical consumption as per the guarantee data sheets then Penalty shall be applicable at a rate of 0.5% of the Contract Value per week of delay in completion and handing over the work. However, total penalty due to late completion or non achievement of performance shall be subject to maximum of 10% of the Contract Value.

The Contractor shall, during operation & maintenance period, submit a fresh Performance Guarantee of 25% of initial PBG. This shall be valid till satisfactory completion of the operation & maintenance period.

**19. Inspection :**

a] All fabrication, manufactured items, equipments, motors, gears, switches etc. shall be subjected to inspection and tests as per the relevant standard at the manufacturer's works before despatch. Tenderer shall give notice of two weeks to the Engineer-in-charge who may depute his representatives at his option to witness such tests. It shall however, be the tenderer's responsibility to supply all materials as per specifications, standards mentioned herein.

b] All tests as required by the Engineer-in-charge either at site or at outside laboratories concerning the execution of the work and supply of materials shall be carried out by the tenderer at his own cost.

c] Tenderer shall ensure that all facilities are extended for inspection of works by the Engineer-in-charge or his representatives at any time during the period of execution of the works. The tenderer shall carry out all instructions given by the Engineer-in-charge or his representative to the entire satisfaction of the Engineer-in-charge.

d] All materials to be used by the tenderer shall be of approved quality and make. The tenderer shall submit the list and makes of materials he intends to use, unless otherwise specified and obtain the prior approval of the Engineer-in-charge. Any material found to be of inferior quality/make other than approved make or unsuitable for the purpose will be rejected by the Engineer-in-charge and the tenderer shall replace at his own cost, the decision of Engineer-in-charge in such event shall be final and binding.

e] Inspection and acceptance by the Engineer-in-charge shall not relieve the tenderer from any of the responsibilities/obligations under the contract.

**20. Testing and Commissioning :**

a] The tenderer shall have to test such equipment used for the plant for continuous running of atleast 72 hours. After testing the individual equipment, the tenderer shall commission and run the whole plant for atleast three months as directed by the Engineer-in-charge. Any defects found in design, workmanship or in any of the equipment supplied by the tenderer shall be rectified by the tenderer at his own cost within a reasonable time to be decided by the Engineer-in-charge. Beyond this period suitable penalty shall be levied and the plant shall be tested again for faultless running of three months to the entire satisfaction of the Engineer-in-charge. All the skilled/ unskilled labour, oil, grease, spares and all other consumable items and other arrangement shall have to arranged by the Contractor at his cost during the testing, commissioning and till handing over the system to M/s.Gujarat Hira Bourse Only Alum and chlorine will be supplied free of charge by M/s.Gujarat Hira Bourse From the commencement date of continuous running of 72 hrs. testing, M/s.Gujarat Hira Bourse will supply electric power free of cost.

b] During the period of testing and commissioning the tenderer shall make available at site experienced personnel including chemist for operating the treatment system. They shall impart adequate training to the staff deputed by M/s.Gujarat Hira Bourse so as to enable them to efficiently handle the operation and maintenance of the system. Six copies of operation manual detailing the function of all the civil, mechanical electrical, units and instruments, operation, routine maintenance, and preventative maintenance shall be supplied before trial run of the water treatment plant.

**21. Chemicals, Reagents & Power :**

Tenderer should furnish specifications, source of supply, mode of transport, storage and handing, current market rates for project site of recommended manufacturer of the chemicals, reagents required for the process. The annual consumption of the chemicals for the normal working of the plant must be guaranteed in the tender. The tenderer must also give

guaranteed power consumption in the tender.

**22. Royalties :**

Royalties for the construction materials i.e. Sand, Stone, aggregates, Rubble, murrum, gravel as specified from time to time by the State Government shall be paid by the contractor. All ruling regulations have to be strictly adhered to.

**23. Guidelines to be followed at work site :**

23.1. All the items occurring in the work and as found necessary during actual execution shall be carried out in the best engineering manner/practice as per specifications and as directed by the Engineer-in-charge.

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

23.3. The Contractor shall engage qualified Engineer for the execution of work who will remain present for all the times on site and will receive instructions and orders from the Engineer-in-charge or his authorized representatives. The instructions and orders given to the contractor's representative on site shall be considered as if given to the contractor himself.

23.4. A work order book as prescribed shall be maintained on the site of the work by the contractor and the contractor shall sign the orders given by the inspecting officers and shall carry them out promptly.

23.5. Figured dimensions of drawings shall supercede measurements by scale. Special dimensions or directions in the specifications shall supercede all other dimensions.

23.6. All levels on drawings are for general guidance and the contractor shall be responsible to take regularly levels at the site before actually starting the work. The level shall be connected to the G.T.S. levels and shall be got approved from the Engineer-in-charge.

23.7. If the arrangement for temporary drainage is required to be made during any work of this contract, this shall be made by the contractor without claiming any extra cost.

**24. Instruction Manual for Operation & Maintenance:**

The contractor shall submit in duplicate draft operational and maintenance manual for all the process units including for equipments and instruments. The manual shall include details such as objectives, pre-commissioning instructions as well as detailed operational aspects and instructions on start up, normal operation and shut down procedure for treatment plant units including analytical methods to be adopted at various stages of monitoring treatment plant to achieve desired results. The detailed characteristics of various supplied equipments shall be part of manual. The necessary detailed drawings such as plant layout, hydraulic flow

diagram and P & I diagram shall be also enclosed. The approved Operation & Maintenance manual shall be finally submitted in Ten sets in proper binding giving various above details also incorporating all details and co flow diagram and P & I diagram shall be also enclosed.

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GENERAL MANAGER (TECH & ADMN)  
M/S.GUJARAT HIRA BOURSE

Signature and seal of Contractor :-

Name :-

Address:-

Date :-

## CHAPTER-II

### PROCESS DESCRIPTION AND DESIGN SPECIFICATION

#### 1.0 Design Basis:

- 1.1 Flow : 20 MLD
- 1<sup>st</sup> Phase : 10 MLD (In present scope)
- 2<sup>nd</sup> Phase : 10 MLD (For future – not in contractor's scope)

#### 1.2 QUALITY :

##### 1.2.1. Raw Water Characteristics

- a. Turbidity : 25 - 300 NTU
- b. pH : 7.0 to 8.0

Bidder should ascertain corrections of data prior to designing the treatment process, at his cost.

##### 1.2.2. Treated Water Quality

- a. Turbidity : Less than 1.0 NTU
- b. pH : 7.0 to 8.0
- c. Residual Chlorine : 0.2 mg/l
- d. MPN : Nil

#### 2.0 Treatment System:

**Gujarat Hira Bourse intends to adopt Water Treatment Plant based on Sludge Blanket Lamella Clarifier Method with high rate filtration.**

**Bidder shall elaborate and illustrate in detailed stagewise process cum flow descriptions with datas/charts.**

#### 2.1 Bidder can also offer Clariflocculator in place of Sludge Blanket Lamella Clarifier.

The specifications are given at 5.0.

### 3.0 Treatment Plant:

The contractor will check the existing site condition and looking to the available area of the plot, he has to prepare the layout plan. The bidder has to furnish the evidence for having satisfactory commissioned and running of such plant having the capacity matching with the proposed plant within India. The contractor shall have to prepare the most economical and efficient hydraulic design adopting the latest and proven technology & having low maintenance cost.

#### 3.1. General :

M/s.Gujarat Hira Bourse has infrastructure comprising of technical and administrative facilities for Water Treatment Plant, with defined space available for future expansions.

#### 3.2 With the quality of raw water available from the Canal, the mode of treatment be considered for treating the raw water.

Pre-chlorination in stilling chamber & Post Chlorination at the Outlet of Filters. The Residual chlorine at outlet will be minimum 0.5 mg/litre.

#### 3.3 Treated Water Quality :

The clarified water turbidity should not exceed 12 NTU under all condition of raw water. Filtered water shall satisfy the following standards:

- |                      |   |  |
|----------------------|---|--|
| a] Turbidity         | : | less than 1.0 NTU  |
| b] Colour            | : | 5 $\mu$ in.t   |
| c] Taste & odour     | : | Unobjectionable  |
| d] pH Value          | : | 7.0 to 8.0   |
| e] Bacterial quality | : | The M P N Index of Coliform bacteria should be Zero or less than 1.00. None of the samples should contain M P N of coliform exceeding 10 per 100 ml. Regarding bacteriological quality of individual and occasional samples the criteria as given in the latest edition of Manual on water supply & treatment published by Government of India, ministry of works & Housing shall be followed. |
| f] Residual Chlorine | : | 0.2 mg/l.  |

#### 3.4. Guarantee of Purification:

The tenderer shall give guarantee for the degree of purification as specified in details above. To establish the quality of filtrate and performance of other units as specified above, the tenderer shall have to arrange for taking samples and send them to recognized laboratory

and get the raw, clarified, and filtered water samples analyzed for physical, chemical and bacteriological qualities of all the three raw clarified and filtered water. The tests are to be taken by the tenderer at his cost during the period of test run of the plant. The contractor shall undertake to run and maintain the whole plant under actual working conditions for a period of 3 months from the date of completion in all respect and shall deliver filtered water from the plant during the above maintenance period. Raw water shall be supplied by the Department free of cost for this purpose.

All the skilled and unskilled labour oil, grease, spares and other consumable items etc. required to be incurred during trial run period of 3 Months from the date of completion in all respect shall be borne by the Contractor but only PAC and chlorine will be supplied free of charge by M/s.Gujarat Hira Bourse during testing, commissioning and till handing over system to M/s.Gujarat Hira Bourse. The contractor shall also train the Developer staff to get the training so that on the expiry of the trial run period the plant can be run independently by those persons.

The commencement of three months trial running period will be counted after the satisfactory test and performance of the plant. However, if certain arrangements are not possible to be made immediately for the running of the plant the commencement of the running and maintenance period shall have to wait till all the necessary arrangements are made. In that case the Developer will intimate the Contractor after it is ready with the necessary arrangements. No claims of the contractor to compensate the delay in commencement shall be entertained because of the time lag between the completion of the plant and commencement of the maintenance period. However under such circumstance the Developer will grant necessary extension in time limit. The contractor can hand over the plant to the Developer only after the expiry of satisfactory running of the plant for 3 months after commencement of the running and maintenance period. Till then it will remain under care and possession of the contractor. The date of completion will be the date of handing over the plant to the Developer by the Contractor after period of trial run.

For the period of twelve months, after certified date of successful completion of three months trial run, the contractor shall have to give 12 month's guarantee for smooth running of the plant. During guarantee period if any component or components of mechanical equipment, or electrical, or electronic instruments and or measuring equipments or valves or pipes or specials etc. gets out of order or found to be malfunctioning the same shall have to be replaced by the contractor at his cost and for the replaced article, the guarantee period shall be twelve months from the date of re-commissioning.

#### **4.0. Specification :**

The various units shall generally conform to the tender specifications and shall be capable of accomplishing the desired results. All Items of work, civil, mechanical, Electrical, instrumentation shall be so designed and installed for capacity of 10 MLD.

Tenderers shall give detailed specifications with name plate details of various treatment units. Manufacturers details, testing/type test certificates etc shall be submitted.

### **Specifications of various treatment units :**

#### **4.1 Stilling Chamber :**

The contractor shall have to construct a Stilling Chamber of 10 MLD capacity with necessary pre-chlorination arrangement. The retention period of Stilling Chamber is 60 sec. It shall be RCC M:25 in material of construction. The RCC Stair case and platform with railing and CI steps for inspection shall be provided in each Stilling Chambers. It shall be plaster with 12 mm thick C.M. 1:3 on inner surface and outside surface shall be applied with snowcem.

#### **4.2 Flash Mixer**

It is proposed to construct One No. Flash Mixer having capacity of 435 M<sup>3</sup>/hr. The retention time for Flash Mixer shall be 60 Sec. A minimum free board of 500 mm shall be provided. The material of construction shall be RCC. Inside finish shall be provided in C.M. 1:3. Smooth cement plaster 20 mm thick and outside finish shall be 20 mm thick Sand face plaster C.M. 1:3. Snowcem shall also be applied for finishing the outer surfaces.

The Flash Mixer Mechanism shall consists of shaft of SS-304, Turbine type Impeller of SS-304, Gear Box and drive as per the required rating.

#### **4.3 PAC Dosing Equipment :**

Providing and erecting PAC dosing equipment for proposed 10 MLD capacity Water Treatment Plant located at the first floor of chemical house. Dosing mechanism shall be capable of requisite feed of PAC so as to ensure desired quality of treated water. Arrangements shall be made for PAC feed so as to take care of the quantity and quality of raw water and dosing pipes to the fullest extent to get the desired solution strength. The inside walls of PAC tanks shall be given epoxy lining.

The Contractor shall have to provide and erect the chemical dosing tanks with necessary mechanical-electrical arrangement. The dosing shall be done in stilling chamber by gravity. The dose of PAC shall be determined by the contractor by carrying out required for tests and all units designed such as tanks, dosing tanks, stirrer, constant head dosing box, dozer piping work etc. The contractor shall indicate in his offer the maximum dose of PAC to be used for treatment during maximum turbidity period.

PAC dosing tanks shall be provided with suitable float and board level indicator to be mounted locally. The dilution & homogenate of the PAC may be affected by means of Turbine type agitator with gear box having stainless steel (S.S.304) shaft and blades. Epoxy lining should be provided over 20 mm thick smooth cement plaster C.M. 1:3 inside the proposed RCC tanks and 20 mm thick sand face plaster with snowcem should be provided outside the proposed tanks. Moreover the proposed tanks shall be connected by RCC walkway with G.I.



railing.

#### **4.4 Sludge Blanket Lamella Clarifier**

The contractor shall have to provide and construct the Sludge Blanket Lamella Clarifier portion having vertical sides and the flat bottom. The main object of this unit shall be to create and maintain a condition of agitation suitable for initial flocculation which shall be completed within the sludge blanket. It shall remove turbidity from the raw water.

After flash mixing the raw water shall be taken to the sludge blanket lamella clarifier for removal of turbidity due to suspended solids. In the sludge blanket clarifier, the incoming water shall be delivered near the bottom of the tank through inlet piping system.

The water rises at a steadily decreasing velocity through suspended particles which shall be allowed to accumulate in clarifier zone. This accumulation leads to the formation of the sludge blanket composed of particles which shall be capable of maintaining their position against the upper velocity of the water because they have been in the clarifier for a period during which their size has grown due to contact with other particles of coagulated matters moving upward with water. The water emerging from the sludge blanket passes up through the straight portion of the clarifier. The PVC tube modules shall be provided to reduce the area further and the clarifier water shall be collected in the clarified water troughs.

It shall be necessary to "Bleed off" a small flow of sludge through the concentrating pockets. The sludge shall be drawn from the sludge blanket zone in to the pocket and then it shall be discharged off. The main discharge pipe shall be used periodically to prevent large accumulation of sludge at the bottom of clarifier. The operation of sludge withdrawal depends on the inlet turbidity of water. The contractor shall have to make provision of mixing of Air through HDPE pipe for preventing chocking of sludge at the bottom of the unit. The clarified water will be lead to filter bed for filtration. More over the drain arrangement of sludge clarifier shall be by means of gravity as far as possible and the same should be disposed off into drain.

The base (leveling course) for RCC slab shall be of 100 mm thick PCC of M:10. The required support for C.I. inlet pipe, PVC modules shall be of R.C.C. Ribs only.

#### **4.5. Rapid Gravity Sand Filters:**

Providing & erecting Civil & Mechanical equipment for required units for Declined Rate Type Rapid Gravity Sand Filters beds complete with filter media necessary equipment including all civil structure and back wash arrangement and connecting pipe draining arrangement for 10 MLD capacity.

The tenderer shall provide 2 Twin (4 Nos.) filter beds. The rate of filtration shall be 6 M3/M2/hr normal working conditions and the tenderer shall guarantee the safe operation of the filters without any harm to the plant or change in quality of filtered water. For economy consideration the area of each filter unit of twin type should be decided. Sufficient free board(not less than 500 mm) shall be provided. The quality of filtered water: The depth of

filter box shall be between 3.5 Mt. The sizes of inlet, outlet wash water, over flow and Air pipes to be provided shall be adequate for estimated flow of 10 MLD capacity.

The pipes & gates shall be of C.I. & leak proof. Filter shall be provided with declining rate type with flow measuring device. Each filter bed shall be self contained and capable of working under full or part load independently of other. Arrangements shall be made for incoming water to be uniformly distributed between the various filters and individual on each filter bed. The filter runs should be normally not less than 24 hours with a loss of head not exceeding 2.5 M.

a) For the provision of wash water gutter and through design, sizes, spacing, minimum height above top of sand bed, level of top edge, slope of the same shall be as per criteria given in design manual on "water supply and treatment" issued by CPHEEO. For this, various factors such as expansion of sand bed, disposal of max, dirty backwash water of filter, backwash water rate etc. should be taken into account. Also hand railing should be provided to all filters to safe guard against accident as per factory Act. At the commencement of the filter run after a backwash the initial loss of head should not exceed within specified unit. Each tenderer shall specify quantity of wash water and also with their respective pressure required to wash the beds.

The valves supplied by the Contractor shall be as per vendor list only. All the filter bed valves shall be of Electrically operated butterfly type with manual arrangement.

b) The filter media to be supplied by contractor and shall be hard grained silica sand and have uniformity co-efficient not greater than 1.70 or not less than 1.30. The effective size of sand shall be between 0.45 to 0.7 mm. The depth of filter materials should be thinnest possible commensurate with safe bacteriological removal. The thickness of stratum shall be minimum 0.75 mtr.

Filter Sand :

Filter sand shall be free of clay, mica, shale, dirt, hard grained silica sand and have uniformity co-efficient not greater than 1.70 or not less than 1.30. The effective size of sand shall be between 0.45 to 0.7 mm. The depth of filter materials should be thinnest possible commensurate with safe bacteriological removal. The thickness of stratum shall be minimum 0.75 mtr.

The weight loss on contract with 2 N hydrochloric acid shall be less than 2% after 24 hours. The friability weight loss after mixing for 15 minutes [750 strokes] shall be less than 10% and for 30 minutes [1500 strokes] shall be less than 20%. The specific gravity of the sand shall not be less than 2.5.

c) Filter media and charging :

Prior to packing, all filter sand, shall be washed heat dried and sieved to conform the specified grading and be tested. Separate test certificates [in triplicate] shall be provided to the Engineer for each 20 cubic meters of media so supplied. Packing shall be in suitable approved double or triple bags to protect the media from spillage or contamination. Any sand media delivered loose or found to be split or open bags shall be rejected out rightly. Storage on site shall be only in an

approved pre-designed area, well drained and free of mud and silt. Following installation and satisfactory testing of all the filter floors and when the Engineer is satisfied that the installations are complete, the contractor will be given written permission to commence filling the filters. The contractor will set out and indicate the method of filling the media in his tender submission and specification.

Filter media shall be carefully placed and not charged by dropping, dumping, machine handling or any other method which in the opinion of the Engineer will be detrimental to the floor media, nozzles/drains or sealants. In each filter, two adjacent halves shall be charged simultaneously. Following the initial charging the filters shall be washed by the contractor. Filter beds, designed for expansion during cleaning, shall be skimmed prior to disinfections and the commissioning of the works. The filter media and supporting media shall be of the best quality and shall have to be got approved by the M/s.Gujarat Hira Bourse. The tenderer shall have to make his own arrangements to get the filtering media tested through a recognized laboratory and shall have to get it finally approved by the M/s.Gujarat Hira Bourse before use, as per standard testing procedure.

d) The under drainage system shall be of standard pattern so as to ensure required filtration rate. The strainer should be designed so as not to dislodge the filtering media when water independently introduced for washing under drainage system and materials to be used shall be of non-corrodible materials. The false floor slab (to be equipped with PVC/PP nozzles) shall be of pre-cast RCC with non corrosive slab to be prepared/manufactured on work site. Bottom of slab shall be epoxy painted. The design of pre-cast/cast in situ slab should be such that the same can withstand against pressure during backwashing. The contractor shall have to take proper care in manufacturing and placing the same in filter bed with necessary RCC supports. The PVC/PP nozzles shall be placed at equal and uniform distance so that even distribution of air/ water pressure occurs.

e) Arrangements for collecting and leading away the dirty wash water shall be so designed as to carry away the same at all depths within the reasonable time by gravity either to reuse facility or to disposal. Each tenderer shall specify the quantity of wash water required for the plant. In washing with air, the quantity of water should not exceed 2%. For air washing adequate compressed air supply facility along with necessary valves and piping shall be provided including erection and commissioning of the same.

f) The declining rate type of filters has to be provided & as such suitable electronic arrangement for measuring loss of head and rate of flow in the filter shall have to be provided by the Contractor without any extra cost for measurement of flow from each bed.

The office cum laboratory of 50 sq.m. area shall be provided on First Floor of the Filter House.

#### **4.6. Chemical House :**

Chemical house shall be provided to accommodate various facilities such as

- Chemical storage facility
- Chlorination facility with provision of storage chlorine Cylinders.
- Blower room
- PAC dosing facility
- Toilet, Soak pit, septic tank, connected drainage line with chambers.

Chemical House should be provided with ground and first floor area so as to have free excess to various facilities. Adequate lifting arrangement shall be provided at PAC dosing, chlorination, and air blower. The chemical house provided with sufficient carpet area for each facility.

Material of Construction :

|                                |   |
|--------------------------------|---|
| PCC for foundation/flooring    | : 1:3:6 (M:10)                            |
| PCC work for footings/columns/ | : M : 200                                 |
| Brick work                     | : CM 1:6                                  |
| Plastering work : inside       | : 15 mm thick CM 1:3                      |
| outside                        | : Two coated 20 mm thick sand face CM 1:3 |

|              |  |
|--------------|--|
| Doors        | : Teak Wood (Fully paneled)                |
| Windows      | : Partly paneled & partly glassed Aluminum |
| Ventilations | : Wired glass Ventilation (louvered)       |

Flooring :

|                                 |  |
|---------------------------------|--|
| Flooring of storage/blower      | : Rough kota stone chlorine room   |
| Flooring of G.E. entrance/      | : Polished Kota Stone staircase/MCC/Laboratory/<br>Office/Toilet/passage |
| Platform and others             | : White cement marble mosaic tiles flooring                              |
| Colour :                        |  |
| Inside                          | : Distemper paint of approved make and quality                           |
| Outside                         | : Snowcem : White cement marble mosaic tiles<br>flooring                 |
| Doors, Windows/Ventilation etc. | : Oil paint of approved make and quality.                                |

(i) PAC dosing tanks:

Two Nos. PAC dosing tanks are to be provided at the first floor of chemical house. The two nos. dosing tanks, having electrical, mechanical, interconnecting pipeline network for dosing shall be provided. The contractor shall have to provide epoxy lining in two tanks & required electrical, mechanical arrangement shall also be provided.

(ii) Chlorine Room: In proposed chlorine room there are Two Nos. chlorinator are to be provided with a capacity of 5.0 kg/hr. The chlorinator shall be vacuum type pressure feed. The foundations for chlorine toners shall be provided by the Contractor. The toner shall be supplied by M/s.Gujarat Hira Bourse

(iii) Chlorine Booster Pumps: The contractor shall have to provide and erect Two Nos. chlorine booster pumps. The required civil work and other allied piping arrangement is also in the scope of the present tender.

(iv) Blower Room: The contractor shall have to provide Two Nos. Air Blowers of required capacity. The required civil work and other allied piping arrangement shall be in the scope of the present tender.

4.7 Electrical Fittings : The provision of M.C.C. panel shall be made with complete electrical system for all mechanical/electrical equipment, lighting etc.

4.8 Service Water Supply : The contractor shall provide necessary distribution network along with valves, piping, taps for PAC dosing tanks.

4.9 Interconnecting Piping : All interconnecting piping of C.S. sand blasted and epoxy painted and as given in detailed specification shall be provided. Velocities in the piping shall be within standard limits. However Raw water inlet pipes shall be of CI. Velocity criteria for interconnecting piping shall be followed as under All interconnecting piping shall be of cast iron only except chemical dosing lines, which will be of HDPE and of 10 kg/cm<sup>2</sup> pressure rating. The valves on alum dosing lines shall be of SS 304 diaphragm type. All other gates and check valves shall be C.I. in construction. The service water line shall be G.I. Class-`C' construction C.I. pipes shall be conforming to IS:1536:1989 and IS 7181 in case of spigot and socket end pipes of LA Class flanged end pipes respectively.

The CS Pipes shall be as per IS 1239 ERW, Heavy Duty or as per 3589 grade 410. The thickness of 200 mm dia pipe shall be 6.35 mm minimum and thickness of pipes more than 200 dia shall be 8 mm. For sizing of pipes, the velocity shall be restricted to following:

|                     |               |
|---------------------|---------------|
| Gravity flow line   | - 0.75 m/sec. |
| Pump suction line   | - 1.2 m/sec.  |
| Pump Discharge Line | - 1.8 m/Sec.  |

4.11 By pass arrangement : The contractor shall provide by pass arrangements so as to have the following arrangements for supply of water with flow up to 10 MLD.

i] To by pass clarifier and to lead raw water in to filters.

4.12 General :

(i) The tenderer shall have to furnish the details regarding the electrical consumption of each unit and chemical consumption of the plant.

(ii) The tenderer shall have to furnish bar chart showing all civil, mechanical, electrical,

instrumentation activities with physical and financial achievement.

(iii) Tenderer will furnish his own Layout, Hydraulic Flow Diagram, P & I Diagram, Site Organization Chart, Construction Equipment List etc.

(iv) Spares :

Tenderer shall supply spares along with plan as per spare list enclosed with tender.

(v) A complete tools box with spanners, screws drivers etc. correctly meant for the mechanical and electrical and instrumentation equipments of the plant should be supplied under this contract and the cost for the same should be included in the quotation. A complete list for this should be given.

(vi) Painting : After the plant has been erected completely the whole iron and steel work piping etc. except where directed otherwise must be painted with two coats of approved quality of epoxy paint after scrapping of all the old paint which has been damaged during transit to store or erection. All the outer side concrete/plastered surface shall be colored with approved shed of snowcem and inside surface shall be colored with approved shed of distemper/oil paint.

(vii) Clearing up :

Upon the completion of the work the contractor must remove all oil and grease marks or other stains from the floors walls of the building and render the whole plant thoroughly clean and orderly. Also all surplus excavated stuff, unused building materials etc. shall be removed from the site of work and the work site left neat and clean as directed.

## **5.0 Specifications incase Bidder offers other option that is Clariflocculator instead of Sludge Blanket Lamella Clarifier.**

### **Clariflocculator (1 No.)**

There will be one no. of circular RCC clariflocculator which shall have a central area for flocculation with flocculators and outer area for clarification settling. They will have a peripheral weir with vertically adjustable 8 mm thk. FRP V notch weir plates for uniform surface withdrawal of clarified water. The weir plates shall be fixed with stainless steel anchors, nuts and washers. The flocculation zone and settling zone shall be separated by circular isolation RCC wall. All inlets, outlets passages of water shall be designed and arranged for a steady and uniform flow without undue turbulence to avoid disintegration. A bridge with peripheral on-board drive with steel wheels traveling on the steel billets on the peripheral wall will be provided with:

- Central platform for the installation of the stirrers and their drives and for the local control panel;
- Paddle stirrers / agitators for slow mixing of the incoming raw water in the central unit;

- A radial scraper system with bottom scraper blades, suspended on the bridge.

**The hydraulic equipment is:**

- The inlet pipe from the flash mixer feeding into the central flocculation part;
- Sludge outlet pipe with pneumatically operated valve for intermittent operation according to an adjustable timer;
- The drain pipe with manually operated gate valve for the complete draining of the clarifier shall be provided.
- Sludge pipe from clariflocculator to dirty water sump.
- A constant bleeding arrangement for de-sludging pipe shall be provided to enable observation of the sludge quality.
- A discharge pipe/channel from the peripheral collecting channel to the main channel leading to filters.

**The electrical equipment is:**

- Incoming cable with slip ring contacts for the on-board power supply and the supply of all motors;
- On-board panel for all operations of the unit with connections to the main control room for indication of the status of the unit components;
- Adjustable drives for the flocculator stirrers;
- Adjustable drive for the bridges;
- Emergency stop buttons at the centre and at the outer side of the bridge;
- Lighting.

The access to the bridge is possible from the peripheral walkway of width not less than 1200 mm with a railing.

**Design Parameters of Clariflocculator** shall be as given below:

**A. Clariflocculator**

|       |   |   |   |
|-------|---|---|---|
| i)    | Nos.                                      | : | 1 No.   |
| ii)   | Flow through each Clariflocculator        | : | 10 MLD (Normal), + losses   |
| iii)  | Surface loading in Clariflocculator zone. | : | 35 M <sup>3</sup> /M <sup>2</sup> /day. (Max.)  |
| iv)   | Detention time in clarification zone      | : | 2.5 hrs.  |
| v)    | Liquid depth                              | : | 3.7 m   |
| vi)   | Free board                                | : | 500 mm min.   |
| vii)  | Floor slope                               | : | 1:12  |
| viii) | Inside dia of clarifier                   | : | As per design criteria  |
| ix)   | Location of launder                       | : | Outside   |
| x)    | Weir loading                              | : | 300 M <sup>3</sup> /M/day   |
| xi)   | Outlet arrangement of the clarified water | : | 90° 8 mm thk FRP adjustable V notch weir plate to be fixed along the periphery of the |

|        |                                      |   |  |
|--------|--------------------------------------|---|--|
|        |                                      |   | clarifier tank as per hydraulic design calculations  |
| xii)   | Clarifier Bridge with wheel assembly | : | Min 1200 mm width  |
| xiii)  | Peripheral speed of Scraper Arm      | : | 1 – 3 cm/sec   |
| xiv)   | Thickness of scraper Blade           | : | 6 mm (min.)  |
| xv)    | MOC of Bridge and Scraper            | : | MS, IS 2062, epoxy painted. All submerged hardware, nuts and Bolts shall be of SS– 304 Material. Rest shall be of G.I. |
| xvi)   | Painting                             | : | 2 coats of primer and 2 coats of epoxy   |
| xvii)  | Telescopic Bleed valve               | : | 1 set of each clarifier  |
| xviii) | Water flushing connection            | : | In sludge Line   |

## **B. Flocculator**

|       |                             |   |  |
|-------|-----------------------------|---|--|
| i)    | Type.                       | : | Set of counter rotating flocculator blades |
| ii)   | Flow                        | : | 10 MLD (Normal) + losses                   |
| iii)  | Detention Time              | : | 30 min. (Minimum)                          |
| iv)   | GT Value                    | : | 10,000 – 1,00,000                          |
| v)    | MOC of Flocculator          | : | MSEP                                       |
| viii) | Service factor for gear box | : | 2.0 (Minimum).                             |

## **Rotating Scraper Bridge and Accessories**

The scraper and rotating bridge shall be of MS construction. Shaft and impeller blades of flocculator shall be of MSEP material. Handrails shall be of GI material of 40 mm. pipe size medium grade.

## **Rotating Bridge Structure**

The rotating bridge structure shall incorporate a walkway having a minimum effective width of 1200 mm which shall be surfaced with M.S, chequered plates, painted black. The bridge shall be designed to take its own dead weight together with uniformly distributed loading of 250 kg/cm<sup>2</sup> over the full span and width of the walkway bridge and a moving point load of 500 kg. Maximum deflection of the bridge under the specified loading shall not exceed 1/360th of the span. The positive camber shall be kept initially to compensate for the maximum deflection under dead weight and superimposed loads.

The bridge shall be so braced as to limit lateral deflection to less than 80 mm measured at mid span under a full load condition.



The central part of the bridge shall be large enough for the installation of the flocculator systems and the control panel.

The bridge shall have hand railing to both sides forming an enclosure at the centre in between. The finished height of the railing shall be 1.0 m above the walkway. Toe guards shall be provided and secured around the bridge walkway which shall not be less than 100 mm high and 5 mm thick.

### **Bridge Support and End Carriage**

The bridge structure shall be supported at the centre of the clariflocculator by means of cast iron bearing assembly of the slewing ring type and incorporating trunnion type mounting to accommodate vertical undulations of the traction wheels at the peripheral wall of the tank. The central bearing assembly shall be adequately lubricated and all grease points shall be extended to a battery plate mounted at the convenient point above the walkway. Oil fill and drain points, where applicable shall be extended to provide a convenient access for filling and draining the system. Catch drains shall be provided under all oil and grease point to prevent spillage from reaching the water surface.

The wheel carriage assembly shall be suitably proportioned to provide adequate stability to the rotating bridge structure, whilst providing the suitable base for the motors, gear box, driving and idling wheels, shafts and bearings. The wheels shall be such that a de-railing cannot occur due to some misalignment. The size and design of wheels and carriage shall be calculated to transmit optimum tractive effort relative to the proportions of the scrapper without producing wheel spin when the wheel path is subject to the climatic conditions.

### **Drive**

The bridge drive shall comprise of either (a) motor with reduction gear, a chain sprocket or (b) a geared motor. The assembly shall be rigidly mounted and shall be adequately rated for continuous service in water treatment works environment.

All lubrication points, all necessary provisions shall be made for routine maintenance and for prevention of oil and grease spillage. A deflector shall be provided and fitted to the leading edge of the driving carriage. It shall be angled at 45° and arranged to be adjustable within 3 mm of the perimeter rail such that material coming in the way of free passage of the wheel shall be deflected.

### **Blades and Fixtures**

Scrappers shall be suspended and arranged to give continuous and progressive scrapping of the entire floor of the clariflocculator and the swept area of the successive blades shall overlap. The configuration of blades shall be designed to carry sludge and deposited suspended solids from the periphery of the tank and deposit it efficiently in the withdrawal hopper / sludge pocket.

The number and length of individual blades shall be designed by the Contractor, but the depth shall not be less than 300 mm and the thickness not less than 6 mm. Renewable fabric reinforced rubber wearing strips of cross section not less than 12 mm x 100 mm shall be fitted to each blade to provide a continuous contact surface which is adjustable for wear. The material shall have hardness not greater than 40 and be manufactured from well-proven compound.

Backing strips shall be fitted to give support to the fixing of the rubber wearing strips and the assembly shall be secured by means of stainless steel bolts. Appropriate washers shall be fitted beneath all bolts head and nuts.

Flocculation zone

The flocculation compartment shall be of RCC construction concentric to RCC clariflocculator tank.

Four (4) nos flocculation paddles shall be suspended from the bridge, one on each side of the center pier in the direction of bridge and one each in direction perpendicular to the bridge. The area of paddles shall be 10 – 15% of the cross sectional area of the flocculation zone. These shall be supported from the rotating bridge. The material of construction and motor HP shall be as per specification

### **Motors, starters and control**

The electrical supply to bridge or flocculator driving motors shall be taken through a multi ring and slip – ring collector unit mounted in a fully water proof enclosure. The unit shall be fitted at the centre of rotation of each bridge and shall be complete with all necessary support bracket, anti – rotation device. A suitable means of lubrication shall be provided.

The slip ring assembly shall be mounted above the top level of the tank walls. Sufficient rings shall be included to cover the motor supply and any ancillary circuits. Bridge drive and flocculator motors shall be of squirrel cage type, protected and shall be rated 25% above design duty and shall meet the specifications of motor mentioned under electrical section.

Overload torque control mechanism included.

All cables shall be connected to a termination box at the wall of the clariflocculator. From there, cables are connected to the main control panel. Overload torque alarm and trip signals shall be fed to PLC for suitable alarm and tripping of the drives.

The bridge drive and the flocculators shall be controlled from an outdoor panel installed in the central part of the bridge. The drive status indicating lamps shall be provided on the main control panel.

### **Clarified Water Collection**

The collection of clarified water shall be in a peripheral launder constructed outside the tank wall. The launder shall receive clarified water through 90 deg, 8 mm thk FRP V notches of adjustable weir plate fitted along the tank perimeter.

### **Clarifier De-sludging**

The sludge shall be discharged at least once in 120 minutes or as per design through pneumatically / electric actuator operated knife gate valves with manual over ride. In addition there shall be a continuous bleed arrangement with telescopic trumpet, placed near the outlet launder and discharging into the wet pit.

The valve chamber shall be dry and wet pit type with an operation platform above. The discharges shall be let into a sludge pumping and disposal plant by gravity through pipes, for ultimate disposal into the drainage system. Suitable flushing arrangement shall be provided.

### **Finishing:**

- 40 mm thick water proof IPS shall be provided on bottom and slope of clarifier. On inside vertical walls of clarifier and other inside RCC components, 20 mm thick water proofing cement plaster shall be provided. 20 mm thick waterproof cement plaster on inner surface of the launder shall be provided.

### **Approach:**

The contractor shall have to provide and construct R.C.C. platform minimum 1.20 mt wide on every common wall & outer wall of clarifier for easy access & approach to each clarifier and other interconnecting units. Moreover the contractor shall have to provide and construct adequate size of RCC M-30 platform for the operation of inlet valve. 1.0 meter high & 1.5 meter horizontally spaced GI pipes (Class-B) railing painted with epoxy/rubber paint shall be provided on along the total length of all platforms. At the end of the last unit of clarifier 1.2 meter wide staircase with GI pipes (Class-B) railing painted with epoxy/rubber paint shall be provided for access on top of unit.

**Make of Clariflocculator Mechanism:** Voltas / Eimco-KCP / Hindustan Dorr Oliver

### **Clariflocculator Outlet Channel: (1 No.)**

#### **Design & details:**

1 No. Clarifier outlet channels of 10 MLD + Losses shall be designed and provided such as to maintain minimum 500 mm clear free board.

On sides of clarifier there shall be clarifier outlet channels, where outlet water from clarifier launder is discharged. This channel shall be extended up to filter inlet channel.

Width of channel shall be designed in such a way that minimum clear free board of 500 mm is provided Channels shall be constructed on RCC columns and these columns should be tied at G.L. also

Material of construction shall be minimum RCC M-30

1.2 meter wide RCC M-30 walkway with 1.00 meter high G.I. (Class-B) railing on both sides shall be provided on the total length of channel for cleaning & maintenance.

**Finishing:**

Outside 20 mm thick double coat sand fanced plaster with water proof cement paint in three coats and columns sandtex painting shall be provided. 20 mm thick water proof cement plaster on sides of walls including free board portion as dado and over 25 mm th. waterproof IPS on bottom inside the total length of all the clarifier outlet channels.

**Drain arrangement:**

For draining out total clarified water of the channel up to the bottom level in 30 minutes time during the plant shut-down period, at least two numbers 300 mm dia. drain puddles shall be provided at bottom of channels (in the slab), and the same shall be extended by flanged C.I. pipeline up to the drain chamber and sluice valve of 300 mm dia. size, shall be provided to operate the valve from operating level.

GENERAL MANAGER (TECH & ADMN)  
M/S.GUJARAT HIRA BOURSE

Signature and seal of Contractor :-

Name :-

Address :-

Date :-

**CHAPTER – III**

**TECHNICAL DATASHEETS**

( To be filled up by bidder)

- 1.0. FLOW : 10 MLD
- 2.0. QUALITY :
- i. Raw Water Turbidity : NTU
- ii. Treated Water Turbidity : NTU
- 3.0. PAC DOSE :
- 3.1. PAC Dose for Avg. Flow : PPM
- 4.0. CHLORINE DOSE
- i. Pre-chlorination : PPM
- ii. Post Chlorination : PPM

GENERAL MANAGER (TECH & ADMN)  
M/S.GUJARAT HIRA BOURSE

Signature and seal of Contractor :-  
Name :-  
Address :-  
Date :-

## **DATA SHEETS**

### **A. DETAIL OF CIVIL UNITS**

#### **1. STILLING CHAMBER:**

|                |   |                        |
|----------------|---|------------------------|
| No. of units   | : | One No.                |
| Flow           | : | 435 M <sup>3</sup> /hr |
| Retention Time | : | 60 sec.                |
| Capacity       | : |                        |
| Size           | : |                        |
| Liquid depth   | : | 1.5 M                  |
| M.O.C.         | : | R.C.C. in M:250        |
| Free board     | : | 500 mm                 |
| Rungs          | : | C.I.                   |

#### **2. FLASH MIXER:**

|                |   |                        |
|----------------|---|------------------------|
| No. of unit    | : | One No.                |
| Flow           | : | 435 M <sup>3</sup> /hr |
| Retention time | : | 60 sec.                |
| Capacity       | : |                        |
| Size           | : |                        |
| Liquid depth   | : |                        |
| Free board     | : | 500mm                  |
| M.O.C.         | : | R.C.C. in M:250        |

**3. SLUDGE BLANKET LAMELLA CLARIFIER:**

|                    |   |   |
|--------------------|---|---|
| No. of unit        | : | One No.   |
| Flow /Unit         | : | 435.0 M <sup>3</sup> /hr  |
| Detention time     | : | 50 - 60 Minutes   |
| Surface loading    | : | 4.5 M <sup>3</sup> /M <sup>2</sup> /hr                          |
| Size               | : |   |
| Side Water depth   | : | 4.5 M   |
| Free Board         | : | 500 mm  |
| Material of Const. | : | RCC M:250 with form finish                                      |
| PVC Tube Modules   | : | 500 mm depth, Hexagonal shape<br>1.1 mm thk 60 Deg. Inclination |
| Platform           | : | 1.0 mt. wide RCC M:200 with<br>40 mm thk IPS                    |

**4. FILTER HOUSE:**

|                                |   |  |
|--------------------------------|---|--|
| Type                           | : | High rate, twin section, gravity   |
| Total Flow M <sup>3</sup> /hr. | : | 450 M <sup>3</sup> /hr.  |
| No. of Units                   | : | Two Nos.   |
| Rate of Filtration             | : | 6 m <sup>3</sup> /m <sup>2</sup> /hr.  |
| Flow of each Unit              | : |  |
| Area of each Twin              | : | 18.75 sq.m.  |
| Size of Filter Beds            | : |  |
| Free Board                     | : | 700 mm   |
| Under Drain system             | : | PVC/PP Nozzles, cast-in-situ false Flooring  |
| MOC                            | : | RCC M-250 with form finish,<br>Filter house with MS frame and glazed<br>window and MS Frame & paneled doors. |
| Painting                       | : | Inside : Distemper<br>Outside : Snowcem  |

Door-windows : Oil Paint

Filter Backwash

|                          |                                 |
|--------------------------|---------------------------------|
| Rate of air scouring     | :600 LPM/sq.m                   |
| Duration of air scouring | :5-8 minutes for each bed       |
| Rate of backwash flow    | :400 LPM/sq.m                   |
| Duration of back washing | : 8-10 minutes for each section |

Filter Media

|                                 |              |
|---------------------------------|--------------|
| Total Media depth               | : 1100 mm    |
| Depth of Sand (Min.)            | : 900 mm     |
| Uniformity co-efficient of sand | :1.3- 1.7    |
| Effective size of sand          | : 0.45 – 0.7 |

**5. CHEMICAL HOUSE :**

|                             |   |   |
|-----------------------------|---|---|
| No. of Unit                 | : | One No.   |
| Area                        | : | 70 M <sup>2</sup> - G.F (minimum)<br>30 M <sup>2</sup> -F.F.(minimum) |
| Size                        | : |   |
| Material of construction    | : | RCC Frame Structure with brick<br>Masonry walls.                      |
| Ground floor to accommodate | : | Chemical Storage/Chlorination<br>System, Air Blower                   |
| First floor to accommodate  | : | Chemical Dosing System  |

PAC Solution Tank:

|                       |   |              |
|-----------------------|---|--------------|
| No. of Unit           | : | Two Nos.     |
| Piping work           | : | SS-304       |
| Inside coating        | : | Epoxy Lining |
| Capacity of each tank | : |              |
| Size                  | : |              |
| Liquid Depth          | : |              |



Free Board : 300 mm

**6. OFFICE CUM CONTROL ROOM**

No. of Unit : One No.  
Size : 50 M<sup>2</sup> (minimum)  
Material of construction : RCC Frame Structure with brick Masonry walls.  
  
First floor to accommodate : Office , Laboratory  
MCC room & Control Room.

**7. DIRTY WATER SUMP & BACKWASH OVERHEAD TANK:**

Dirty water sump

No. of units : One No.  
Capacity : 200 Cu.M(minimum)  
Size (Mini) Plan Area : 10 M. Dia  
Liquid Depth : 2.6 M.

Backwash Overhead Tank

No of units : One No.  
Capacity : 200Cu.M  
Size (Mini) Plan Area :  
Liquid Depth :

**B. DETAIL OF MECHANICAL ITEMS**

**1. Flash Mixer :**

No of Unit :  
Impeller Type :  
Speed rpm/Motor HP :  
Material of construction :

**2. Air Blowers:**

No. of Unit :  
Type :  
Rated Capacity of each :  
Pressure :  
Motor HP/RPM :  
Material of construction :  
Casing :  
Lobe :  
Shaft :  
Gear :  
Base From :

**3. Pre and Post Chlorinator:**

No. of Units :  
Capacity :  
Type :

**4. Chlorine Booster Pumps**

No. of unit :  
Type :  
Capacity :  
Head :  
Motor KW :  
Material of construction :

**5. Poly Dosing Pump (if required)**

No. of Unit :  
Capacity :  
Head :  
Type :  
Motor KW/RPM :  
Material of construction :  
Wetted parts :  
Diaphragm :  
Gland :  
Base plate :  
Relief Valve :

**Agitators**

Material of construction :  
Speed rpm :  
Motor HP/rpm :

**6. Dirty Water Pumps**

No of Pumps :  
Capacity :  
Head :  
Type :  
Motor KW :  
Material of construction :

**7. Backwash Water Pumps**

|                          |   |
|--------------------------|---|
| No of Pumps              | : |
| Capacity                 | : |
| Head                     | : |
| Type                     | : |
| Motor KW                 | : |
| Material of construction | : |

**8. Electrically Operated Butterfly Valves (mimimum size)**

|                         |   |   |
|-------------------------|---|---|
| Filter Inlet Valves     | : | 250 mm Dia Electrically operated Butterfly valves |
| Filter Outlet Valves    | : | 250 mm Dia Electrically operated Butterfly valves |
| Backwash Inlet Valves   | : | 300 mm Dia Electrically operated Butterfly valves |
| Wash Water Drain Valves | : | 400 mm Dia Electrically operated Butterfly valves |
| Air Inlet Valves        | : | 150 mm Dia Electrically operated Butterfly valves |

**C. DETAIL OF ELECTRICAL /INSTUMENT ITEMS**

**a) ELECTRICAL ITEMS**

1. MCC :
2. Cables :
3. Push Button/Earthing Material :  
Earthing Materials
4. Internal Plant Lighting :

**b) INSTRUMENT ITEMS :**

1. Rate of Flow Indicator and Loss of Head Indicator  
Nos. :  
Type :  
Filter range :  
Head loss range :
2. PLC Control Panel/SCADA Sys :
3. Ultrasonic Flow Meter(outlet) :
4. Pressure Gauge :
5. Ultrasonic flow transmitter :

- 6. Ultrasonic Level Switch :
- 7. Float & Board Type level gauge :
- 8. Ultrasonic Level Transmitter :

## **CHAPTER - IV**

### **SPECIFICATION FOR CIVIL AND STRUCTURAL WORKS**

#### **A. I. GENERAL**

##### Scope

- a. This specification gives the general design requirements and manners of construction of all civil and structural works, the scope of which is given separately.
- b. Placing in position and fixing of all mechanical items, insert plates, sleeves, anchor bolts are also part of work covered by this specification.
- c. Contractor shall be responsible for the designs and construction of all RCC works, structural steel and other relevant civil works.
- d. **The contractor** shall submit to the Gujarat Hira Bourse all the design calculations and drawings for sub structure, superstructure and all other connected works for approval. However the approval of the drawings by the Gujarat Hira Bourse does not absolve the contractor of his responsibilities regarding the soundness of the structure.
- e. The contractor shall submit a schedule of drawings proposes to make in line with the time schedule included elsewhere in these specification. The contractor shall submit necessary prints at the time of submissions for approvals and final records.
- f. All RCC works to be provided with inside waterproof plaster C.M.1:3 and outside plaster in C.M.1:3 with snowcem on the outer face.

#### **II. Design :**

- a. The design shall generally be on the basis of structural design specifications according to various I.S. codes.

- b. All structures/part of structures in contact with water shall be designed as water retaining structures as per IS 3370 parts I to IV [latest revision].
- c. Soil data to be used for the design of the structures shall be as per the relevant information enclosed herewith.

**III. Construction :**

- a. The construction shall be done as per relevant Indian standards.

**Design Specifications :**

**Scope :**

The design criteria given herein establish the minimum basic requirements for design of reinforced concrete, structures and structural steel works.

**IV Codes and Standards :**

- a. Design loads in building : IS : 875 and IS 1893:2002 with latest revisions.
- b. Concrete Structures :
  - General Purpose : IS : 456:2000
  - Raft foundations : IS : 2950
  - Machine foundations : IS ; 2974
  - Water retaining Structures. : IS ; 3370 ( part-I to IV)
  - Expansions Joints : IS 1893:2002
- c. Steel Structures :
  - Structural steel in General building const. : IS : 800 IS 1786
  - Steel tubes in general building construction. : IS : 806
  - Metal arc welding for general building const. : IS : 816
- d. All other relevant codes specified or referred in the above codes and wherever the reference is made it shall be with latest revisions.
- e. Any exceptions or additions to these specifications, including any mandatory rules or regulations which are to apply, will be indicated on the design drawings/calculations.

**Recommendations :**

For design of foundation following recommendations are given.

For all the structure.

1. Adopt shallow reinforced cement concrete [RCC] foundation.

**B. GENERAL TECHNICAL SPECIFICATIONS :**

**1. GENERAL :**

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

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

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

A work order book as prescribed shall be maintained on the site of the work by the contractor and the contractor shall sign the orders given by the inspecting officers and shall carry out them promptly.

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

Diversion of road, if necessary, shall be provided and maintained during the currency of the contract by the contractor at his cost. Figured dimensions of drawings shall supercede measurements by scale. Special dimensions or directions in the specification shall supercede all other dimensions.

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

If the arrangement for temporary drainage is required to be made during any work of this contract. The same shall be made by the contractor without claiming any extra cost.



**2. LOCATION AND ACCESS TO SITE ;**

Location of Water treatment plant, as is described in the document.

**3. DESCRIPTION OF WORK :**

The work under the contract consist of providing and executing civil, mechanical, electrical instrumentation works services to be executed for water treatment plant of capacity 10 MLD, which includes the necessary items to be executed.

The work also includes providing necessary inserts, brackets supports in walls are required for installing any other facilities to be provided by other agencies.

Painting and coloring operating platforms, ladders, hand railing, rungs etc. with one coat of red oxide primer and two coats of approved enamel.

It is not the intention of this tender to give detailed description and specifications of each and every item. The successful tenderer shall execute each item so as to ensure smooth and efficient working of the total system of which a item is a part. The successful tenderer shall not refuse to carry out any additional items of construction if the same are required for smooth and efficient working of the total system in the opinion of the Engineer-in-charge.

All the items specified in the tender shall be carried out by the successful tenderer as per the practices set out in the relevant latest editions of Indian Standard specifications and IRC specifications.

**4. WATER SUPPLY FOR WORK ;**

The contractor shall make his own arrangement for supply of proper quantity and quality of water required for construction work and also for consumption of his employees.

**5. POWER SUPPLY :**

Electrical power for construction purpose shall be in Tenderer's scope including energy consumption.

Developer shall provide a electrical power connection of adequate capacity at a single point for operation & maintenance . Energy consumption for operation & maintenace shall be in Developer's scope.

**6. CEMENT AND STEEL :**

As per Volume-I.

**7. CLASSIFICATION OF STRATA :**

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

**8. SOILS & HARD MURRUM ;**

Soils of all sorts, silt, sand, gravel, soft murrum, stiff clay, kankar and other excavation not covered in the item mentioned hereunder.

GENERAL MANAGER (TECH & ADMN)  
GUJARAT HIRA BOURSE  
SURAT

Contractor's seal & Signature :-

Name :-

Address :-

Date :-

## CHAPTER - V

### SPECIFICATIONS OF MATERIALS

#### M-1 WATER :

- 1.1 Water shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-1978.
- 1.2 If required by the Engineer-in-charge it shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in I.S. 269-1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 percent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.
- 1.3 Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements which significantly affect the hydration reaction or otherwise interfere with the hardening of mortar or concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.
- 1.4 Hard and bitter water shall not be used for curing.
- 1.5 Portable water shall generally be found suitable for curing mortar or concrete.

#### M-2 LIME :

- 2.1 Lime shall be hydraulic lime as per I.S. 712-1973. Necessary tests shall be carried out as per I.S. 6932 (Parts I to X) 1973.

2.2 The following field tests for limes are to be carried out -

- a] A very rough idea can be formed about the type of lime by its visual examination i.e. fat lime bears pure white colour, lime in form of porous lumps of dirty white colour, indicates quick lime, and solid lumps the unbrunt lime stone.
- b] Acid tests for determining the carbonate content in lime. Excessive amount of impurities and rough determination of class of lime.

2.3 Storage shall comply with I.S. 712-1973. The slaked lime, if stored, shall be kept in a weather proof and damp proof shed with impervious floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it. All lime that has been damaged in any way shall be rejected and all rejected materials shall be removed from site of work.

2.4 Field testing shall be done according to I.S. 162-1974 to show the acceptability of materials.

**M-3 CEMENT :**

3.1 Cement shall be Portland Pozzolana Cement as per I.S. 1489:1991 or Part-I.

**M-4 WHITE CEMENT :**

4.1 The white cement shall conform to I.S. 8042-1978.

**M-5 SAND :**

5.1 Sand shall be natural sand, clean, well graded, strong, durable and gritty particles free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles, shale, alkali, salts, organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-charge. The sand shall not contain more than 8% of silt as determined by field tests. If necessary the sand shall be washed to make it clean.

5.2 Coarse Sand : The fineness modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse shall be as under ---

| I.S. Sieve Designation | % by weight passing sieve | I.S. Sieve Designation | % by weight passing sieve |
|------------------------|---------------------------|------------------------|---------------------------|
| 4.75 mm                | 100                       | 600 Micron             | 30 – 100                  |
| 2.36 mm                | 90 – 100                  | 300 Micron             | 5 – 70                    |
| 1.18 mm                | 70 – 100                  | 150 Micron             | 0 – 60                    |

- 5.3 Fine Sand : The finesse modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under ---

| I.S. Sieve Designation | % by weight passing thru' | I.S. Sieve Designation | % by weight passing thru' |
|------------------------|---------------------------|------------------------|---------------------------|
| 4.75 mm                | 100                       | 600 Micron             | 40 – 85                   |
| 2.36 mm                | 100                       | 300 Micron             | 5 – 50                    |
| 1.18 mm                | 75 – 100                  | 150 Micron             | 0 – 10                    |

**M-6 STONE GRIT :**

- 6.1 Grit shall consist of crushed or broken stone and be hard, strong, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless a special stone of a particularly quarry is mentioned, grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer-in-charge. The grit shall have no deleterious reaction with cement.

- 6.2 The grit shall conform to the following gradation as per sieve analysis :

| I.S. Sieve Designation | % by weight passing sieve | I.S. Sieve Designation | % by weight passing sieve |
|------------------------|---------------------------|------------------------|---------------------------|
| 12.50 mm               | 100                       | 4.75 mm                | 0.20                      |
| 10.00 mm               | 85 – 100                  | 2.36 mm                | 0.25                      |

- 6.3 The crushing strength of grit will be such as to allow the concrete in which it is used to build-up the specified strength of concrete.

- 6.4 The necessary tests for grit shall be carried out as per the requirements of I.S. 2338 (Parts I to VIII)1963, as per instruction of the Engineer-in-charge. The necessity of test will be decided by the Engineering-in-charge.

**M-7 LIME MORTAR :**

- 7.1 LIME : Shall conform to specification M-2.  
WATER : Water shall conform to specification M-1.  
SAND : Sand shall conform to specification M-6.
- 7.2 PROPORTION OF MIX : Mortar shall consist of such proportions of slaked lime and sand as may be specified in the item. The slaked lime and shall be measured by volume.
- 7.3 PREPARATION OF MORTAR : Lime mortar shall be prepared by wet process as per I.S. 1625-1971. Power driven mill shall be used for preparation of lime mortar. The slaked lime shall be placed in the mill in an even layer and ground for 180 revolutions with sufficient water. Water shall be added as required during grinding (care being taken not to add more water) that will bring the mixed material to a consistency of stiff paste. Thoroughly wetted sand shall then be added evenly and the mixture ground for another 180 revolutions.
- 7.4 STORAGE : Mortar shall always be kept damp, protected from sun and rain till used up, covering it by tarpaulin or open sheds.
- 7.5 USE : All mortar shall be used as soon as possible after grinding. It should be used on the day on which it is prepared. But in no case mortar made earlier than 36 hours shall be permitted for use.

**M-8 CEMENT MORTAR :**

- 8.1 Water shall conform to specification M-1. Cement shall conform to specification M-3. Sand shall conform to M-5.
- 8.2 PROPORTION OF MIX : Cement and sand shall be mixed to specified proportions, sand being measured by measuring boxes. The proportion of cement shall be by volume on the basis of 50 Kg./Bag of cement being equal to 0.0342 cu.m. The mortar may be hand mixed or machine mixed as directed.
- 8.3 PREPARATION OF MORTAR : In hand mixed mortar, cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous mixture of uniform colour is obtained. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar or mortar shall flow out. While mixing, the water shall be gradually added and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be

completely covered with a film of wet cement. The water cement ratio shall be adopted as directed.

- 8.4 The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes.

**M-9 STONE COARSE AGGREGATE FOR NOMINAL MIX CONCRETE :**

- 9.1 Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.
- 9.2 The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement concrete and ordinary reinforced cement concrete shall generally be as per the table given below. However, in case of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6mm. Less than the cover whichever is smaller.

**TABLE**

| I.S.<br>Sieve<br>Designation | Percentage passing<br>for single sized<br>aggregates of<br>nominal size |            |            | I.S.<br>Sieve<br>Designation | Percentage passing<br>for single sized<br>aggregates of<br>nominal size |       |      |
|------------------------------|---|------------|------------|------------------------------|---|-------|------|
|                              | 40mm  | 20 mm      | 16 mm      |                              | 40mm  | 20 mm | 16mm |
| 80 mm                        | -   | -          | -          | 12.50 mm                     | -   | -     | -    |
| 63 mm                        | 100   | -          | -          | 10.00 mm                     | 0.5   | 0.20  | 0.30 |
| 40 mm                        | 85-<br>100  | 100        | -          | 4.75 mm                      | -   | 2.50  | 0.50 |
| 20 mm                        | 0-20  | 85-<br>100 | 100        | 2.35 mm                      | -   | -     | -    |
| 16 mm                        | -   | -          | 85-<br>100 |                              |   |       |      |

NOTE: This percentage may be varied somewhat by the Engineer-in-charge when considered necessary for obtaining better density and strength of concrete.

- 9.3 The grading test shall be taken in the beginning and at the change of source of materials. The necessary tests indicated in I.S. 383-1970 and I.S. 456-1978 shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different

aggregates. If the aggregates are covered with dust, they shall be washed with water to make, them clean.

**M-10 BLACK TRAP OR EQUIVALENT HARD STONE COARSE :**

10.1 Aggregate for Design Mix Concrete : Coarse aggregate shall be of machine crushed stone of black trap or equivalent hard stone and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

10.2 The aggregates shall generally be cubical in shape, unless special stones of particular quarries are mentioned, aggregates shall be machine crushed from the best, black trap or equivalent hard stones as approved. Aggregate shall have no deleterious reaction with cement.

10.3 The necessary tests indicated in I.S. 383-1970 and I.S. 456-1978 shall have to be carried out to ensure the acceptability of the material.

10.4 If aggregate is covered with dust it shall be washed with water to make it clean.

**M-11 BRICK BATS AGGREGATE :**

11.1 Brick bat aggregate shall be broken from well burnt or slightly over burnt and dense bricks. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt of any other foreign material. The brick bats shall be of 40 mm to 50 mm size unless otherwise specified in the item. The under burnt or over burnt brick bats shall not be allowed.

11.2 The brick bats shall be measured by volume by suitable boxes as directed.

**M-12 BRICKS :**

12.1 The bricks shall be hand or machine moulded and made from suitable soils and kiln burnt. They shall be free from cracks and flaws not nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour. The bricks shall be moulded with a frog of 100mm x 40mm and 10mm to 20mm deep on one of its flat sides. The bricks shall not break when dropped on the ground from a height of 600 mm.

12.2 The size of modular bricks shall be 190mm x 90mm x 90mm.

12.3 The size of conventional bricks shall be as under ---

225 x 110 x 75mm.



- 12.4 Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work..

Length : 3.00 mm

Width : 1.50 mm

Height : 1.50 mm

- 12.5 The crushing strength of the bricks shall not be less than 35 Kg./Sq. Cm. The average water absorption shall not be more than 20% by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per I.S. 3495 (Part I to IV)-1976.

**M-13 STONE :**

- 13.1 The stone shall be of the specified variety such as Granite/Trap stone/Quartzite or any other type of good hard stones. The stones shall be obtained only from the approved quarry and shall be hard, sound, durable and free from defects like cavities, cracks, sand holes, flaws, injurious veins, patches of loose or soft materials etc. and weathered portions and other structural defects or imperfections tending to affect their soundness and strength. The stone with round surface shall not be more than 5% of dry weight. When tested in accordance with I.S. 1134-1974. The minimum crushing of the strength of the stone shall be 200 Kg./Sq. Cm. unless otherwise specified.
- 13.2 The samples of the stone to be used shall be got approved before the work is started.
- 13.3 The khanki facing stone shall be dressed by chisel as specified in the item for khanki facing in required shape and size. The face of the stone shall be so dressed that the bushing on the exposed face shall not project by more than 40 mm. from the general wall surface and on face to be plastered it shall not project by more than 19 mm nor shall it have depressions more than 10 mm from the average wall surface.

**M-14 MILD STEEL BARS :**

- 14.1 Mild steel bars reinforcement for R.C.C. work shall conform to I.S. 432 (Part-II)-1966 and shall be of tested quality. It shall also comply with the relevant part of I.S. 456-1978.
- 14.2 All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing.
- 14.3 For the purpose of payment the bar shall be measured correct upto 10 mm length and weight payable worked out as per the rate specified below :

|            |              |            |              |
|------------|--------------|------------|--------------|
| i ] 6mm    | 0.22 Kg/Rmt. | viii] 20mm | 2.47 Kg/Rmt. |
| ii ] 8mm   | 0.38 kg/Rmt. | ix ] 22mm  | 2.98 kg/Rmt. |
| iii ] 10mm | 0.62 kg/Rmt. | x ] 25mm   | 3.85 kg/Rmt. |
| iv ] 12mm  | 0.89 kg/Rmt. | xi ] 28mm  | 4.83 kg/Rmt. |
| v ] 14mm   | 1.21 kg/Rmt. | xii ] 32mm | 6.31 kg/Rmt. |
| vi ] 16mm  | 1.58 kg/Rmt. | xiii] 36mm | 7.31 Kg/Rmt. |
| vii] 18mm  | 2.00 Kg/Rmt. | xiv] 40mm  | 9.86 Kg/Rmt  |

**M-15 HIGH YIELD STRENGTH STEEL DEFORMED BARS :**

- 15.1 High yield strength steel deformed bars shall be either cold twisted or hot rolled and shall conform to I.S. 1739-1966 and I.S. 1139-1966 respectively.
- 15.2 Other provision and requirements shall conform to specification No. M-14 for Mild Steel Bars.

**M-16 HIGH TENSILE STEEL WIRES :**

- 16.1 The high tensile wires for use in pre stressed concrete shall conform to I.S. 2090-1962.
- 16.2 The tensile strength of the high tensile steel bars shall be as specified in the item. In absence of the given strength and minimum strength shall be taken as per para 6-1 of the I.S. 1785-1962. Testing shall be done as per I.S. requirements.
- 16.3 The high tensile steel shall be free from loose mill scale, rust, oil, grease or any other harmful matter. Cleaning of steel bars may be carried out by immersion in solvent solution, wire brushing or passing through a pressure box containing carborundum.
- 16.4 The high tensile wire shall be obtained from manufactures in coils having diameter not less than 350 times the diameter of wire itself so that wire springs back straight on being uncoiled.

**M-17 MILD STEEL BINDING WIRE :**

- 17.1 The mild steel wire shall be of 1.63mm or 1.22mm (16 or 18 gauge) diameter and shall conform to I.S. 280-1972.
- 17.2 The use of black wire will be permitted for binding reinforcement bars. It shall be free from rust, oil, paint, grease, loose mill scale or any other undesirable coating which may prevent adhesion of cement mortar.

**M-18 STRUCTURAL STEEL :**

- 18.1 All structural steel shall conform to I.S. 226-1965. The steel shall be free from the defects mentioned in I.S. 226-1975 and shall have a smooth finish. The material

shall be free from loose mill scale, rust pits or other defects affecting the strength and durability. Rivet bars shall conform to I.S. 1148-1973.

18.2 When the steel is supplied by the contractor test certificates of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

#### **M-19 SHUTTERING :**

19.1 The shuttering shall be either of wooden planking of 30mm minimum thickness with or without steel lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical bellies properly cross bracked together so as to make the centering rigid. In places of ballie props, bricks pillar of adequate section built in mud mortar may be used.

19.2 The form work shall be sufficiently strong and shall have camber, so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration of concrete, live load of men working with it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout.

19.3 If at any stage of work during or after placing concrete in the structure, the form work sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and approved from the Engineer-in-charge, before the reinforcement bars are placed in position.

19.4 The props shall consists of bullies having 100mm minimum diameter measured at mid length and 80mm at thin end and shall be placed as per design requirement. These shall rest squarely on wooden sole plates 40 mm. thick and minimum bearing area of 0-10 sq.m. laid on sufficiently hard base.

19.5 Double wedges shall further be provided between the sole plate and wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.

19.6 The timber used in shuttering shall not be so dry so as to absorb water from concrete and swell or bulge nor so green or wet so as to shrink after erection. The timber shall be properly sawn and planed on the sides and the surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted.

19.7 As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.

19.8 The surface of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done.

Alternatively coat of raw linseed oil or oil of approved manufacture may be applied in place of soap solution. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances black or burnt oil shall be permitted.

- 19.9 The shuttering for beams and slabs shall have camber of 4mm per metre (1 in 250) or as directed by the Engineer-in-charge so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50 of the projected length or as directed by the Engineer-in-charge.

#### **M-20 TEAK WOOD :**

- 20.1 The teak wood shall be of good quality as required for the item to be executed. When the kind of wood is not specifically mentioned, good Indian teak wood as approved shall be used.
- 20.2 Teak wood shall generally be free from large, loose, dead or cluster knots, flaws, warps, twists, shakes, bends or any other defects. It shall generally be uniform in substance and of straight fibers as far as possible. It shall be free from rot, decay, harmful fungi and other defects of harmful nature, which will affect the strength, durability or its usefulness for the purpose for which it is required. The colour shall be uniform as far as possible. Any effort like painting, using any adhesive or resinous materials made to hide the defects shall render the pieces liable to rejection by the Engineer-in-charge.
- 20.3 All scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grains and of uniform thickness.
- 20.4 The tolerances in the dimensions shall be allowed at the rate of 1.5 mm per face to be planed.
- 20.5 First Class Teak Wood : First class teak wood shall have no individual hard and sound knots, more than 6 sq. cm. in size and the aggregate area of such knots shall not be more than 1% of area of piece. The timber shall be closed grained.
- 20.6 Second Class Teak Wood : No individual hard and sound knots shall be more than 15 sq. cm. in size and aggregate area of such knots shall not exceed 2% of the area of piece.

#### **M-21 NON-TEAK WOOD :**

The non teak wood shall be chemically treated, seasoned as per I.S. Specifications and of good quality. The type of wood shall be got approved before collecting the same on site. Fabrication of wooden members shall be started only after approval. For this purpose wood of Bio, Kalai, Sires, Saded, Behda, Jamun, Sisoo will be used for door

frames whereas only Kalai, Siras, Halda, Kalam etc. will be permitted for shutters after proper seasoning and chemical treatment.

The non teak wood shall be free from large, loose dead of cluster knots, flows, shakes, warps, bends, or any other defect. It shall be uniform in substance and of straight fibers as far as possible. It shall be free from rots, decay, harmful fungi and other defects of similar nature which will affect the strength, durability or its usefulness for the purpose for which it is required. The colour of the wood shall be uniform as far as possible. The scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grain and of uniform thickness.

The department will use the Agency to produce a certificate from the Forest Department in the event of a dispute and the decision of the Department shall be final and binding to the contractor.

The tolerance in the dimension shall be allowed at 1.5 mm. per face to be planed.

#### **M-22 WOODEN FLUSH DOOR SHUTTERS (SOLID CORE) :**

22.1 The solid core type flush door shutters shall be of decorative or non-decorative type as specified in the drawing. The size and thickness of the shutter shall be as specified in drawings or as directed. The timber species for core shall be used as per I.S. 2202-(Part-I)-1980. The timber shall be free from decay and insect attack. Knots and knot holes less than half the width of cross-section of the members, pitch streaks and harmless pin holes shall be permissible except in the exposed edges of the core members. The commercial plywood, cross bands shall conform to I.S. 303-1275.

22.2 The face panel of the shutters shall be formed by gluing by the hot press process on both faces of the core with either plywood or cross bands, and face veneers. The lipping, rebating, opening of glazing, venation etc. shall be provided if specified in the drawing.

22.3 All edges of the door shutters shall be square. The shutters shall be free from twist or warp in its plane. Both faces of the shutters shall be sand papered to smooth even texture.

22.4 The shutters shall be tested for :

- i] End Immersion Test : The test shall be carried out as per I.S. 2202 (Part-I) 1980. There shall be no de-lamination at the end of the test.
- ii] Knife Test : The face panel when tested in accordance with I.S. 1659-1979 shall pass the test.

- iii] Glue Adhesion Test : The flush door shall be tested for glue adhesive test in accordance with I.S. 2202(Part- I)-1980. The shutters shall be considered to have passed the test if no delamination occurs in the glue lines in the plywood and if no single delamination more than 80 mm. in length and more than 3 mm. in depth has occurred in the assembly glue lines between the plywood face and the style and rail. Delamination at the corner shall be measured continuously around the corner. Delamination at the knots knot, hole and other permissible wood defects shall not be considered in assessing the sample.

22.5 The tolerance in size of solid core type flush door as under :

In nominal thickness # 1.2 mm. In nominal height # 3 mm. The thickness of the shutters shall be uniform throughout with a permissible variation of not more than 0.8 mm. When measured at any two points.

#### M-23 ROLLING SHUTTERS :

- 23.1 The rolling shutters shall conform to I.S. 6248-1979. Rolling shutters shall be supplied of specified type with accessories. The size of the rolling shutters shall be specified in the drawings. The shutters shall be constructed with interlocking lath sections formed from cold rolled steel strips not less than 0.9 mm. thick and 80 mm. wide for shutters upto 3.5 m. Width not less than 1.25 mm. thick and 80 mm. wide for shutters 3.5 m. in width and above unless otherwise specified.
- 23.2 Guide channels shall be of mild steel deep channel section and of rolled pressed or built up (fabricated) jointless construction. The thickness of sheet used shall not be less than 3.15 mm.
- 23.3 Hood covers shall be made of M.S. sheets not less than 0.92 mm. thick. For shutters having width 3.5 mts. and above, the thickness of M.S. sheet for the hood covers shall be not less than 1.25 mm.
- 23.4 The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in position. The spring pipe shaft etc. shall be supported on strong M.S. or malleable C.I. brackets. The brackets shall be fixed on the or under the lintel as specified with raw plugs and screws bolts etc.
- 23.5 The rolling shutters shall be of self rolling type upto 8 sq.m. clear area without ball bearing and upto 12 sq.m. clear area with ball bearing. If the rolling shutters are of larger then gear operated type shutters shall be used.

23.6 The locking arrangement shall be provided at the bottom of shutter at both ends. The shutters shall be opened from outside.

23.7 The shutters shall be completed with door suspension, shafts, locking arrangements, pulling hooks, handles and other accessories.

**M-24 COLLAPSIBLE STEEL GATE :**

24.1 The collapsible steel gate shall be in one or two leaves and size as per approved drawings or as specified. The gate shall be fabricated from best quality mild steel channels, flats etc. Either steel pulleys or ball bearings shall be provided in every double channel. Unless otherwise specified the particulars of collapsible gate shall be as under ---

- i] Pickets : These shall be of 20 mm. M.S. channels of heavy sections unless otherwise shown on drawings. The distance centre to centre of pickets shall be 12 cms. with an opening of 10 cms.
- ii] Pivoted M.S. flats shall be 20 mm. x 6 mm.
- iii] Top and bottom guides shall be from tee or flat iron of approved size.
- iv] The fittings like stoppers, fixing hold fasts, locking cleats, brass handles and cast iron rollers shall be of approved design and size.

**M-25 GLASS :**

25.1 All glass shall be of the best quality, free from specks, bubbles, smokes, veins, air holes blisters and other defects. The kind of glass to be used shall be as mentioned in the item or specification or in the special provisions or as shown in detailed drawings. Thickness of glass panes shall be 4 mm. The specifications for different kinds of glass shall be as under ;

**Sheet Glass :**

In the absence of any specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 7.5 Kg./Sq.m. for panes upto 600 mm. x 600 mm.

For panes larger than 600 mm. x 600 mm. and upto 800 mm. x 800 mm. glass weighing not less than 8.75 Kg./Sq.m. shall be used. For bigger panes upto 900 mm. x 900 mm. glass weighing not less than 11.25 Kg./Sq.m. shall be used.

Sheet glass shall be patent flattened glass of best quality and for glassing and framing purposes shall conform to I.S. 761-1960. Sheet glass of the specified colours shall be used, if so shown on detailed drawings or so specified. For important buildings and for panes with any dimensions over 900 mm. plate glass of specified thickness shall be used.

**Plate Glass :**

When plate glass is specified it shall be "Polished Patent Plate Glass" of best quality. It shall have both the surface ground flat and parallel and polished to obtain clear undisturbed vision and reflection. The plate glass shall be of the thickness mentioned in the item or as shown in the detailed drawing or as specified. In the absence of any specified thickness, the thickness of plate glass to be supplied shall be 6 mm. and a tolerance of 0.20 mm. shall be admissible.

**Obscured Glass :**

This type of glass transmits light so that vision is partially or almost completely obscured. Glass shall be plain rolled, figured, ribbed or fluted, or frosted glass as may be specified as required. The thickness and type of glass shall be as per details on drawings or as specified or as directed.

**Wired Glass :**

Glass shall be with wire netting embedded in a sheet of plane glass. Electrically welded 13 mm. Georgian square mesh shall be used. Thickness of glass shall not be less than 6 mm. wired glass shall be of type and thickness as specified.

**M-26 FIXTURES & FASTENINGS :**

**General :**

- i] The fixtures and fastenings, that is, butt, hinges, tee and strap hinges, sliding door bolts, tower bolts, door latch, bath-room latch, handles, door stoppers, casement window fasteners, casement stays and ventilator catch shall be made of the metal as specified in the item or its specifications.
- ii] They shall be of iron, brass, aluminium, chromium plated iron, chromium plated brass, copper oxidized iron, copper oxidized brass or anodized aluminium as specified.
- iii] The fixtures shall be heavy, medium or light type. The fixtures and fastenings shall be smooth finished and shall be such as will ensure ease of operation.
- iv] The samples of fixtures and fastenings shall be got approved as regards quality and shape before providing them in position.
- v] Brass and anodized aluminium fixtures and fastenings shall be bright finished.



**Holdfasts :**

- i] Holdfasts shall be made from mild steel flat 30 cm. length and one of the holdfasts shall be bent at right angle and two nos. of 6 mm. dia. hooles shall be made in it for fixing it to the frame with screws. At the other end, the holdfast shall be forked and bent at right angles in opposite directions.

**Butt Hinges :**

- i] Railway standard heavy type butt hinges shall be used when so specified.
- ii] Tee and strap hinges shall be manufactured from M.S. sheet.

**Sliding Door Bolts (Aldrops) :**

- i] The aldrops as specified in the item shall be used and shall be got approved.

**Tower Bolts (Barrel Type) :**

- i] Tower bolts as specified in the item shall be used and shall be got approved.

**Door Latch :**

- i] The size of door latch shall be taken as the length of latch.

**Bathroom Latch :**

- i] Bathroom latch shall be similar to tower bolt.

**Handle :**

- i] The size of the handles shall be determined by the inside grip length of the handles. Handles shall have a base plate of length 50 mm. more than the size of the handle.

**Door Stoppers :**

- i] Door stoppers shall be either floor door stopper type or door catch type. Floor stopper shall be of overall size as specified and shall have a rubber cushion.

**Door Catch :**

- i] Door catch shall be fixed at a height of about 900 mm. from the floor level such that one part of the catch is fitted on the inside of the shutter and other part is fixed in the wall with necessary wooden plug arrangements for appropriate fixity. The catch shall be fixed 20 mm. inside the face of the door for easy operation of catch.

**Wooden Door Stop With Hinge :**

- i] Wooden door stop of size 100 mm. x 60 mm. x 40 mm. shall be fixed on the door frame with a hinge of 75 mm. size and at a height of 900 mm. from the floor level.

The wooden door stop shall be provided with 3 coats of approved oil paint.

**Casement Window Fastner :**

- i] Casement window fastener for single lead window shutter shall be left or right handed as directed.

**Casement Stays (Straigot Peg.Stay) :**

- i] The stays shall be made from a channel section having three holes at appropriate position so that the window can be opened either fully or partially as directed.

Size of the stay shall be 250 mm. to 300 mm. as directed.

**Ventilator Catch :**

- i] The pattern and shape of the catch shall be as approved.

**Pivot :**

- i] The base and socket plate shall be made from minimum 3 mm. thick plate, and projected pivot shall not be less than 12 mm. dia. and 12 mm. length and shall be firmly riveted to the base plate case of iron pivot and in single piece base in the case of brass pivot.

**M-27 PAINTS :**

**27.1 Oil Paints :**

Oil paints shall be of the specified colour and shade, and as approved. The ready mixed paints shall only be used.

However, if ready mixed paint or specified shade or tint is not available white ready mixed paint with approved stainer will be allowed. In such a case, the contractor shall ensure that the shade of the paint so allowed shall be uniform.

All the paints shall meet with the following general requirements ;

- i] Paint shall not show excessive setting in a freshly opened full can and shall easily be redispersed with paddle to a smooth homogeneous state. The paint shall show no curdling, livering, caking or colour separation and shall be free from lumps and skins.
- ii] The paint as received shall brush easily, possess good levelling properties and show no running or sagging tendencies.
- iii] The paint shall not skin within 48 hours in a three quarters filled closed container.
- iv] The paint shall dry to a smooth uniform finish free from roughness, grit unevenness and other imperfections.

Ready mixed paint shall be used exactly as received from the manufacturers and generally according to their instructions and without any admixtures whatsoever.

#### **27.2 Enamel Paints :**

The enamel paint shall satisfy in general requirements as mentioned in specification of oil paints. Enamel paints shall conform to I.S. 2933-1975.

#### **M-28 FRENCH POLISH :**

The French polish of required tint and shade shall be prepared with the below mentioned ingredients and other necessary materials :

- i] Denatured spirit of approved quality.
- ii] Shellac.
- iii] Chandras.
- iv] Pigment.

The french polish so prepared shall conform to I.S. 348-1968.

#### **M-29 MARBLE CHIPS FOR MARBLE MOSAIC TERRAZZO :**

29.1 The marble chips shall be of approved quality and shades. It shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering.

- 29.2 The size of various colours of marble chips ranging from the smallest upto 20 mm. shall be used where the thickness of top wearing layers is 6 mm. in size. The marble chips of approved quality and colours only as per grading as decided by the Engineer-in-charge shall be used for marble mosaic tiles or works.
- 29.3 The marble chips shall be machine crushed. They shall be free from foreign matter, dust etc. Except as above the chips shall conform to I.S. 2114-1962.

#### **M-30 FLOORING TILES :**

##### **A] Plain Cement Tiles -**

- 30.1.1 The plain cement tiles shall be of general purpose type. These are the tiles in the manufacture of which no pigments are used. Cement used in the manufacture of tiles shall be as per Indian Standards.
- 30.1.2 The tiles shall be manufactured from a mixture of cement and natural aggregates by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 140 Kg./Sq.cm. The proportion of cement to aggregate in the backing of the tiles shall be not leaner than 1:3 by weight. The wearing face, though the tiles are of plain cement, shall be provided with stone chips of 1 to 2 mm size. The proportion of cement to the marble chips aggregate in the wearing layer of the tiles shall be three parts of cement to one part of chips by weight. The minimum thickness of wearing layer shall be 3 mm. The colour and texture of wearing layer shall be uniform throughout its face and thickness. On removal from mould, the tiles shall be kept in moist condition continuously at least for seven days and subsequently, if necessary, for such long period as would ensure their conformity to requirements of I.S. 1237-1980 requiring resistance to wear and water absorption.
- 30.1.3 The wearing face of the tiles shall be plain, free from projections, depressions and cracks and shall be reasonably parallel to the back face of the tile. All angles shall be right angle and all edges shall be sharp and true.
- 30.1.4 The tile sizes shall generally be square shape 24.85cm. x 24.85cm. or 25cm. x 25cm. The thickness of the tiles shall be 20 mm.
- 30.1.5 The tolerance of length and breadth shall be plus or minus 1 mm. The tolerance on thickness shall be plus 5 mm.

30.1.6 The tiles shall satisfy the tests as regards transverse strength, resistance to wear and water absorption as per I.S. 1237-1980.

**30.2 B] Plain Coloured Tiles :**

30.2.1 These tiles shall have the same specifications as for plain cement tiles as per (A) above except that they shall have a plain wearing surface wherein pigments are used. They shall conform to I.S. 1237-1980.

30.2.2 The pigment used for colouring cement shall not exceed 10% by weight of cement used in the mix. The pigments, synthetic or otherwise, used for colouring tiles shall have permanent colour and shall not contain materials detrimental to concrete.

30.2.3 The colour of the tiles shall be specified in the item or as directed.

**30.3 C] Marble Mosaic Tiles :**

30.3.1 These tiles have the same specifications as per plain cement tiles except the requirements as stated below ;

30.3.2 The marble mosaic tiles shall conform to I.S. 1237-1980. The wearing face of the tiles shall be mechanically ground and filled. The wearing face of tiles shall be free of projections, depressions and cracks and shall be reasonably parallel to the back face of the tiles. All angles shall be right angles and all edges shall be sharp and true.

30.3.3 Chips used in the tiles be from smallest upto 20 mm. size. The minimum thickness of wearing layer of tiles shall be 6 mm. For pattern of chips to be bad on the wearing face, a few samples with or without their full size photographs as directed shall be presented to the Engineer-in-charge for approval.

30.3.4 Any particular samples, if found suitable shall be approved by the Engineer-in-charge, of he may ask for particular sized chips to be more or less in the sample presented. The samples shall have to be made by the contractor till a suitable sample finally approved for use in the work. The contractor shall ensure that the tiles supplied for the work shall be in conformity with the approved sample only, in terms of its dimensions, thickness of backing layer and wearing surface, materials, ingredients, colour shade, chips, distribution etc. required.

30.3.5 The tiles shall be prepared from cement conforming to Indian Standards or coloured portland cement generally depending upon the colour of tiles to be used or as directed.

**30.4 D] Chequered Tiles :**

- 30.4.1 Chequered tiles shall be plain cement tiles or marble mosaic tiles. The former shall have the same specification as per (A) above and the latter as per marble mosaic tiles as per (C) except as mentioned below.
- 30.4.2 The tiles shall be of nominal size of 250mm. x 250mm. or as specified. The center to center distance of the chequer shall not less than 25mm. and not more than 50mm. The overall thickness of the tile shall be 22mm.
- 30.4.3 The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3mm. The chequered tiles shall be plain, coloured or mosaic as specified. The thickness of the upper layer measured from the top of the chequers shall not be less than 6mm. The tiles shall be given the first grinding with machine before delivery to site.
- 30.4.4 Tiles shall conform to relevant I.S. 1237-1980.

**30.5 E] Chequered Tiles for Staircases :**

- 30.5.1 The requirements of these tiles shall be the same as chequered tiles as per (D) above except in following respects :
- i] The length of a tile including nose shall be 330 mm.
  - ii] The minimum thickness shall be 28 mm.
  - iii] The nosing shall have also the same wearing layer at the top.
  - iv] The nosing edge shall be rounded.
  - v] The front portion of the tile for a minimum length of 75mm. from and including the nosing shall have grooves running parallel to nosing and at centres not exceeding 25mm. Beyond that the tiles shall have normal chequer pattern.

**M-31 ROUGH KOTAH STONE :**

- 31.1 The kotah stones shall be hard, even, sound and regular in shape and generally uniform in colour. The colour of the stone shall generally be green. Brown coloured stones shall not be allowed for use. They shall be without any soft veins, cracks or flaws.
- 31.2 The size of the stones to be used for flooring shall be size 600mm. x 60mm. and/or size 600mm. x 450mm. as directed. However, smaller sizes will be allowed to be used to the extent of maintaining the required pattern. Thickness shall be as specified.
- 31.3 Tolerance of minus 30 mm. on account of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be plus 3mm.

- 31.4 The edges of stones shall be truly chiseled and table rubbed with coarse sand before paving. All angles and edges of the stone shall be true, square and free from chipping and the surface shall be true and plain.
- 31.5 When machine cut edges are specified, the exposed edges and the edges at joints shall be machine cut. The thickness of the exposed machine cut edges shall be uniform.

**M-32 POLISHED KOTAH STONES :**

- 32.1 Polish kotah stone shall have the same specifications as per rough kotah stone except as mentioned below.
- 32.2 The stone shall have machine polished smooth surface. When brought on site, the stones shall be single polished or double polished depending upon its use. The stones for paving shall generally be single polished. the stones to be used for dedo, skirting, platforms sink, veneering, sills, steps etc. where machine polishing after the stones are fixed in situ is not possible shall be double polished.

**M-33 White Glazed Tiles :**

- 33.1 The tiles shall be of best quality as approved by the Engineer-in-charge. They shall be flat and true to shape. They shall be free from cracks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade.
- 33.2 The tiles shall be of nominal size of 150mm. x 150mm. unless otherwise specified. The maximum variation from the stated sizes, other than the thickness of tile, shall be plus or minus 1.5mm. The thickness of the tile shall be 6mm. except as above the tiles shall conform to I.S. 777-1970.

**M-34 GALVANISED IRON PIPES AHND FITTINGS :**

Galvanized iron pipe shall be of the medium type and of required diameter and shall comply with I.S. 1239-1979. The specified diameter of the pipes shall refer to the inside diameter of the bore. Clamps, screw and all galvanized iron fittings shall be of the standard 'R' or equivalent make.

**M-35 BIB COCK AND STOP COCK :**

- 35.1 A bib cock is a draw off tap with a horizontal inlet and a free outlet. A stop cock is a valve with a suitable means of connection for insertion in a pipe line for controlling or stopping the flow.
- 35.2 They shall be of screw down type and or brass chromium plated and of diameter as specified in the description of the item. They shall conform to I.S. 781-1977 and they shall be of best Indian make. They shall be polished bright.

35.3 The minimum finished weight of bib cock and stop shall be as given below ;

| Dia.   | Bib Cock | Stop Cock | Dia.   | Bib Cock | Stop Cock |
|--------|----------|-----------|--------|----------|-----------|
| 8 mm.  | 0.25 Kg. | 0.25 Kg.  | 15 mm. | 0.40 Kg. | 0.40 Kg.  |
| 10 mm. | 0.30 Kg. | 0.35 Kg.  | 20 mm. | 0.75 Kg. | 0.75 Kg.  |

**M-36 GUN METAL WHEEL VALVE :**

36-1 The gun metal wheel valve shall be of approved quality. These shall be of gun metal fitted with wheel and shall be of gate valve opening full way and of the size as specified. These shall conform to I.S. 778-1971.

**M-37 WHITE GLAZED PORCELAIN WASH BASIN :**

37-1 Wash basin shall be of white porcelain first quality best Indian make and it shall conform to I.S. 2556-(Part-IV)-1972 and I.S. 771-1979. The size of the wash basin shall be as specified in the item. The wash basin shall be of one piece construction with continued over-flow arrangements. All internal angles shall be designed so as to facilitate cleaning. Wash basin shall have single tap hole or two holes as specified. Each basin shall have a circular waste hole which is either rebated or bevelled internally with 65 mm. dia. at top and 10 mm. depth to suit the waste fitting. The necessary stud slot to receive the bracket on the under side of the basin shall be provided. Basin shall have an internal soap holder recess which shall fully drain into the bowl.

37.2 White glazed pedestal of the quality and colour as that of the basin shall be provided where specified in the item. It shall be completely recessed at the back for reception of supply and water pipe. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 750 mm. to 800 mm. as directed.

**M-38 CAST IRON PIPES AND FITTINGS :**

38.1 All soil, waste, vent and antisiphonage pipes and fittings shall conform to I.S. 1729-1964. The pipes shall have spigot and socket ends with head on spigot end. The pipes and fittings shall be true to shape, smooth, cylindrical their inner and outer surfaces being as nearly as practicable concentric. They shall be sound and nicely cast and shall be free from cracks, laps, pin holes or other imperfections and shall be neatly dressed and carefully fettled.

38.2 The end of pipes and fittings shall be reasonably square to their axis.

38.3 The sand cast iron pipes shall be of the diameter as specified in the description and shall be in length of 1.5 M., 1.8 M. & 2.0 M. including socket ends of the pipe unless shorter length are either specified or required at junction



etc. The pipes and fittings shall be supplied without ears unless specified or directed otherwise.

- 38.4 Tolerances : The standard weights and thickness of pipes shall be as shown in the table below. A tolerance upto minus 10% may however be allowed against these standard weights.

| Sr. No. | Nominal Dia. of Bore | Overall Thickness | Weight of Pipe Excluding Ears |           |           |
|---------|----------------------|-------------------|-------------------------------|-----------|-----------|
|         |                      |                   | 1.5M.long                     | 1.8M.long | 2M.long   |
| 1.      | 75 mm.               | 5.0 mm.           | 12.83 Kg.                     | 16.52 Kg. | 18.37 Kg. |
| 2.      | 100 mm.              | 5.0 mm.           | 18.14 Kg.                     | 21.67 Kg. | 24.15 Kg. |
| 3.      | 150 mm.              |                   |                               |           |           |
| 4.      | 250 mm.              |                   |                               |           |           |

A tolerance upto minus 15% in thickness and 20 mm. in length will be allowed. For fittings tolerance in lengths shall be plus 25 mm. and minus 10 mm.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights and thickness shall be the same as for straight pipes.

**M-39 ASBESTOS CEMENT PIPE (A.C. PIPE) :**

- 39.1 The asbestos cement pipe of diameter as specified in the description of the item shall conform to I.S. 1926-1980. Special like bends, shoes cowl, etc. shall conform to relevant Indian Standards. The interior of pipe shall have a smooth finish, regular, surface and regular internal diameter. The tolerance in all dimensions shall be as per I.S. 1926-Part-I-1980.

**M-40 BITUMEN FELT FOR WATER PROOFING AND DAMP PROOFING :**

- 40.1 Bitumen felt shall be on the fibre bases and shall be of type 2, self finished felt grade-2 and shall conform to I.S. 1322-1970.

**M-41 SELECTED EARTH :**

- 41.1 The selected earth shall be that obtained from excavated material or shall have to be brought from outside as indicated in the item. If item does not indicate anything, the selected earth shall have to be brought from outside.
- 41.2 The selected earth shall be good yellow soil and shall be got approved from the Engineer-in-charge. In no case black cotton soil or similar expansive and shrinkable soil shall be used. It shall be clean and free from all rubbish and perishable materials, stones or brick bats. The clods shall be broken to a size of 50 mm. or less. Contractor shall make his own arrangements at his own costs for land for borrowing selected earth. The stacking of materials shall be done as directed by the Engineer-in-charge in such a way as not to interfere with any constructional activities and in proper stacks.
- 41.3 When excavated material is to be used, only selected stuff got approved from the Engineer-in-charge shall be used. It shall be stacked separately and shall comply with all the requirements of selected earth mentioned above.

**M-42 MARBLE SLAB :**

Marble slabs shall be white or of other colour and of best quality as approved by the Engineer-in-charge. Slab shall be hard, close, uniform and in texture. They shall also be free defects and cracks. The surface shall be machine polished to an even and perfectly plane surface and the edges, machine cut true and square. The rear face shall be rough enough to provide key for the mortar.

Marble slabs with natural veins, if selected shall have to be laid as per the pattern given by the Engineer-in-charge. Size of the slabs shall be minimum 450mm. x 450mm. and preferably 600mm. x 600mm. However, smaller sizes will be allowed to be used to the extent of maintaining required pattern.

The slab shall not be thinner than the specified thickness at its thinnest part. A few specimen of finished slab to be used shall be deposited by the contractor in the office for reference.

Except as above, the marble slabs shall conform to I.S. 1130-1969 or as revised from time to time.

**M-43 INDIAN TYPE WATER CLOSET :**

The Indian type white glazed water closet of first class quality, size as specified in the item and conforming to I.S. 771-1979 and I.S. 2556-(Part-II)-1981. Each pan shall have integral flushing ring of suitable type with adequate number of holes all around as directed to have satisfactory flushing. It shall also have an inlet at back of front for connecting flush pipe as directed. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform

and smooth. Pan shall be provided with 100 mm. diameter 'P' or 'S' trap with approximately 50 mm. water seal and 50 mm. diameter vent horn.

**FOOT RESTS :**

A pair of white glazed earthen ware rectangular foot rests of minimum size 250 mm. x 130 mm. x 20 mm. shall be provided with the water closet.

**M-44 GLAZED EARTHEN WARE SINK :**

The glazed earthenware sink shall be of specified size, colour and quality. The sink shall conform to I.S. 771- Part-II-1979. The brackets for sinks shall conform to I.S. 775-1970.

The pipes shall conform to I.S. 1239-Part-I-1973 and I.S. 404-1962 for steel and lead pipes respectively. 32 mm. brass waste coupling of standard pattern with brass chain and rubber plug shall be provided with sink.

**M-45 GLAZED EARTHEN WARE LIPPED TYPE FLAT BACK URINAL/CORNER TYPE URINAL :**

The lipped type urinal shall be flat back or corner type as specified in the item and shall conform to I.S. 771-1979.

It shall be of best Indian make and size as specified and approved by the Engineer-in-charge. The flat back or corner type urinal must be of first class quality, free from any defects, cracks etc.

**M-46 FLUSH COCK :**

Half turn flush cock (heavy weight) shall be of gun metal chromium plated of diameter as specified in the description of the item. The flush cock shall conform to relevant Indian Standards.

**M-47 NAHNI TRAP :**

Nahni trap shall be of cast iron and shall be sound and free from porosity or other defects which affect serviceability. The thickness of the base metal shall not be less than 6.5 mm. The surface shall be smooth and free from crack, chips and other flaws or any other kind of defects which affect serviceability. The size of nahni trap shall be as specified and shall be of self cleansing design.

The nahni trap shall be of quality approved by the Engineer-in-charge and shall generally conform to the relevant Indian Standards.

The nahn trap provided shall be with deep seal, minimum 50 mm. except at places where trap with deep seal can not be accommodated. The cover shall be cast iron. Perforated cover shall be provided on the trap of appropriate size.

**M-48 GULLY TRAP :**

Gully trap shall conform to I.S. 651-1960. It shall be sound, free from defects such as fire cracks or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.

The size of the gully trap shall be as specified in the item.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions, of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300mm. x 300mm. the cover weighing not less than 4.53 Kg. and the frame not less than 2.72 Kg. The grating cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

**M-49 GLAZED STONE WARE PIPE AND FITTINGS :**

The pipes and fittings shall be of best quality as approved by the Engineer-in-charge. The pipe shall be of best quality manufactured from stone-ware of fire clay, salt glazed thoroughly burnt through the whole thickness, of a close even texture, free from air blows, fire blisters, cracks and other imperfections, which affect the serviceability. The inner and outer surfaces shall be smooth and perfectly glazed. The pipe shall be capable to withstand pressure of 1.5 m. head without showing signs of leakage. The thickness of the wall shall not be less than (1/12)th of the internal dia. The depth of socket shall not be less than 38 mm. The socket shall be sufficiently large to allow a joint of 6 mm. around the pipe. The pipes shall generally conform to relevant I.S. 651-1980.

**M-50 CRYDON BALL VALVE :**

Ball valve of screwed type including polythene float and necessary lever etc. shall be of the size as mentioned in the description of item and shall conform to I.S. 1703-1977.

**M-51 CRACKSEAL :**

Crack seal manufactured by Chemistic / Chemisol Indian Ltd., is an acrylic base ready application compound.

**M-52 WATER STOPPER :**

150 mm wide 6 mm thick., PVC ribbed stopper or approved by Engineer-in-charge. It shall be either "Cali Plast", "omal" or as directed by Engineer-in-charge.

**M-53 Structural Steel Work :**

Supplying, fabricating & erecting in position mild steel structures from angles, channels, flats, plates etc. including cost of steel, cutting to required size. riveting, bolting or welding, fixing in the line and level, painting with two coats of approved enamel paint.

**General :**

1. Requirements specified in this section will form a part of detailed specifications for item of works falling under this category. Indian Standards shall apply as if included herein. Design of structure shall be in compliance with Indian Standards [IS] viz. for rivetts IS:1148-1964 for Bolts IS:1148-1964 and IS:800-1962, for structural fabrication IS:800-1962, etc. and its latest edition.

**Principal items are :**

- a] Structural steel member.
- b] Steel joints.
- c] Plates and connections.
- d] Steel chair assemblies.
- e] Pipes supports and hangers for piping in all locations.
- f] Ladders and stairs.
- g] Miscellaneous metal work for water supply.

2. **Quality Assurance :**

Unless otherwise specified all work specified herein and shown on the drawings shall conform to the applicable requirements of the following specifications and codes.

- a] Fabrication and erection of structural steel shall be in accordance with IS:800-1962.

- b] **Welding Inspection :**

The contractor shall perform all structural field welding under continuous inspection of a special Inspector representative of the owner. Notice will be given at least 24 hours in advance of needed inspections.

3. **Submittals :**

- a] **Shop Drawings :**

The contractor shall submit shop drawings for approval before fabrication of any of the work. Complete fabrication details with material and

specification lists showing all welds, fabrication and finish details, will be shown in the drawing. In approving shop drawings, the owner does not assume responsibility for accuracy of the work relative to other components as constructed.

4. Shop Fabrication :

i] General :

- a] The maximum possible fabrication of structural steel work shall be manufactured off - site in a fabrication shop.
- b] Shop connections shall be welded, or bolted unless otherwise indicated.
- c] As far as possible, all work shall be fitted and assembled in shop ready for erection.

ii] Members :

- a] All members shall be free from twists, kinks, buckles, or open joints.
- b] All members, holes, and their spacing shall be so accurately made that when assembled the parts shall come together and bolted without distortion.
- c] Parts assembled with bolts shall be in close contact, except where separators are required where unlike metals are in contact to insulate as necessary to prevent corrosion.

iii] Welding :

- a] Welding in shop and field shall be done by qualified welders who have experience of similar work. The standard for welders will be as required by IS:817-1966.
- b] All steel before being fabricated shall be thoroughly wire brushed, cleaned of all scale, and rust, and thoroughly straightened by approved methods that will not injure the materials being worked on.

iv] Erection :

- a] Erection shall include the installation and erection of all structural steel as called for in this section. The contractor shall verify correctness before starting erection.
- b] As erection progresses, the work shall be securely bolted up to take-care of all dead load, wind, and erection stresses.

c] No. final bolting or welding shall be done until each portion of the structure has been properly aligned and plumbed.

d] Bolts shall be drawn up tight and threads set so that nuts cannot become loose.

e] Damaged Members :

During erection, member which are bent twisted, or damaged shall be straightened or replaced as directed.

f] Anchor Bolts and Anchors:

Anchor bolts and anchors shall be properly located and built into concrete work. Bolts and anchors shall be placed by the use of templates or such other method as may be required to locate the anchors and anchor bolts accurately.

g] Bearing Plates :

Bearing plates shall be provided under beams and columns resting on walls or footings. Bearing plates may be attached or loose and aligned by steel welds or shims.

h] Substitutions :

Unless otherwise directed, the exact sections, shapes, thickness, sizes, weights, and the details of construction shown for the structural steel work shall be furnished. However, if the contractor because of his stock or shop practices, suggest changes if the net area of section is not thereby reduced if the section properties are at least equivalent and if the overall dimensions are not exceeded the same may be approved by the Engineer-in-charge. All substitutions or other deviations from drawings and/or specifications shall be specially noted or quoted on the shop drawing submittals.

i] Flame Cutting :

Flame cutting by the use of a gas cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. The use of a flame – cutting torch will be permitted only on minor members, when the member is not under stress, and only after the approval of the owner has been obtained.

j] Storage of Materials :

Structural material, either plain or fabricated, shall be stored above ground upon platforms, skids, or other supports. Materials shall be kept free from dirt, grease and other foreign matter and shall be protected from corrosion.

k] Steel Stairs :

To be fabricated true to size and details and provided complete with all attachments such as pipe rails and hand rails, checker plates grating type treads and landings. Shop and setting drawings shall be submitted beforehand for approval of the Engineer-in-charge.

M-54 Ladders :

i] Contingent upon designated requirements for different locations, galvanized steel unit will be fabricated conforming to requirements. Rails where indicated will be provided.

ii] M.S. Ladders

The M.S. Ladders with stringers as specified & the steps of M.S. bars of specified dia shall be curved. The size and dimensions shall be as specified or as shown in the drawings.

m. Steel Checkered Plate:

The checkered plate [size, location & type] shall be as shown in the drawing. Steel checkered plate and frames shall be galvanized from fabrication unless noted otherwise.

n. Stair Abrasive Safety Nosings :

Extend nosings to within 150 mm of wall or stringer and equip each with embedded anchorage of secure attachment. Finish flush with concrete at all cast-in-place concrete.

o. Test Reports :

Certified physical and chemical mill test reports for material used for major structural members shall be furnished. All tests shall be performed in accordance with applicable IS standards.

M-55 Structural steel and Miscellaneous Metal Works :

General :



This work shall include the furnishing and installation of all structural steel and miscellaneous metal work and related work including grating and grating supports, pipe hangers and supports, tanks, manhole steps, equipment guards, anchors and other appurtenances, and any other work shown on the drawings or herein specified. All materials shall be new, sound and of the best quality available.

a] Material :

Steel rolled sections, plates, and bars shall conform to the latest editions of IS:226, 808, 1730, 1731, 1732 & 3954. Pipe used for columns or other structural purposes shall conform to IS:1161-1968. Iron for castings shall conform to IS:210.

b] Steel Pipe :

Where used for columns or other structural purposes, pipe shall conform to IS:1161-1968.

c] Steel Joints :

These shall be fabricated true to size and details shown on drawings in strict conformity with requirements of appropriate standards.

d] Checkered Plate:

Plate shall be of regular quality carbon steel of the thickness shown on the drawings. The raised lugs shall be diamond shaped and have an angled and opposed pattern.

e] Common Bolts :

Bolts and nuts shall conform to IS:1363-1967.

f] Welding Electrodes :

The electrodes shall conform to the requirements of IS:814 latest edition.

g] Shop Painting :

Structural steel not designated to be galvanized shall be shop-coated using priming coat of red lead as specified in painting section of these specifications. The portion of steel to be embedded in concrete shall not be painted.

h] Galvanizing :

All metal work shown or specified to be galvanized shall be zinc coated as per IS : 2629-1966. The zinc coating should be free from defects and shall have uniform thickness of coating.

i] Galvanized coatings marred or damaged during erection or fabrication shall be repaired by any approved process as directed by the Engineer-in-charge.

ii] Test Reports :

Certified physical and chemical mill test reports shall be furnished by the contractor for material used for major structural members.

j] Shop Drawings :

Five sets of shop drawings shall be submitted. The Engineer does not assume responsibility for accuracy of the work relative to other plant components as constructed.

k] Anchor Bolts :

Anchor Bolts shall be galvanized and shall be fabricated as shown, or as specified by the equipment manufacture.

l] Steel Grating :

Seat angles and anchors shall be of steel, grating and support shall be galvanized. Gratings to be supplied and installed as detailed in the drawings.

m] Mechanical equipment guards :

All rotating belts, pulleys, and shafting shall be covered and guarded in conformity with applicable safety requirements or as directed by the Engineer-in-charge.

n] Miscellaneous structural works :

Steel fabricated components, units and assemblies for various equipment for water supply installation shall be fabricated as per drawings and conforming to various standard codes of manufacture as specified and applicable.

6. Final Painting After Erection :

a] After erection, wherever noticed all signs of rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust or dirt shall be dried and warmed by sun or otherwise before final painting is undertaken.

- b] After cleaning the surface as mentioned above, second coat shall be given with red oxide zinc chromate primer as per IS:2074 or as specified.
- c] Two coats of final paints of specified quality and shades as mentioned in the schedule of quantities shall be given over the primer coats.
- d] Application :

The paint shall be applied with brushes [not rags] and spread by 'crossing' as evenly and as smooth as possible. The surface shall be given two or more coats each coat being allowed to dry out sufficiently before the application of the subsequent coat. The brush shall finally be laid off softly and carefully in parallel strokes in a direction contrary to the crossing taking care that the brush marks are not left visible. The surface shall then present a uniform appearance and glossy texture, free from streaks, blisters etc.

**M-56 G.I. Hand Railing :**

Providing and fixing 40 mm dia. G.I. pipe (Class-B) railing in two rows 1000 mm high for the openings, platforms, stairs etc. including three coats of approved enamel paint etc. complete. Hand railing shall be with 40 mm of GI pipe in double rows with 40 mm of GI pipe upright at a spacing not more than 1.0 m and of one metre clear height. A toe guard (height 150 mm minimum) at the bottom of G.I. railing shall be provided. Hand railing shall be painted with two coats of enamel paint over a coat of red oxide primer. Hand railing shall be provided all around platforms, approach bridge, staircase and walkways.

**M-57 C.I. Steps :**

Providing and fixing in concrete or brick wall C.I. steps of required length & width as per specifications etc. complete.

C.I. Steps for sump shall be as per IS:5455. The shall be clean, well cast and shall be free from oil and sand holes wrapping etc. The C.I. steps shall be heavy duty type having size 300 x 150 x 25 mm portion of the step which projects from the wall of the wet well shall have a raised chequered design to provide an adequate non-slip grip.

Minimum weight of each step be as per I.S. The step shall be coated with approved bituminous paint.

**M-58 Manhole cover & frame :**

Manhole cover and frame shall be of provided and fixed as per the standard details given in IS:1726 [latest]. The dimension shall be as per the details specified in the drawing. The weight of manhole cover & frame should not be less than 100 Kg.

GENERAL MANAGER (TECH & ADMN)  
GUJARAT HIRA BOURSE  
SURAT

Contractor's seal & Signature :-

Name :-

Address :-

Date :-

## **CHAPTER - VI**

### **DETAILED SPECIFICATIONS FOR CIVIL WORKS**

#### **1.0 CLEARING THE SITES :**

- 1.1 The site at which the construction is to be done and the areas required for setting out and other operations shall be cleared of all obstructions, loose stones, and rubbish of all kinds, stumps of trees, C.I. Pipes, R.C.C. Pipes, brushwood as well as all trees shall be removed as directed. The roots shall be entirely grubbed up.
- 1.2 The products of the clearing to be stacked in such a place and in such a manner as directed by Engineer-in-charge.
- 1.3 In site clearing all trees not specially for preservation, bamboos, jungle wood and brushwood shall be cut down and their roots grubbed up. All wood and materials from the clearing shall be the property of Gujarat Hira Bourse and shall be arranged as directed by the Engineer-in-charge or his authorized agent. The materials found to be useful by the Engineer-in-charge shall be conveyed and properly stacked as directed within the specified limit. seless materials will be burnt or otherwise disposed off as directed.
- 1.4 All holes or hollows, whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well rammed and leveled off, as may be directed.
- 1.5 The contractor shall have to dismantle the existing concrete/ steel structure obstructing in construction area above as well as below ground shall be removed and cleared of as directed.
- 1.6 The contractor shall have to visit the site and familiarized themselves thouroughly with the site condition and all obstruction in construction of treatment plant before submitting the tender and shall have to quote the tender accordingly.

1.7 The contractor shall have to remove the existing C.I. and hume steel pipe line and any kind of structure obstructing during excavation.

1.8 No extra charge will be paid for removing any kind of obstructions.

**2.0 EXCAVATION :-**

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as directed. The contractor shall do the necessary shoring and shuttering in required. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required. No earth filling will be allowed for bringing it to level, if by mistake or any other reason excavation is made deeper or wider than that shown on the plan or as directed. The extra depth or width shall be made up with concrete of the same proportion as specified for the foundation concrete at the cost of the contractor.

**2.1 DISPOSAL OF EXCAVATED MATERIALS :**

2.1.1 No materials excavated from the foundation trenches, of whatever kind they may be, are to be placed even temporarily, upto 1.5 mts. or at the distance prescribed by the Engineer, from the outer edge of excavation. All materials excavated shall remain the property of the Gujarat Hira Bourse. Materials suitable and useful for backfilling or other use shall be stacked in convenient places but not in such a way as to obstruct free movement of men, animals and vehicles or encroach upon the area required for constructional purposes. The site shall be left clean of all debris on completion.

2.1.2 Disposal of excavated materials is subject to the following Unsuitable materials obtained from clearing site and excavation shall be disposed off within City Limit area as directed. Useful materials obtained from clearing site and excavation shall be stacked at convenient place as directed. Materials suitable for backfilling shall be stacked at convenient places as directed.

**2.2 CARTING OF SURPLUS EXCAVATED EARTH**

2.2.1 The contractor has to convey the surplus excavated stuff from the site to the place as directed by Engineer-in-charge within the GUJARAT HIRA BOURSE limit, (maximum distance of 10 KM. from work site) should be dumped and/or spread in such a way as not to obstruct the path of vehicles but it should also make approach to lay the earth beyond that dump. Neither any excuse for difficulties for passing the vehicle over the dumped earth shall be allowed not any extra charge will be paid to the contractor for the same.

2.2.2 The conveying of earth shall be done in such a manner that it shall not cause any delay in the progress of the work.

2.2.3 During the conveying of the earth due care shall be taken that the earth should not be misused or wasted. The contractor shall have arranged to collect the mis- spread earth with his own cost.

2.2.4 The earth should be loaded, unloaded and spread or dumped in the presence of the Engineer-in-charge or his representative.

### 3.0 DEWATERING :

3.1 The contractor shall arrange bailing out of water in the foundation or trenches, accommodated due to rains or by springs subsoil water, canal or river seepage and broken water mains or drains. The excavation shall be kept free from water and moisture content.

(i) During inspection.

(ii) When concrete work is in progress and will come above the natural water level.

3.2 Pumping from the interior of any foundation enclosure shall be done in such a manner as not to produce the possibility of the movement of water through any fresh concrete.

3.3 No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter unless it is done from a suitable sump separated from the concrete work by a water tight wall or similar other means or by any other method.

3.4 The operations of removal of water from trenches shall be so conducted by the contractor that there is no danger to foundation or stability of adjoining earth or structure.

3.5 In no case the dewatering should be stopped or failed during the work in progress.

3.6 The contractor has to arrange his own machinery, motor, engine, pump and other mechanical equipments with all the maintenance and labour as required for full efficiency of the work.

3.7 Necessary fuels and/or electrical power will be arranged by the contractor with all expenditure due to that on his part.

### 4.0 PLAIN CEMENT CONCRETE :

4.1 Before starting concrete the bed of foundation trenches shall be cleared of all loose materials, leveled, watered and rammed as directed.

4.2 Mixing : The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quality of work if approved by the Engineer-in-charge. When hand mixing is permitted by the Engineer-in-charge in case of breakdown of machineries and in the interest of the work, it shall be carried out on a

water tight platform and shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mixing in mechanical mixer shall be done for a period of 1.5 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose.

- 4.3 Transporting and placing the concrete : The concrete shall be handed from the place of mixing to the final position in not more than 15 minutes by the method as directed and shall be placed into the final position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences.

The concrete shall be laid in layers of 15 cms. to 20 cms.

- 4.4 Compacting : The concrete shall be rammed rapidly with heavy iron rammers to get the required compaction and to allow all the interstices to be filled with mortar.
- 4.5 Curing: After the final set, concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.

**5.0 REINFORCED CEMENT CONCRETE :**

- 5.1 The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case greater than one fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and to fill the concrete of the form.
- 5.2 For reinforced concrete work, coarse aggregate having a nominal size of 20 mm are generally considered satisfactory.
- 5.3 For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of coarse aggregate should usually be restricted to 5 mm. main bars, or 5 mm. less than the minimum cover to the reinforcement whichever is smaller.
- 5.4 Where the reinforcement is widely spaced as in solid slabs, limitations of size of the aggregate may not be so important, and the nominal maximum size may sometimes be as great as or greater than the minimum cover.
- 5.5 Admixture may be used in concrete only with approval of Engineer-in-charge based upon the evidence that with the passage of time, neither the compressive strength of concrete is reduced nor are other requisite qualities of concrete and steel impaired by the use of such admixture.
- 5.6 Form work shall conform to the shape lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to

safeguarded against any settlement of the form work during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bracing etc. shall be as per design.

### Cleaning and Treatment of forms

All rubbish, particularly chippings shaving and saw dust shall be removed, from the interior of the form before the concrete is placed and the form work in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil or form oil of approved manufacturer may be applied in case of steel shuttering in used. Soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surface and reinforcement bars.

### Stripping Time

In normal circumstances and where ordinary cement is used forms may be struck after expiry of following period

|  |          |
|--|----------|
| a] Sides of wall columns and vertical faces of beams | 2-4 Days |
| b] Beam soffits [crops left under]                   | 7 Days   |
| c] Removal of props slabs                            |          |
| i ] Slabs spanning upto 4.5 Mts.                     | 7 Days   |
| ii] Spanning over 4.5 Mts.                           | 14 Days  |
| d] Removal of porops to beams and Arches             |          |
| i] Spanning upto 6 Mts.                              | 14 Days  |
| ii] Spanning over 6 Mts.                             | 21 Days  |

### Procedure when removing the form work

All form work shall be removed without such shock or vibration as would the reinforced concrete. Before the soffit form work and struts are removed, the soffits and the concrete surface shall be where necessary in order to ascertain that the concrete has sufficiently hardened.

## 5.7 Centering

The centering shall be sufficiently strong to ensure absolute of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see



that behavior of centering and form work is satisfactory during concreting. erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the form to be removed.

#### **5.8 Scaffolding**

All scaffolding, hoisting arrangements and ladders etc. required for the facilitating of concreting shall be provided and removed on completion of the work by the contractor. The scaffolding, hoisting arrangements and ladders etc. shall be strong enough to withstand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge. However, the contractor shall be wholly responsible for the safety to the scaffolding, hoisting arrangements, ladders, work and workman etc.

The scaffolding, hoisting arrangements and ladders shall allow easy approach to the work spot and afford easy inspection.

#### **5.9 Re-use**

Before re-use, all forms shall be inspected by the Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

##### **Reinforcement**

The bars shall be kept in position by the following methods ;

- [ i] In case of beam and slab construction, sufficient number of precast cover blocks in cement mortar 1:2 (1 Cement, 2 coarse sand) about 4 x 4 cms. section and of thickness equal to the specified cover shall be placed between the bars and shuttering as to secure and maintain the requisite cover of concrete over the reinforcement.
- [ii] In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them, the templates shall be removed after concreting has been done below it. The bars may also be suitably tied by means of annealed steel wires to the shuttering to maintain their position during concreting.

All bars projecting from pillars, columns beams slabs etc. to which other bars and concrete are to be attached or bounded to later on, shall be protected with a coat of thin neat cement grout, if the bars are not likely to be incorporated with succeeding mass of concrete within the following days. This coat of thin neat cement shall be removed before concreting.

#### **5.10 Mixing**

For all works, concrete shall be mixed in a mechanical mixer which alongwith other accessories shall be kept in first class working condition and so maintained throughout the construction. Measured quantity of aggregate, sand and cement required for each

batch shall be poured into the drum of the mechanical mixer while it is continuously running. After about half a minute of dry mixing measured quantity of water required for each batch of concrete mix shall be added gradually and mixing continued for another one and a half minute. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons, it shall be done on a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign materials gets mixed with concrete not does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Specified quantity of water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10% above that specified.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the Engineer-in-charge the first batch of concrete from the mixture shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

#### **5.11 Consistency**

The degree of consistency which shall depend upon the nature of the work and methods of vibration of concrete, shall be determined by regular slump tests in accordance with I.S. 1199-1959. The slump of 10 mm to 25 mm shall be adopted when vibrators are used and 80 mm when vibrators are not used.

#### **5.12 INSPECTION**

Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment and general fitness but such inspection shall not relieve the contractor of his responsibility for the safety of men, machinery, materials and for results obtained. Immediately before concreting, all forms shall be thoroughly cleaned. Centering design and its erection shall be got approved from the Engineer-in-charge. One carpenter with helper shall invariably be kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited from reinforcement laid in position. For access to different parts, suitable mobile platforms

shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover mortar blocks of suitable size shall be cast and tied to the reinforcement timber, kapachi or metal pieces shall not be used for this purpose.

### **5.13 TRANSPORTING AND LAYING**

The method of transporting and placing concrete shall be as approved. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place.

All form work shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

Concreting shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes of its discharge from the mixer. Except where otherwise agreed to by the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 metres when internal vibrators are used and not exceeding 0.30 metres in all other cases. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into placed from a height exceeding 2 metres. When trunking or chutes are used they shall be kept close and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened swept clean, thoroughly wetted, and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all fresh water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old work, particular attention being given to corners and close spots.

All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of breakdowns. Concrete shall be judged to be compacted when the mortar fills the spaces between coarse aggregate and begins to cream up to form an even surface. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to dry mixture. During compaction, it shall be observed that needle vibrators are not applied on reinforcement which is likely to destroy the bond between concrete and reinforcement.

### **5.14 COMPACTING**

Concrete shall be properly compacted by use of vibrators or by rodding and spacing as directed by the Engineer, tamping as above shall be continued until all the entrained air is removed and the concrete has been compacted and completely fills the form. The sides of the form work shall be gently tapped by spades during concreting.

#### **5.15 CURING OF CONCRETE**

All concrete work shall be protected from direct rays of the sun and be kept wet for a minimum period of 10 days or for longer directed by Engineer-in-charge. Concrete laid shall not be disturbed and shall be suitably protected from any injury until completely set, particular care shall be taken at all corners and edges of the member. All horizontal concrete surface shall be kept constantly wet by ponding or any other manner. Concrete surface shall be cured either by sprinkling or by spraying water. Flat or fine vertical surfaces may be covered with damp gunny bags and watered frequently. In order to ensure adequate quantities of water for curing, the contractor shall make necessary arrangement such as providing sufficient lengths of temporary pipe line of suitable sizes, storage of water in tanks and/or use of blisties.

#### **5.16 CONCRETING THOROUGH WATER :**

Concrete shall not be deposited under water without the prior consent in writing of the Engineer. In the event of permission being given, the amount of cement in every batch shall be increased by twenty five percent entirely at the expense of the contractor and he shall take every reasonable precaution to ensure that cement or fine aggregate is not washed out of any concrete so deposited by any flow of water.

#### **5.17 FINISH OF CONCRETE :**

- [a] On removal of the shuttering and after the approval of the Engineer, honey combed surfaces shall be made good immediately by the method approved by the Engineer and superficial water and air holes shall be filled in. Unless instructed to the contractor the faces of exposed concrete placed against shuttering shall be rubbed down with a carborandum stone immediately upon removal of the shuttering to remove fins or other irregularities. The face of concrete for which shuttering is not provided other than a slab, shall be smoothed with a wooden float to give finished equal to that of the rubbed down face where shuttering is provided. No cement wash, mortar or paint may be applied to any concrete surface without the express instruction or permission of the Engineer.
- [b] All floors, slabs and inverts shall be laid to the required depths, thickness inclinations and curvatures, shown on the detail drawings Subsequently, and just before settling the concrete shall be finish off to a smooth and even surface with metal floats, unless otherwise ordered.

- [c] Laying of concrete floors and inverts in two courses will not be permitted, except where specified or special permission of the Engineer in writing. Where screeds are required or approved, the structural concrete shall be keyed and prepared as specified for construction joints and the screeding properly bonded.
- [d] First class plane surface free from ripples, hollows air holes or exposed aggregate is required.

#### 5.18 SAMPLING & TESTING OF CONCRETE

Samples from fresh concrete shall be taken as per I.S. 1199-1959 and cubes shall be made, cured and tested at 7 days or 28 days as per requirements in accordance with I.S. 516-1959. A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all mixing units. The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

| Quantity of Concrete in the work | No. of Samples  |
|----------------------------------|---|
| 1 - 5 Cmt.                       | 1   |
| 6 - 15 Cmt.                      | 2   |
| 16 - 30 Cmt.                     | 3   |
| 31 - 50 Cmt.                     | 4   |
| 51 & above                       | 4 + 1 additional<br>sample for each<br>additional 5 Cmt<br>or part thereof <sup>2</sup> |

Note : Atlest one sample shall be taken from each shift. Ten test specimens shall be made from each sample, five for testing at 7 days and the remaining five at 28 days. the samples of concrete shall be taken on each day of the concreting as per above frequency. The number of specimens may be suitable increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveals a poor quality of concrete and in other special cases.

The average strength concrete in proportion 1:4:8; 1:3:6; 1:2:4 & 1:1.5:3; 1:1:2 of the group of cubes cate for strength of 75, 100, 150, 200 & 250 Kg/Sq.cm. respectively at 28 days. 20% of the cubes cast for each day may have value less than the specified strength provided the lowest value is not less than 85% of the specified strength. If the concrete made in accordance with the proportions given for a particular grade does not yield the specified strength, such concrete shall be classified as belonging to the appropriate lower grade. Concrete made in accordance with the proportions given for a particular grade shall not, however, be placed in a higher grade on the ground that the test strength are higher than the minimum specified.

**5.19 STRIPPING**

The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike the form work. While fixing the time for removal of form work, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. In normal circumstances (generally where temperatures are above 20 degrees centigrade) and where ordinary concrete is used, forms may be struck after expiry of periods specified for respective item of form work. All form work shall be removed without causing any shock or vibration as would damage the concrete. Before the soffit and struts are removed, the concrete surface shall be and struts are removed, the concrete surface shall be exposed, where necessary in order to ascertain that the concrete has sufficiently hardened, centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metalities are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal parts shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to re-use the form work, it shall be cleaned and made good to the satisfaction of the Engineer-in-charge. After removal of form work and shuttering, the Engineer-in-charge shall inspect the work and satisfy by random checks that concrete produced is of good quality. Immediately after the removal of forms, all exposed bolts etc. passing through the cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes be filled by cement mortar. All fine caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in proportions used in the grade of concrete that is being finished and of as dry consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which are pointed shall be kept moist for a period of 24 hours. If rock pockets/honeycombs in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and required the removal and replacement of the portions of the required the removal and replacement of the portions of the structure affected.

**CONSTRUCTION JOINTS :-** Concreting shall be carried out continuously upto construction joints, or predetermined by the Engineer-in-charge. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. The surfaces shall then be thoroughly cleaned, and all laitance removed with wire brushes and compressed air. In addition to that, the surface shall be completely wetted and slushed with a coat of neat cement grout immediately before placing of new concrete. The first layer of concrete to be placed on these surfaces shall not exceed 150 mm in

thickness and shall be well rammed against old work, particular attention being paid to corners and close sports. Shear keys shall be provided to all construction joints.

Reinforcing rods shall be extended 35 diameters beyond construction joints unless otherwise indicated. Joints in beams shall be kept at places where the shear force is minimum and these shall be at right angles to the direction of main reinforcement. In the case of columns, the joints shall be horizontal and about 150 mm below the bottom of the deepest beam framing into the column head, and the portion of the column between the stopping off level and the top of the slab shall be concreted with the beam. Joints in the R.C.C. slab shall be provided parallel to main reinforcements, or slabs supported thereon. Beams, girders, brackets, columns capitals and branches shall be considered as part of the floor system and shall be monolithically placed therewith.

Construction joints in water retaining structure :

Construction joints for the water retaining structures and underground storage area and lift pits in water logged areas shall be constructed as directed by the Engineer-in-charge prior to taking up any work of this type. Work shall conform to I.S. 3370 unless shown other wise.

Standard key joints should, however, be provided if so directed, in addition to the water stoppers in the concrete. The water stoppers shall be PVC or rubber type. Whenever required the transverse joints of the sheets shall either be welded or brased, or overlapped. In case of overlapping of the stoppers the overlap should be minimum and equal to the width of such water stoppers. In case of the PVC or rubber water stoppers, the stoppers can be of approved make. Deposition and compaction of concrete prior and after the construction joint should be very carefully done, so as to avoid internal honey combing. Before the next pour of concrete, the joints should be cleaned of the loose mortar, aggregates dust, preferably by hosing down the water. The surface of the old concrete which is coming in contact with the next pour should be wire brushed and reasonably sprinkled with thick cement slurry so as to ensure proper bond.

#### **5.20 PROTECTION OF CONCRETE :**

a] Concrete placed below ground level shall be protected from falling earth during and after placing. Concrete placed in ground containing deleterious substances shall be kept free from contact with such ground and with water draining there during placing for a period of three days or as otherwise instructed thereafter.

b] No load of any kind, however light, shall be allowed on concrete which has not properly set, and unless it has been pronounced by the Engineer.

c] Immediately after the compaction of the concrete has been completed contractor shall ensure that it is adequately protected from the weather. Protective materials

shall be kept continuously damp and in position for a minimum period of fourteen days or such other times as the Engineer may direct.

d] Where large sections of concrete are poured special precautions as approved by the Engineer shall be taken to reduced and dissipate the heat generally by the settling and hardening of the concrete.

**5.21 CONCRETE ADDITIVE :**

a] The use of retarders will not be permitted.

b] Other additives shall only be used if written permission has been obtained from the Engineer. They shall be obtained from a manufacturer approved by the Engineer and shall be used strictly in accordance with the manufacturer's and the Engineer's instruction.

c] Water Proofing additive at a rate of one packet per bag of cement shall be added in the concrete for M:20 grade.

**5.22 PERMISSION FOR STARTING THE CONCRETE WORK :**

The surface whether concrete or rock or form work etc. on which concrete is to be placed, shall be got inspected and approved by the Engineer, who shall then issue the permission for starting the work. Any concrete work done without such a permission shall be cut and removed at the cost of contractors. If concreting is to be done on concrete previously laid, the surface of the old concrete shall be cleaned with wire brushes and all laitance removed to expose the original surface of metal and sand particles, etc. It shall then be covered with a 7 mm thick layer of cement mortar [1:2] before laying the fresh concrete.

**B] FORM WORK :**

**1] Material :**

All form work for concrete works shall be made either of planned and matched timber or M.S. plates. The timber for the form work shall be hard wood dry and well seasoned. It shall not be so dry to absorb water from concrete nor shall it be so green as to shrink after erection. When steel plate are used for forms, the plates shall be free from wrinkles, dents, lumps or other imperfections. The timber boards or steel plates shall have sufficient thickness to withstand the construction loads and the pressure exerted by the wet concrete as well as vibration during placing of concrete. Normally the thickness shall not be less than 38 mm for timber and 18 gauge for M.S. plates. However, in case where the depth of concrete to be poured in the form work is small, the thickness of timber planks may be reduced in consultation with the Engineer.

**2] Arrangements :**



All the forms shall conform to the shape, lines dimensions as shown on the drawings. The form work shall include all wedging, bracing, tie rod, clamps, stop off boards and other devices necessary to mould the concrete to the desired shape. The form work shall be so constructed as to remain sufficiently rigid during the placing and compacting of concrete.

The use of bolts passing through concrete members which form parts or any water retaining structures shall be permitted for the purpose of securing and aligning the form work. The form work shall be so arranged as to permit easy erection initially and later easy removal without disturbing the concrete.

Before concrete is placed all rubbish shall be removed from the interior of the forms and the surfaces of the work in contact with concrete shall be cleaned and thoroughly wetted, and inside surface treated with lime, oil or any other material. The slab centering shall be covered with double wax' water proofing paper' or tar paper or polythene sheet as directed by the Engineer.

### 3] Removal of form work :

In no circumstances shall forms be struck off untill the concrete reaches adequate strength as required, without obtaining permission of the Engineer. All the form work shall be removed without such shock or vibration as would damage the concrete. Removal of the form work whether whole or in part, shall rest entirely with the contractor who must never the less be guided by the opinion of the Engineer in this regard.

### 4] Surface treatment and finish :

When the form work is struck, all the faces of concrete shall be smooth and sound, free from voids and air holes, If any roughness filled up while the concrete is still green, with cement wash and/or 1:1/2 cement mortar properly towolled and finished as directed by Engineer. If the concrete shall be dismantled and fresh concrete of proper quantity be reinstated at contractor's cost.

## 5.23 CONCRETE IN WATER RETAINING STRUCTURES :

### General

- a] The specifications define the materials, constructional and performance requirements for water tight concrete necessary for following structures. The work shall be done in accordance with this specification together with IS:3370 [PART-I to IV].
- b] The water retaining structure is to be constructed as per the general design indicated in the drawings supplied/ However, necessary for piping and electric conduits are to be provided during construction without any extra cost to owner.

- c] After construction, the structure has to be tested for water tightness as detailed hereunder and as per relevant Indian Standard Specifications, which is also included in the scope of this contract.
- d] For such structures where water tightness in addition to structural strength is of prime importance, special care shall be taken to get the most suitable grading of aggregate so as to produce the densest possible concrete. Water cement ratio shall also be controlled, consistent with the requirement of workability, to produce an impervious concrete.
- e] Concrete shall have at least the minimum cement required as per IS:3370.
- f] The concrete between the reinforcement and the form work on the water face shall be well compacted and the board joints made tight so that seepage of water shall not take place. Shutter vibrators at a rate of one vibrator per 2.5 m<sup>2</sup> of shutter area shall be used to produce a compact concrete with dense skin. wherever it is not possible to use shutter vibrators, pin vibrator shall be used. No extra payment will be made for use of shutter vibrators. The form work must also be so designed that shutter vibrators can be fixed and dismantled quickly.

**5.24 Admixture :**

Admixture shall be used in concrete only with the approval of the Engineer-in-charge. Normally approved compounds like "CICO", "PIDIPROOF" or equivalent of proven quality shall be permitted. It shall be used as per manufacturers specifications and the direction of the Engineer-in-charge. Contractor shall provide test certificates from recognized laboratories before use of admixture, if so desired by the Engineer-in-charge. Calcium chlorides shall not be used in admixture.

**Construction, contraction and Expansion joints :**

Joints are potential positions of leakage. It is also advantageous to avoid horizontal joints by using continuously moving forms or by providing sufficient form work of ordinary type to enable the entire wall to be concrete without interruption. Where days' work joints are formed whether horizontally or vertically, they shall be rebated as called out on drawings. Care shall be taken to remove from the earlier lift all loose pieces of gravel/stone chips, wooden, country nails or any other foreign materials. All laitance shall also be thoroughly removed. If necessary the face of the old concrete shall be well hacked to expose the aggregate and after washing the surface, a thin coat of mortar or grout [1 Cement : 1 Sand] shall be applied immediately before resuming concreting. A waterstop shall be placed through the joint specifically where the tank walls bond into the floor. Where an effective bond cannot be assumed at horizontal joints, a method that has been successful is to form a socket and spigot joint well caulked with asphalt or a bitumen filler and arrange to ensure that the water pressure tends to force the filling into rather than out of the joint. joints shall not be made at changes of concrete section if they can be conveniently placed elsewhere. Moving them even a few cms is often sufficient to prevent the secondary stresses being concentrated in one place leading to cracks. In long reservoir walls the design often

incorporates permanent joints which assist in preventing cracks due to shrinkage and temperature changes. When these joints are not indicated in drawings, it is best to concrete the wall in short section and provide spaces as per drawings between sections. As far as possible after completing the sections, the intervening spaces shall be filled in taking care to bond the old with the new work.

**5.25 WATER STOPPER :**

- 5.25.1 The quality of water stoppers shall be of 150 mm wide 6 mm thick ribbed type or approved by the Engineer-in-charge, before bring the same to the site of work. It shall be either "Cali Plast" "Omal" or "Chem Plast" or any other make as approved by the Engineer-in-charge.
- 5.25.2 At every horizontal and vertical joints of water retaining structure, water stopper of approved quality is to be provided as directed by Engineer-in-charge.
- 5.25.3 The water stops shall be thoroughly examined before putting it to use. It shall be placed in position carefully so as not to damage the same. Half of the width shall be embedded on each side of the joints between the adjacent sections, when embedding the first half of the width of the water stops great care should be taken to protect the other half from coming into contact with concrete by means of a suitable covering. After the concrete on the first half of the water stop sets, the protecting cover on the other half shall be removed and concrete poured to embed it.
- 5.25.4 It is essential that the water stop is properly aligned and placed in position during embedding. Where necessary the water stops shall be welded so as to have water proof joints.
- 5.25.5 The instructions for welding and/or vulcanizing as prescribed by the manufacturer shall be strickly adopted. It shall be seen that during the welding and vulcanizing of two pieces alignment of the central bulb is taken care of as this is essential for the correct finishing of the water stop.
- 5.25.6 The concrete shall not be poured from excessive height so as not to damage the water stops to prevent bending of the water stops.

**5.26 RENDERING :**

Rendering of cement mortar with addition of water proofing compound or equivalent shall be used with the object of covering weak patch in the concrete which still fresh the form work being struck as early as possible and the rendering applied immediately. The concrete surface shall be well wetted and if necessary, hacked or otherwise treated to form a key. If the rendering is applied in two coats, the joints shall be broken. The mortar shall be steel trowelled, but finished with a wooden flat.

**5.27 HYDRAULIC TESTING :**

Testing shall be restricted to underground, on ground and overhead structure only. These structures shall be tested strictly in accordance with IS : 3370 [PART-I] for water tightness. for underground structure the total maximum drop in water surface level over seven days shall not exceed 40 mm.

#### **5.28 TREATMENT OF SUSPENSION OF WORK :**

Whenever work is suspended on any section for more than one hour, the horizontal edges of the concrete next to the forms on surface which will be exposed shall be brought to a horizontal place perpendicular to the plane of the forms and treated so that the finished work will shown smooth straight line.

#### **5.29 FITTINGS :**

Pipes or other fittings passing through the walls and bottoms of water retaining structures are another potential source of weakness, and shall be on site in time to erect them in position in the shuttering before concreting commences. They shall be well embedded in the concrete and if provided with normal water bar flanges, there is little risk or leakage. An objection to building in fittings is that of the flanges are not in line with connecting flanges extra labour is required in making adjustments. Some Engineers prefer to have holes and fix the pipes fittings subsequently after completing the concrete work, however this difficult to ensure that this construction shall definitely be leak proof. Fittings built into concrete shall preferably be of non-corrosive material, so as to avoid frequent replacement leading to water leakage. If made of ferrous metals, the sections should be sufficiently substantial to prevent weakening by small corrossions. Care shall be taken that corrossive metal coming in contact with Portland cement shall receive a bitumen or equivalent corrossion preventing paint.

#### **5.30 GROUTING :**

##### **i] Grouting of Pockets :**

The grouting shall be done with C.M. in proportion of one part of portland cement plus one part of sand and one part of grit (mix. size 6 mm). Adequate quantity of water shall be added. The pockets shall be thoroughly cleaned before fixing the holding-down bolts. In cases where the anchor bolts with sleeves are orivuded, it should be the responsibility of the contractor to keep them clean. Similarly, the treated portion of the bolts shall be greased to protect them from damage. Grout shall be gradually poured in the pockets without disturbing the holding down bolts, and shall be tamped with a steel rod for proper compaction.

##### **[ii] Grouting under base plates & machine bases :**

The grouting shall be done in C.M. of one part of Portland cement and 2 parts of sand mixed with adequate quantity of water, unless otherwise specified. It shall be worked in and compacted, so that the entire space under base plates and around the anchor bolts in

thoroughly filled with the dense grout. Care should be taken that no air bubbles are left inside the grout. The grout shall be cured for a minimum period of 7 days by wetting the exposed areas. The shin plates under the bases should be left undisturbed while grouting is undertaken, prior to grouting, the space under the steel shall be thoroughly cleaned and watered without disturbing the shin plates. No grouting work shall be carried out all the basis are properly aligned and plumbed. After the grouting is done, anchor bolts should be tightened, while the grout is green till all the air bubbles cease and cement slurry comes out to ensure that the surface of bearing plate is entirely in contact with the grout.

#### **5.31 REINFORCED CEMENT CONCRETE [R.C.C.] :**

##### **MIX DESIGN [M-15 & M-20, M-25 and M30 ONLY)**

The contractor if desires to do concrete on mix design basis for Reinforced Cement Concrete. The mix design for the R.C.C. work shall have to get approved from the Engineer-in-charge of Gujarat Hira Bourse. The mix for the R.C.C. work shall have to be designed by the Government approved laboratories. The contractor shall follow the following specifications for mix design reinforced cement concrete work. The cost of mix design shall be borne by the contractor.

##### **5.31.1 PROPORTIONING MIX :**

The mix of fine and coarse aggregates, cement and water shall be designed by preliminary test to give the most dense concrete requiring the minimum quantity of cement paste for binding the materials to give the required strength, Water content and the water cement ratio shall be determined from the results of preliminary tests of concrete to give the specified strength with the materials proposed for use in actual work carried out before the work is started, adopting the consistency suitable for the work and method of compaction that will be actually used on site subject to the water cement Ratio as per Tabulated Separately.

##### **5.31.2 TEST :**

Test shall confirm to the specification laid down in I.S.456-1964. These test shall be got done in an approved laboratory at the cost of contractor.

##### **5.31.3 PRELIMINARY TESTS :-**

In preliminary test, three separate tests shall be carried out on samples collected from different stacks. Each test shall be carried out with six samples of 15 cm. [About 6"] cubes and 3 of these shall be tested at 7 days and 3 at 28 days. In preliminary tests the average crushing strength attained shall be 33 percent higher than that required on work tests.

##### **5.31.4 WORK TEST :**

For each of the work test, 6 samples shall be prepared from the concrete being used on the work 3 samples being tested at 7 days and the remaining 3 samples at 28 days. Work tests shall be carried out on each of the first six days and subsequently once in three working days or for every 60 cu.m. of concrete whichever is less and also whenever the quality or grading of the materials is changed when a relation between the strengths at 7 days and 28 days is established only 3 samples may be prepared and tested at 7 days only. This number of control specimen tests may be increased if the Engineer-in-charge considers if necessary.

#### **5.31.5 FIELD MIX :**

The actual proportion of the fine and coarse aggregates will be determined by preliminary tests. In the works tests, bulking of sand due to moisture if any, should be allowed for different batches according to the moisture actually present at the time of mixing. The moisture will be taken into account in controlling the mixing water also. The proportions once fixed by preliminary tests shall not be changed so long as the materials are the same, subject only to the quantities of fine aggregate and water being adjusted to compensate for bulking due to the moisture in sand and free water in fine aggregate at the time of use.

No change of materials shall be allowed unless fresh tests with new materials shows satisfactory results.

Water and cement content per batch of concrete as determined by preliminary tests shall be maintained constant except for suitable allowances to be made for surface moisture of the aggregates at the time of actual use.

Immediately upon the receipt of the award of the contract, the contractor shall inform the Engineer-in-charge the exact location of the sources of the acceptable materials which he proposes to use and get approved materials to be used shall be got designed in an approved laboratory by the Contractor with minimum water cement ratio as specified later in this specification to give specified strength in the preliminary tests and the proportions got approved by the Engineer-in-charge in writing. These proportions shall be used so long as the materials contains to be of the same quality and from the same sources subject only to slight changes in the relative quantities of fine and coarse aggregates for the purpose of promoting workability provided the works tests also the required.

If during the progress of the work, the Contractor wishes to change the materials, the proportion shall be fixed on the basis of fresh preliminary tests to give the required strength after the Engineer-in-charge is satisfied that the materials satisfy the specifications. No adjustment of cost shall be made for change of proportions of cement fixed in the original preliminary tests.

#### **5.31.6 MINIMUM WATER CEMENT RATIO :**

| Sr. No. | Types of concrete   | Mix Strength | Minimum water cement ratio |
|---------|---------------------|--------------|----------------------------|
| 1.      | Reinforced concrete | [a] M-300    |                            |
|         |                     | [b] M-250    | 0.55                       |
|         |                     | [c] M-200    | 0.60                       |
|         |                     | [d] M-150    | 0.62                       |

#### 5.31.7 PROPORTIONING OF FIELD MIX :

The proportion of sand and coarse aggregate shall be determined by weight. The weight-batch machine shall be used for maintaining proper control over the proportioning of aggregates as per mix design. Volumetric field mix shall be allowed only after prior sanction of Engineer.

| Field Mix :<br>Grade | Minimum Cement Content<br>(kg/Cu. M.) |
|----------------------|---------------------------------------|
| 150                  | 300                                   |
| 200                  | 400                                   |
| 250                  | 410                                   |

Workability shall be according to clause 6 of IS 456.

#### Minimum Compressive Strength :

| Grade | Compressive Strength in Kg/Cm <sup>2</sup><br>on 150 mm Cubes as per IS 516 |         |
|-------|---|---------|
|       | 7 Days  | 28 Days |
| 150   | 100   | 150     |
| 200   | 135   | 200     |
| 250   | 170   | 250     |
| 300   |   |         |

Note : In all cases 28 Days strength as specified above will be alone the criteria for acceptance or rejection.

#### 6.0 SAND FILLING :

- 6.1 The sand to be use for filling shall be free from salts, organic or other foreign matter. All clods of sand shall be broken.
- 6.2 As soon as the work in foundation has been completed the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc. sand filled with sand in layers not exceeding 20 Cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The sand shall be rammed with iron rammers where feasible and with the butt ends of crowbars, where rammer cannot be used.
- 6.3 The plinth shall be similarly filled with sand in layers not exceeding 20 cms. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 6.4 The finished level of filling shall be kept to shape intended to be given to floor.
- 6.5 The sand shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.
- 7.0 WATER PROOFING MATERIAL :
- 7.1 The water proofing compound ("CEM WET") or equivalent) shall conform to I.S. 9103-1979 and shall be approved by the Engineer-in-charge
- 7.2 The water proofing material of approved make shall be added to the cement at the rate of 200 gms. per 50 Kgs. cement bag or the proportion of water proofing materials to be mixed with 50 kgs. cement bags shall be as recommended by the manufacturer of the water proofing material and before using it shall be got approved by Engineer-in-charge.
- 7.3 The water proofing materials and cement in specified proportion shall be thoroughly mixed till a homogeneous mixture of uniform colour is obtained and to have efficient workability.
- 8.0 REINFORCEMENT :
- 8.1 General :  
Requirement specified here in provided for reinforcing work, complete as indicated, specified and required and including supply and delivery of reinforcing bars, and mesh, bending, wire brushing and cleaning, steel fixing and the attendance of a fitter during concreting, to inspect fixed reinforcing bars and maintain bars in correct position at each four locations. Whenever mention of I. S. code is made, the latest editions thereof shall be applicable.
- 8.2 Quality Assurance :



a] Code requirement -

Unless otherwise stated herein all work specified herein and as shown on the drawings shall conform to be applicable requirement of IS-456-latest edition. In case of water retaining structure IS-3370 Part-I and IV shall be applicable.

b] Standards :

Steel for reinforcing shall be of the following kinds as may be specified in the drawings. Mild steel plain bars conforming to IS:432-1960 and its latest edition. High yield deformed bars conforming to IS:1139-1966 and its latest edition.

c] Field quality control :

All continuous inspections shall be performed by the Engineer-in-charge's representative or his authorized assistant or a specialist called by the Gujarat Hira Bourse or the Engineer-in-charge. Reports as required by code or authorities concerned shall be prepared and submitted to the Gujarat Hira Bourse and such authorities.

The steel brought by the contractor when tested should comply with the test specifications in IS:1521 and IS:1608-1960.

8.3 Submittals :

A] Drawing :

The Engineer-in-charge will supply detail drawing of reinforced concrete work and bar bending schedules. The contractor shall check the drawing and the schedules and satisfy himself that these complement each other. In the event of a discrepancy the Engineer-in-charge shall be notified in writing and his ruling obtained.

8.4 Materials :

A] Reinforcing bars :

Reinforcement bars shall have to be brought by the Contractor as laid down in the tender condition.

B] Welded Wire mesh :

Mesh reinforcement, where specified shall conform to IS:1566-1967.

C] Binding wire :

Steel fixing shall be by 1.65 mm dia soft annealed wire.

**D] Supports and Accessories :**

Supports, cover or spacer for reinforcement shall be provided by precast mortar [1:2] blocks made with embedded wire ties. The cover blocks shall be made so as to provide the exact specified cover to reinforcement. Stays, blocks, ties, spacers or other supports as approved by Engineer-in-charge shall be provided at appropriate intervals to avoid sagging of bars between supports. Broken stones, bricks pieces, wooden blocks shall not be allowed.

**E] Dowels :**

Where and as designated on the drawings, steel bars dowels shall be provided for anchorage to previously cast concrete for anchorage where shown or required to existing construction, an approved non-shrink epoxy type grout or approved deferred bolting devices shall be used.

**8.5 Execution :**

**A] Bending :**

Unless otherwise indicated or specified bars shall be bent and fixed in accordance with the provisions of IS:2502. All bending shall be done with the use of an approved bending tool. Rebending of incorrectly bent bars shall not be permitted.

**B] Cleaning :**

Before placing reinforcement and again before concrete is placed, reinforcement shall be wire-brushed and cleaned of loose mill scale, oil, or other coating that might destroy or reduce bend.

**C] Concrete cover :**

Cover over reinforcing bars shall be as indicated. Correct concrete cover to reinforcement shall be maintained with the aid of approved cover blocks. Top reinforcement in slabs shall be maintained in position by means of chairs made out of mild steel, the diameter and quantity bending sufficient to ensure security of the reinforcement in shape and position.

**D] Securing in place :**

All reinforcement shall be securely and accurately fixed in positions shown on the drawings, care being taken to prevent contact with coated shuttering and forms. All

intersection of bar should be secured with approved clips or with wire, the ends being turned into the body of concrete.

E] Splices shall be wired contract lap splices unless otherwise indicated or approved. Splices at points of maximum tensile stress shall be avoided and shall be staggered elsewhere, lap length and other provisions shall conform to IS:456. Splicing of vertical bars in concrete be at approved positions.

Unless otherwise shown in case of horizontal bars lap splices shall be made with at least one continuous bar between adjacent splices, where double mats of bars occur in walls, lap splices in opposite mats shall offset at least 1.5 m.

#### **8.6 Welding :-**

When permitted or required joints of reinforcement bars shall be welded so as to transmit their full stresses. Welded joints shall preferably be located at points when steel will not be subjected to more than 75% of the maximum permissible stresses and welds so staggered that at any one section not more than 20% of the rods are welded. Only electric welding using a process which excludes air from molten and conforms to any or all other special provisions of or the work shall be accepted. Suitable means shall be provided for holding bars securely in position during welding. It shall be ensured that no voids are left in welding and when welding is done in two or three stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S. electrodes used for welding shall conform to IS:814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed.

#### **9.1 FABRICATION WORK :**

The structural steel work shall conform to M-18, red lead paint primer shall conform to I.S.-102-1962.

#### **9.2 The steel sections as specified or required shall be cut, square and to correct lengths. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member, except as permitted prior to starting of work as directed. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner so as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permitted.**

#### **9.3 The steel structure as per direction of the Engineer-in-charge shall be laid out on a level platform to full scale and in size or parts. A steel tape shall be used for measurements to ensure maximum accuracy.**

9.4 Welding shall generally be done by electric process. Gas welding shall be resorted to, using oxyacetylene flame with specific prior approval. Gas welding shall not be permitted for structural steel work.

9.5 The welding work shall conform to I.S. 816-1969.

9.6 Preparation of surfaces : Surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

9.7 Assembly for welding : Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the plates accurately in place without displacement.

9.8 Precautions :

All operations connected with welding and cutting equipment shall conform to safety requirements given in I.S.-1118-1968.

The following points shall be borne in mind during the process of welding :

a] Welds shall be made in flat position wherever practicable.

b] Arc length, voltage and amperage shall be suited to the thickness of material type of groove & other circumstances of the work.

c] The segments of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.

9.9 The defective welds which shall be considered harmful to the structural strength shall be cut out and re-welded.

9.10 Finished welds and adjacent parts shall be protected with clean boiled lined oil and after all slag has been removed welds and adjacent parts shall be painted after the same are approved.

9.11 All the members shall be thoroughly cleaned, of rust, scales, dust etc. and given a priming coat of red lead paint before fixing them in position. Testing of welding to be done as recommended by Engineer-in-Charge.

10.0 BRICK WORK :

10.1 Proportion :

The proportion of cement mortar shall be 1:6 (1 cement, 6 fine sand) by volume. In case of more than 230 mm thick brick wall and Cement mortar shall be 1:4 (1 Cement : 4 Fine sand) by volume in case of half brick work.

- 10.2 Wetting of bricks : The bricks required for masonry work shall be thoroughly wetted with clean water for about two hours before use or as directed. The cessation of bubbles, when the bricks are wetted with water is an indication of thorough wetting of bricks.

- 11.3 Laying :

Bricks shall be laid in English bond unless directed otherwise. Half or cut bricks shall not be used except when necessary to complete the bond. Closures in such case shall be cut to required size and used near the ends of the walls.

A layer of mortar shall be spread on full width for suitable length of the lower course. Each brick shall first be properly bedded and set home by gently tapping with handle of trowel or wooden mallet. Its inside face shall be flushed with mortar before the next brick is laid and pressed against it. On completion of course, the vertical joints shall be fully filled from the top with mortar.

The walls shall be taken up truly in plumb. All courses shall be truly horizontal and all vertical joint shall be truly vertical. Vertical joints in alternate course shall generally be directly one over the other. The thickness of brick course shall be kept in uniform.

The brick shall be laid with frogs up wards. A set of tools comprising of wooden straight edges, mason's spirit level, square half metre rule, and pins, string and plumb shall be kept on the site of work for frequent checking during the progress of work.

Both the faces of walls of thickness greater than 23 cms. Shall be kept in proper place. All the connected brick work shall be kept not more than one metre over the rest of the work. Where this is not possible, the work shall be raked back according to bond (and not left toothed) at an angle not steeper than 45 degrees.

All fixtures, pipes, outlet of water, hold fasts of doors and windows etc. which are required to be built in wall shall be embedded in cement mortar.

- 10.4 Joints :

Bricks shall be so laid that all joints are quite flush with mortar. Thickness of joints shall not exceed 12 mm. The face joints shall be raked out as directed by raking tool daily during the progress of work, when the mortar is still green so as to provide key for plaster or pointing to be done.

The face of brick shall be cleaned the very day on which the brick work is laid and all mortar dropping removed.

**10.5 Curing :**

Green work shall be protected from rain suitably. Masonry work shall be kept moist on all the faces for a period of seven days the top of masonry work shall be kept well wetted at the close of the day.

Preparation of Foundation Bed : If the foundation is to be laid, directly on the excavated bed, the bed shall be leveled, cleared of all loose materials, cleaned and wetted before starting masonry.

If masonry is to be laid on concrete footing the top of concrete shall be cleaned and moistened. The contractor shall obtain the engineer's approval for the foundation bed, before foundation masonry is started. When pucca flooring is to be provided flush with the top to plinth, the inside plinth of set shall be kept lower than the outside plinth top by the thickness of the flooring.

**10.6 Fixtures :**

The frames of doors, windows, cup-boards etc. shall be housed into the brick work at the correct location and level as directed. The heavy steel doors, window frames etc. shall be built in with brick work, but for ordinary steel doors and windows required opening for frames, hold-fasts etc. shall be left in the wall and frames embedded later on in order to avoid damage to the frames.

**10.7 Scaffolding :**

Necessary scaffolding shall be provided. The supports of the scaffolding shall be sound and strong tied together with horizontal pieces, over which the scaffolding plunks shall be fixed. Simple scaffolding shall be allowed normally. In this case scaffolding hole shall rest in hole header horizontal course only. Minimum number of holes shall be left in brick work for supporting horizontal scaffolding poles. The contractor is responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.

**10.8 Packing out of Joints :**

For the face of brick work, where plastering is to be done, joints shall be raked out to a depth not less than thickness of joints. The face of brick work shall be cleaned and mortar dropping removed on very same day that brick work is laid.

**11.0 UNCOURSED RUBBLE MASONRY :**

Providing uncoursed rubble masonry work, cement mortar 1:6 upto plinth level including providing scaffolding, curing, racking out joints including all labour and material.

**11.1 Stone :**

Stone shall be of approved quality. It shall be should, uniform in colour and free from decay and weathering, stone with round surface shall not be used. Unless otherwise approved, stones from one single quarry shall be used for any one work.

**11.2 Dressing :**

Stone shall be hammer dressed on the face and sides. The "bushing" on the face shall not project more than 20 mm on an exposed face and 15 mm on an exposed face and 15 mm on the face to be plastered.

**11.3 Mortar :**

The mortar to be used for jointing shall be as specified in the schedule of rates.

**11.4 Laying :**

All stones shall be wetted before use. They may be laid at random without being brought upto any level except at plinth. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones. For stones shall extend and bond well into the backing. Proper breaking of joints shall be done. Their height shall not be greater than the breadth at face or the depth inward.

Interior filling of the wall face shall consist of rubble stones not less than 130 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar.

No hollow space shall be left anywhere in the masonry chips not more than 20% of quantity of stone masonry may be used in the interior to fill interstices between adjacent stones in hearting wherever necessary to avoid thick mortar bed or joints. At about one meter interval vertical "plumbs", projecting upward about 50 to 200 mm shall be firmly embedded to forth a bond between successive courses. The masonry in a structure shall be carried regularly.

**11.5 Bond stone :**

Bond or through stone running right through the thickness of wall shall be provided in the walls having thickness upto 600 mm. If the walls are thicker that 600 mm, two or more bond stones overlapping each other by atleast 150 mm shall be provided in a line from face to back. Atleast one bond stone or a set of bond stones shall be provided for every 0.5 sq.m. of wall surface.

**11.6 Quoins :**

The quoins shall be of selected stones neatly dressed to the required angle and shall be of the same height as the course in which they occur and laid header and stretcher alternately. No quoin stone shall be less than 0.03 cu.m.

**11.7 Joints :**

Stones shall be so laid that all joints are full of mortar. Face joints shall vary from 12 mm to 25 mm thick, but not less than 12 mm. Joints shall be raked to a depth of 20 mm during construction, if walls are to be plastered or pointed. For the faces of wall which are not to be plastered stone surfaces shall be cleared of mortar dropping to give uniform appearance.

**11.8 Curing :**

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly wet for a minimum period of 10 days.

**12.0 PLASTER :**

**12.1 Inside plaster:**

Cement plaster shall be of 15 mm thick with cement mortar 1:3 (1 Cement : 3 fine sand)

**12.2 Scaffolding :**

Wooden bellies, bamboos, planks, treatles and other scaffolding shall be sound. These shall be properly examined before erection and use. Stage scaffolding shall be provided for ceiling plaster which shall be independent of the walls.

**12.3 Preparation of Background :**

The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, effloresce and other foreign matter by water or by brushing. Smooth surface be roughened by wire brushing if it is not hard and hacking if it is hard. 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. Trimming of projections on brick/concrete surfaces where necessary shall be carried out to get an even surface.

Raking of joints in case of masonry work where necessary shall be allowed to dry out for sufficient period before carrying out the plaster work.

The work shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry, such areas shall be moistened again.



#### 12.4 Outside plaster:-

Providing and applying 20 mm. thick sand faced cement plaster on walls up to height 10 metres above ground level consisting of 12 mm. thick backing coat of C.M. 1:3 [1 cement:3 sand and 8 mm. thick finishing coat in C.M.1:1 [1 cement:1 sand] etc. comp.

Materials :-

Water shall conform to M-1 cement mortar shall conform to M-8.

Workmanship :-

The work shall be carried out in two coats. The backing coat [basecoat] shall be 12 mm. thick in C.M. 1:3. The relevant specifications of Item No.14 shall be followed except that the thickness of back coat shall be 12 mm. average and the proportion shall be of cement mortar 1:3 [1 cement:3 sand]. Before the first coat hardens its surface shall be beaten up by edges of wooden tappers and close dents shall be made on the surface subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days, depending upon the weather conditions. The surface shall not be allowed to dry during this period.

The second coat shall be completed to 8 mm thickness in C.M. 1:1 as described above, including raising sand facing by bushing. The sample of sand face shall be got approved before the work is started. The whole work shall be carried out uniformly as per sample approved.

For external plaster, the plastering operation shall be started from top floor and carried downwards. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready and the temporary supports of the ceiling resting on the wall of the floor have been removed. Ceiling plaster shall be completed before starting plaster to walls.

#### 12.5 APPLICATION OF PLASTER

The plaster about 15 x 15 Cms. shall be first applied horizontally and vertically at not more than 2 metres intervals over the entire surface to serve as gauge. The surface gauges shall be truly in place of the finished plastered surface. The mortar shall then be applied in uniform surface slightly more than the specified thickness then brought to a true surface by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally, the surface shall be finished off true with a trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering, corners, junctions etc. shall be carried out with proper templates to the size required.

Cement plaster shall be used within half an hour after addition of water. Any mortar or plaster which is partially set shall be rejected and removed forthwith from the site.

In suspending the work at the end of the day, the plaster shall be left out clean to the line both horizontally and vertically. When recommencing the plaster, the edges of the old work shall be scrapped clean and wetted with cement putty before plaster is applied to the adjacent areas to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and nearer than 15 cms. to any corners or arises. It shall not be closed on the body of features such as plaster bands and cornices not at the corners or arises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as those invariably lead to leakage. No portion of the surface shall be left out initially to be packed up later on.

Each coat shall be kept damp continuously till the next coat is applied for a minimum period of 7 days. Moistening shall commence as soon as plaster is hardened sufficiently. Soaking or walls shall be avoided and only as much water as can be readily absorbed shall be used, excessive evaporation on the sunny or windward side of building in hot air to dry weather shall be prevented by hanging matting or gunny bags on the outside of the plaster and keeping them wet.

### **13.0 WATER PROOF PLASTER :**

- 13.1 The relevant specification of Item No. 12 shall be followed except that the water proofing materials as cement or approved make as per I.S. 9130-1979 shall be added to the cement at the rate specified or as directed by the Engineer-in-charge. The proportion of water proofing materials to be by the manufacturer of the water proofing materials.

### **14.0 I.P.S. FLOORING :**

- 14.1 I.P.S. flooring shall be 40 mm thick in cement concrete 1:2:4 (1 Cement : 2 coarse sand : 4 Stone aggregate 20 mm. nominal size) with a floating coat of neat cement.
- 14.2 The cement concrete flooring of 40 mm. thick (average) is to be laid as per the site conditions. The concrete shall be mixed in a mechanical mixer at the work. Hand mixing may be allowed for smaller quantities of work and in case of failure of machineries or as permitted by the Engineer-in-charge. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such cases 10% more cement than otherwise required shall have to be used without any extra cost. The mechanical mixing shall be done for a period of 1.5 to 2 minutes. the quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose. Flooring of specified thickness shall be laid in accordance with the approved pattern or as directed. Finishing operation shall start shortly after the

cessation or beating and shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be left for some time till moisture mixed with water to form a thick slurry and spread over the surface while the concrete is still green. Use of dry cement or cement and sand mixture sprinkled on this surface to stiffen the concrete or absorb excessive moisture shall not be permitted. The cement slurry shall then be properly pressed twice by means of iron floats, once when the slurry is applied and the second time when cement starts setting and finished floated smooth. The surface shall be marked with string or B.R.C. fabric jali to make the surface non-slippery as and when directed. The junction of floors with wall plaster, dado or skirting shall be rounded off where so required upto 25 mm. radius flooring in lavatories and bath rooms shall be laid after fixing of water closet and squatting pans and floor traps which shall be plugged while laying the floors and opened after the floors are completed. Any damage done to the water supply or sanitary fittings during execution of work shall be made good.

14.3 After the final set, the concrete shall be kept continuously wet, if required by ponding for a period of not less than 7 days from the date of placement.

14.4 The form work shall be provided if necessary as directed by the Engineer-in-charge. Concreting shall be done as per alternate bay method with necessary centering either by mastic or cement mortar as directed.

15.0 DOORS, WINDOWS AND VENTILATIONS :

a] Thickness of shutters - 35 mm.

b] Size of frame : 10 cm x 7 cm.

15.1 Frames :

All members of frames shall be exactly at right angles. The right angle shall be checked from inside surfaces of the respective members.

All members of frames shall be straight without any warp or bow and shall have smooth surfaces well planned on the three sides exposed at right angles to each other. The surfaces touching the wall may not be planned unless it is required in order to straighten up the member or to obtain the overall sizes within the tolerances as specified.

Frame shall have dovetail joints. When windows is included, it shall be provided by having full length one piece post for door or windows and clearstory window extending the frame on top at eh head to the required extent. Horns shall not be provided in the head of the frame. When no sills are provided, the vertical posts of the frame in the ground floor shall be embedded in the sill masonry for 10 cm. on upper floors, the vertical posts shall be fixed in the floor or masonry by forming notches 10 mm. deep. Sight adjustment of spacing as necessary shall be done to have

the holdfasts in the joints of masonry course. The frame shall be erected in position and held plumb with strong support iron both sides and built in masonry as it is being built. The transom shall be through tenoned in the mortises of the jamb post to the full width of the jamb post and the thickness of the tenon shall be not less than 15 mm.

- 15.2 Tolerance - Unless specially mentioned otherwise tolerance of 01 # 1.5 mm. shall be allowed for each wrought face.
- 15.3 The tenons shall be closely fitting into the mortices and suitably pinned with wood dowels not less than 10 mm. dia meter. The depth of rebates for housing the shutter shall be as directed.
- 15.4 The contact surface of tenon and mortise shall be treated before putting together with an adhesive of approved make.
- 15.5 Minimum number of three holdfasts shall be fixed on each side of door and window frames, one at the centre point and the other two at 30 cms. from the top and the bottom of the frames. In case of window and ventilator frames whose height is less than 1 M. two holdfasts, in each side shall be fixed at quarter points of the frames. The size of each holdfasts shall be 300 x 25 x 6 mm. and of mild steel with split end. The holdfasts shall be fixed with screws to frames.
- 15.6 Mild steel hold fasts shall be protected with a coating of coal asphalt tar. The surface of frame abutting the masonry or concrete faces shall be properly treated by applying a coat of approved coating.

Shutters - Pannelled shutters shall be constructed in the form of timber frame work of styles and rails with panel inserted of type as specified in the detailed drawings. Panel shall be fixed by providing grooves in the styles and rails. The styles and rails shall be joined to each other by mortise and tenon joints at right angles.

All members of the shutters shall be straight without any warp or bow and shall have smooth, well planned faces at right angles to each other.

The size of styles and rails shall be as per drawings or as directed. Styles and rails of shutters shall be made of one piece only.

Timber Panelling - Thickness of the panel shall be as specified in the drawings or as directed. If the panel is made from more than one piece, the piece shall be finished as shown in the detailed drawings and shall be joined with continuous groove with specified size. The end pieces of the panel and the top and the bottom of the panel shall be provided with continuous tongue to frame into groove of the frame shutter. An air space of 1.5 mm. shall be left in the groove of frame of shutter while framing the panel in it.

The faces of the panel as well as various pieces of the panel shall be closely fitted to the sizes of the grooves.

Finishing of the corners or raised panel edge shall be done as shown in drawings or as directed.

The thickness specified shall be finished thickness and no tolerance will be permitted.

Glazing - The glass panels shall be embedded in putty and secured to the rebate by wooden beads, or mouldings shape and size as approved with counter sunk screws of suitable size.

The glass panel shall be properly cut to fit the rebate of the frames and sashes fully with a slight minus margin of about 1.5 mm. of all sides. Before glazing the frame shall be primed and prepared for painting so that wood may not draw oil out of putty. The rebate shall be putted to an extent to provide bedding all round the glass.

The glass shall than be bedded in putty and fitted to frames with wooden beads or moulding as directed and screwed with wooden beads or moulding as directed and screwed with counter sunk screws. The screws shall be spaced not more than 100 mm. from each corner and nor more that 200 mm. apart.

The size of the rebate in the frame and size and shape of beads or moulding shall be as per detailed drawing or as directed. The beads or mouldings shall have mitred corners.

Fixtures & Fastenings - All fixtures and fastening of approved quality shall be provided with necessary screws. The hinges, bolts and other items cromium plated of iron mongery with moving part shall be properly oiled by the contractor before handing over the building.

- 15.8 Painting - The surface shall be cleaned and rubbed with sand paper to bring it in the one place. When finished, no scratches from the sand paper should show. After preparing the surface, one coat of white paint shall applied as priming coat.

After priming coat, all small holes, cracks, open joints and similar other minor defects of every kind shall be stopped with putty made from pure whitenin mixing to the appropriate consistency with raw linseed oil.

Little white lead being worked in other mixing to help hardening of putty. The work shall be rubbed down smooth with sand paper and the consequent coats of paint of the specified shade approved by the Engineer-in-charge shall be applied.

The paints shall be applied with brush. It shall be spread as smoothly as possible. Final coat shall be very crossed and laid off, so that brush marks are not visible.

Each coat of paint shall be allowed to dry thoroughly and shall be little rubbed in before the next one is laid.

Finish surface shall not show any hair marks ridges or dry patches of paint and no puddles shall be left in the corners of panels, angles of the mouldings etc.

**16.0 ROLLING SHUTTER :**

- 16.1 Rolling Shutter - The rolling shutter shall conform to I. S. 6248-1979. Rolling shutter shall be supplied of specified type with accessories. The size of the rolling shutter shall be as required & as directed. The shutter shall be constructed with interlocking plate sections formed from cold rolled steel strupes not less than 0.9 mm. thick and 80 mm. wide for shutters upto 3.5 m. width and not less than 1.25 mm. thick and 80 mm. wide for shutters 3.5 m. in width and above unless otherwise specified.

Guide channels shall be of mild steel deep channel section & of rolled pressed or built up(fabricated) jointless construction. The thickness of sheet shall not be less than 3.15 mm.

The rolling shutter shall be of self rolling type upto 8 Sq.M. clear area without ball bearing and upto 12 Sq.M. clear area with ball bearing. If the rolling shutters are of larger than gear operated type shutters shall be used.

The locking arrangements shall be provided at the bottom of shutters at both ends. The shutter shall be opened from the outside.

The shutters shall be completed with door suspension shafts locking arrangements, pulling hooks, handles and other accessories.

**17.0 20 MM THICK MARBLE/MOSAIC WHITE CEMENT TILES :**

- 17.1 Bedding - Before spreading the mortar, the sub-base of the floor shall be cleaned of all dirt, scum and loose materials and then well wetted without forming any pools of water on the surface.

In case R.C.C. floors, the top shall be left a little rough. All points of level for the finished surface shall be marked out. The lime mortar of proportion 1:1.5 (1 lime putty : 1.5 fine sand) or cement mortar of proportion C.M. 1:6 as directed shall then be evenly and smoothly spread over the base. Bedding layers of mortar shall be not less than 10 mm. and average thickness of bedding shall be 25 mm.

- 17.2 Laying - Before laying the terrazzo (marble/mosaic) tiles. The tiles shall be thoroughly wetted with water. Neat cement grout of required consistency at 4.4 Kg. cement per Sq.Mt. shall be spread on the mortar bed. The tiles shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope. There shall be no hollows left. The joints shall be of uniform thickness and in straight line as per the pattern.

The surface of flooring shall be checked frequently with a straight edge atleast two metres long so as to obtain a true surface with the required slope.

The tiles which are fixed in the floor adjoining the wall shall go about 10 mm. under plaster. Skirting or dado shall be left unfinished for about 50 mm. above finished floor level and unfinished strip then left earlier shall be finished.

In places where full tiles cannot be fixed. The tiles shall be cut to the size and smoothened at edges to give straight joints.

After the tiles have been laid, the surplus cement slurry and the joints shall be cleaned and washed fairly deep before cement hardens.

The day after tiles have been laid, the joints shall be cleaned of gray cement grout with a wire brush to a depth of about 5 mm. and then grouted with cement with or without pigment to match the shade of the topping of the tiles. The same cement slurry shall then be spread over the whole surface in a thin coat to protect the surface from abrasive damage and to fill pin holes that may exist on the surface.

- 17.3 Curing - The flooring shall be kept wet with damp sand or water for seven days. It shall be kept undisturbed at least for 14 days. The grinding shall normally be commenced after 14 days.

Polishing - After the tiles are properly cured, first grinding shall be done with carboundum stone of 48 to 60 gms. Grit fitted in machine. Water shall be properly used durin grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water, bearing all pin holes. It shall then be covered with a thin coat of white cement mixed with or without pigments to match the colour of the topping of the tiles.. Pin holes if any shall thus be filled. This grout shall be kept moist for a week. Thereafter, second grinding shall be started with carborundum of 120 grit. Grouting and curing shall follow again. Final grinding shall be done when other works are finished. The machine shall be fitted with carborundum of grit 220 to 350 using water in abundance. The floor shall then be washed clean with water. Oxalic acid powder shall then be dusted at 33 gms. per square metre on the surface and the surface rubbed with machine fitted with hessian bobs or rubbed hard with pad of woolen rags. The floor shall then be washed clean and dried with a soft cloth or linen. The finished floor shall not sound hollow when tapped with mallet.

If any tile is disturbed or damaged it shall be refitted or replaced properly jointed and polished.

Testing of the tiles shall be carried out by the contractor at his own cost as per I.S. requirement for required tests.

#### 18.0 WATER CLOSET :

- 18.1 The pan shall be sunk into the floor and embedded in a cushion of average 15 cms. cement concrete 1:5:10 (1 cement; 5 fine sand; 10 graded stone aggregate or brick aggregate 40 mm. nominal size) or as specified. This concrete shall be left 115 mm.

below the top level of the pan so as to allow for flooring and its bed concrete. The floor should be suitably sloped so that the waste water is drained into the pan. The pan shall be provided with 100 mm. 'P' or 'S' trap with approximately 50 mm. seal. The joints between the pan and the trap shall be made leak-proof with cement mortar 1:1 (1 cement; 1 fine sand).

- 18.2 The 'P' or 'S' trap shall be fixed with pan and cast iron pipe with C.M. 1:1. The pan shall be provided with a 100 mm. 'P' or 'S' trap an approximately 50 mm. seal. The joint between the pan and the trap shall be made leakproof with cement mortar 1:1 (1 cement; 1 fine sand).
- 18.3 After laying the floor, the floor shall be suitably sloped so that the waste water is drained into the pan. A pair of footrests of size 250 mm x 130 mm x 30 mm of white vitreous china shall be set in cement mortar 1:3 (1 cement; 3 coarse sand). The foot rests shall be fixed at a distance of 175 mm. from the inner edge of the back side of the pan and shall be fixed at convenient angle.

#### 19.0 WASH BASIN :

- 19.1 The wash basin shall be fixed on the wall as and where directed. The wash basin shall be supported on a pair of R.S. or C.I. brackets fixed in C.M. 1:3 (1 cement; 3 sand). The bracket shall conform to I.S. 775-1962. The wall plaster on the rear shall be cut to rest the top edge of the wash basin. After fixing the basin, plaster shall be made good and surface finished to match with the existing one.
- 19.2 The bracket shall be painted white with ready mixed paint. The C.P. brass trap and union shall be connected to 32mm.dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into an open drain leading to a gully trap or direct into the gully trap on the ground floor and shall be connected to a waste pipe through a floor trap on the upper floors. C.P. brass trap and union may not be provided where the surface drain or a floor trap is placed directly under the basin and the waste is discharged into vertically.
- 19.3 The height of the front edge of the wash basin from the floor level shall be 80 cms.
- 19.4 The capstan head pillar tap of specified dia. shall be fixed as directed with required washers of selected leather or rubber asbestos composition or plastic as directed. The cock shall be fixed with pipe line with white zink and spun yarn, to make joint water tight. The work shall be carried out in best workman like manner.
- 19.5 C.P. brass waste trap and union shall be connected to 32mm.dia. waste pipe which shall be connected suitably towards the wall and which shall discharge into the drain



through a floor trap. The C.P. brass waste trap shall be provided for wash basin or sink as the case may be.

- 19.6 The stop cock shall be fixed in position by means of jam, nut & socket. The stop cock shall be fixed near the inlet of the water metre or as directed. The joints shall be done with white zinc and spun yarn. The joint shall be tested for leak proofing.
- 19.7 The necessary inlet, outlet connections and fittings such as pillar coasks, C.P. brass waste trap, waste pipe, stop cock etc. shall be fixed as specified above.

**20.0 URINAL :**

- 20.1 The white earthenware flat back or corner type urinal of size 430mm. x 260mm. x 350mm. shall conform to M-45.
- 20.2 The urinals shall be fixed in position by using wooden plugs and screws and shall be at a height of 65 cms. from the floor level to the top of the lip of urinal, unless otherwise directed. The wooden plug shall be 50 mm. x 50 mm. at base lapping to 38 mm. x 38 mm. at top and 50mm. in length shall be fixed in wall in cement mortar 1:3 (1 cement; 3 coarse sand). The urinal shall be connected to a 32 mm. dia. Galvanized mild steel waste pipe which shall discharge in the channel or after tap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

**21.0 GLAZED TILES :**

- 21.1 Bedding -The sub-grade shall be cleaned, wetted and mopped. The bedding shall then be laid evenly over the surface tamped and corrected to desired levels and allowed to harden enough to offer a rigid cushion to tiles and to enable the mason to place wooden planks across and squat on it.

The white glazed tiles shall be laid on cement mortar bedding of 12 mm. thick in C.M. 1:3. The mortar shall have sufficient plasticity for laying and there shall be no hard lumps that would interfere with the evenness of bedding. The base shall be cleared and well wetted. The mortar shall then be spread in thickness not less than 10 mm. any place and on an average 12mm. thickness. The proportion of the cement mortar shall be as specified in the item.

- 21.2 Fixing Tiles -The tiles before laying shall be soaked in water for at least two hours. Neat grey cement grout at 3.3 Kgs./ Cement/ Sq.Mts. of honey like consistency shall be spread over the mortar bedding as directed. The edges of the tiles shall be well pressed and gently tapped with a wooden mallet till they are properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints between the tiles shall be as thin as possible in straight line or as per pattern.

The tiles shall not have staggered joints. The joints shall be thereto centre line both ways. The nahni trap coming in the flooring shall be so positioned that its grating shall replace only one tile as far as possible. Where full size tiles cannot be fixed, they shall be cut (sawn) to the required size and the edge rubbed smooth to ensure straight and true joints. The joints shall be filled with gray cement grout with wire, brush or trowel to a depth of 5mm. and loose material removed. White cement shall be used for pointing the joints. After fixing the tiles finally in an even plane the flooring shall be kept wet and allowed to stay undisturbed for 7 days.

- 21.3 Cleaning - The surplus cement grout that may have come out of the joints shall be cleared off before it sets. Once the floor has set, it shall be carefully washed, cleared by dilute acid and dried. Proper precautions and measures shall be taken to ensure that the tiles are not damaged in any way till the completion of the construction.

- 21.4 For skirting risers of steps and dado :

Preparation of Surface - In case of brick masonry work, the joints shall be raked out to a depth of at least 15 mm. while the masonry is being laid. In case of concrete wall the surface shall be chiseled and roughened with wire brushes. The surface shall be cleaned and wetted thoroughly before commencing the laying work.

Laying - The wall surface shall be covered with 10 mm. thick plaster of cement mortar 1:3 mix and allowed to harden. The plaster shall be roughened with wire brushes both ways. The back of tiles shall be floated with gray cement slurry and edges with white cement slurry set in bedding mortar. The tiles shall be gently tapped in position one after the other keeping the joints as thin as possible. Dado shall be truly horizontal and the joints vertical or as per the required pattern.

Risers of steps, skirting and dado shall rest on top of treads or flooring. Where full size tiles cannot be fixed, they shall be cut to the required size and the edges to be smoothened.

The joints shall be cleaned and flush pointed with white cement. The surface shall be kept wet for seven days. After curing the surface shall be washed clean.

- 22.0 C.I.NAHNI TRAP (75 MM DIA) :

- 22.1 The nahni trap with 100 mm. dia inlet and 50 mm. dia outlet shall be fixed as required or as directed.

- 22.2 The nahni trap shall be jointed with C.I. pipe, 75 mm. dia with lead joints. The lead joints shall be done in conformation with I.S. 782-1976.

- 23.0 GULLY TRAP : (150 MM X 100 MM) :

23.1 The gully trap shall be set in c.c. 1: 4: 8 extending 30 cms. beyond the trap on the three sides over which shall be constructed one brick masonry chamber of suitable size with C.I. cover in top. The lid of cast iron along with C.I. frame of size 300 mm. x 300 mm. inside shall be of approved quality and fixed in c.c. 1:2:4 75 mm. thick at top. The trap shall have C.I. gratings on top.

23.2 The C.I. cover shall be painted with two coats of anticorrosive paint of approved make.

**24.0 SEWER TRAP : (100 MM X 150 MM) :**

24.1 Necessary excavation shall be done as required. The foundation cement concrete of 1: 4: 8 shall be laid for a thickness of 15 cms. The S.W. trap shall be fixed into the position on the main sewer side of the chamber as directed. Brick masonry chamber of one brick thickness in C.M. 1:5 shall be constructed with the inside dimensions 60cms. x 45cms.

24.2 The inside of the chamber shall be plastered in 12 mm. thick C.M. 1:3 and shall be finished smooth with cement slurry. The outside of the chamber shall be plastered to a depth of 30 cms. from the top of the chamber. The item also includes providing and laying 1: 2: 4 cement concrete for fixing the C.I. frame and cover. The C.I. frame and cover shall be of the specified size and it shall not weigh less than 50 Kgs. including frame and cover.

**25.0 GALVANIZED MILD STEEL TUBES :**

25.1 Galvanized mild steel tubes of specified dia. nominal bore shall conform to I.S. 1239- 1961. The galvanized fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in-charge.

25.2 Cutting, Laying & Jointing - When the tubes are to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the tubes shall then be threaded conforming to the requirements of I.S. 554- 1955 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together.

The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack as the latter procedure may not result in a water tight joint. The screw threads for the tube and fittings shall be protected from edge until they are fitted.

In jointing the tubes, the inside of the socket screwed end of the tubes shall be oiled and smeared with white or red lead and wrapping around with a few turns of fine spun yarn round the screwed end of the tube. The end shall then be tightly screwed in the socket, tees, etc. with a pipe wrench. Care shall be taken that all pipes and fittings are

properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after 3 jointing shall be painted or in the case of under ground piping thickly coated with approved anti-corrosive paint to prevent corrosion.

- 25.3 Laying in Trenches - The width and depth of the trenches for different diameters of the tubes shall be as - For 15 to 80 mm. dia. tube width of trenches shall be 30 cms. and depth of trenches 60 cms. At joints, the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications of earth work in trenches.

The pipes shall be painted with two coats of anti-corrosive bitumastic paint of approved quality. The pipe shall be laid on a layer of 75mm. sand filled upto 150mm. above the pipe if so specified. The remaining portion of trench shall be then filled with excavated earth. The surplus earth shall be disposed of as directed.

When the excavation is done in rock the bottom shall cut deep enough to permit the pipe to be laid and cushion of sand 75mm. In case of bigger diameter of tube where pressure is very high, thrust block of cement concrete 1:2:4 (1 cement; 2 coarse sand; 4 graded stone aggregate of 20 mm. nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground and spreading it over a sufficient area if so specified.

- 25.4 Fixing of Tube Fittings to wall ceiling & floors - In case of fixing of tubes and fittings to the walls or ceilings, these shall run on the surface of the wall or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern, holder clamps keeping the pipes about 15mm. clear of the wall. When it is found necessary to conceal the pipe and when specified so, chasing may be adopted or pipe fixed in ducts or recesses etc. provided that there is sufficient space to work on the pipe with usual tools. The pipe shall not ordinarily be buried to walls or solid floors, where unavoidable, pipes may be buried for short distances provided that adequate protection is given against damage and where so required joints are not buried. Where required M.S. tube sleeves shall be fixed at a place a pipe is passing through a wall or floor for expansion and contraction and other movements. In case the pipe is embeded in walls or floors, it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime, under the floors, the pipe shall be laid in layer of sand filling.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern clamps or required size and shape, one end of which shall be properly plugged or cemented into walls with cement mortar 1:3 (1 cement; 3 coarse sand) and the other tightened round the pipes

to hold it securely. These clamps shall be spaced at regular intervals in straight lengths at 2 M c/c interval in horizontal run and 2.5 M. intervals in vertical run. For pipe of 15 mm. dia. upto 25 mm. dia. the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick or concrete. However, for higher diameter pipes and holes shall be carefully made of the smallest required size. After fixing the pipe holes shall be made good with cement mortar 1:3 (1 cement; 3 coarse sand) and properly finished to match the adjacent surface.

- 25.5 Testing of Joints - After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone, and all leaking pipes removed and replaced without extra cost.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6 Kg./sq.cm. The pipe shall be slowly and carefully charged with water allowing all air to escape and avoiding all stock and water hammer. The draw off takes and stock shall then be closed and specified hydraulic pressure shall be applied gradually. The pressure gauge must be accurate. The pipes and fittings shall be tested in sections as the work of laying proceeds, veeping the joints exposed for inspection during the testing.

26.0 R.C.C.NP2 CLASS PIPE :

- 26.1 Excavation of Trenches- The width of trenches shall be required and depth shall correspond to inlet level of the pipe and to the required levels as directed.

At joints, the trench width shall be widened where necessary.

The work of excavation and refilling shall be done true to line, and gradient in accordance with general specifications of earth work in trenches.

- 26.2 Laying - The pipe shall be laid accurately and perfectly true to line, levels and gradients. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulation. All junctions and changes in direction and diameter shall be made in cement concrete finished smooth and benched on both sides. The body of the pipe shall rest for its entire length, on an even level bed grips being made or left on the bed to receive the sockets of the pipes.

- 26.3 Jointing - Trarred gaskin or yarn soaked in near cement slurry shall first be placed with in coughing space of each pipe and the collar shall then be placed well home over the joint of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and gaskin ceulked home so as to fill not more than 1/4th of the total depth of (13 mm. in depth) the collar. The remainder of the collar shall be filled with stiff mixture of cement mortar in proportion of one part of cement and one part of sharp sand. When the collar is filled, a filled shall be formed round the joints trowel, forming an

angle of 45° with the barrel of the pipe. The cement mortar of (prop. 1:2) shall be mixed as necessary for immediate use. After the joint is made, any extraneous materials shall be removed from the inside of the joints with a suitable scraper or 'badger'. The newly made joints shall be protected, until set, from the sun, dry winds, rain or frost, sacking of other suitable materials which shall be used for the purpose.

The mortar shall be cured for 10 days.

- 26.4 Testing of joints - The pipe line shall be tested as directed. If any leakage is visible the defective part of the work shall be made good at no extra cost. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

27.0 SLUICE VALVE :

[i] (a) All Cast Iron Sluice Valves shall be manufactured strictly in accordance with and conforming to Indian standard specification IS : 2906 : 1984 and detailed specification of GUJARAT HIRA BOURSE.

(b) The valves are intended to be used in water supply system in vertical/horizontal position.

[ii] The material for different component parts of sluice valves shall conform to requirements given in Table : 1.

**TABLE-1**

| Sr.No. | Components   | Material  | Ref. to IS                   |
|--------|--|---|------------------------------|
| a.     | Body, bonnet, wedge, stuffing box, gland, thrust plate, cap. | Grey Cast Iron (F.G.200)                          | 210:1980.                    |
| b.     | Stem   | High tensile brass(forged)                        | 320:1980<br>6912:1973 (HT.2) |
| c.     | Wedge nut  | Leaded tin (Bronze)                               | 318:1981<br>(LTB.2)          |
| d.     | Body seating wedge facing ring.                              | “   | “                            |
|        | Bolts & Nuts (Class 4:6)                                     | Carbon steel                                      | 1363:1967                    |
| f.     | Bonnet gasket (class 4:6)                                    | Carbon steel                                      | 1363:1967                    |
| g.     | Gland packing  | a) Jute & hemp:2414:1969<br>b) Asbestos 4687:1980 |                              |
| h.     | Shoe & channel   | Brass 320:1980                                    |                              |

(iii) Manufacturing :

- (a) Bodies and Bonnets : Bodies & Bonnets shall be so designed as to withstand the best pressure specified in IS: 2906: 1984.
- (b) Flange : The flanges and their dimensions of drilling shall be in accordance with IS : 1538 : 1976.
- (c) Wedge : The Valves shall be fitted with double faced cast iron wedge made in one piece and having two machined facing rings security fixed in to machined recesses in the wedge (also not 'F' below)
- (d) Guides & Lugs : The guides and lugs shall be provided to guide the wedge through its full travel. The lugs & guide shall be lined with bronze.

- (e) The clearance between lugs and guides for different sizes of sluice valves shall be as given below :-

| Valve size<br>mm | Maximum clearance on<br>either sides of lug mm |
|------------------|--|
| 350 to 450       | 4  |
| 500 to 600       | 5  |
| 700 to 1200      | 6  |

- (f) Facing or seat rings : The dimensions of the body seat rings and wedge facing rings shall conform to IS 2906 : 1984. The wedge facing rings & body seat rings shall be secure riveted over and above sufficient hydraulic press fittings.
- (g) Stems & Wedge Nuts : The dimensions of stems and wedge nuts shall be in accordance with IS : 2906 : 1984 stems shall have a machine cut, single start trapezoidal threads of such length that the wedge can be raised to a position so as to ensure full or part flow passage through the valves. In fully closed position of the value the stem/spindle shall remain in full contract with wedge nut for its entire length with at least 10 mm projection. The length of the stem particularly below the collar should be kept accordingly.
- (h) The spindle nut must remain security engaged in the wedge. The detailed drawing showing dimension of spindle nut and portion of wedge engaging the spindle nut

must be furnished and in case of order, got approved prior to manufacturer. The fulfillment of this condition is a must whether included in the relevant Indian Standard or not.

- (i) Stuffing Box : The minimum inside dimensions of the stuffing box shall be in accordance with IS 2906:1984.
- (j) Valve Caps : All valves shall be provided with caps/ Valves caps shall be provided with nominal dimensions in accordance with IS 2906 : 1984. The direction of closing shall be indicated on the caps.
- (k) Gum metal scour or C.I. clearing door at the bottom of S.V. body shall be provided.
- (l) Bolts & Nuts : Bolts and nuts shall conform to IS 1363 : 1967 and IS 4218 : 1967.
- (m) Height of valve : The height of valves shall conform to IS 2906 : 1984.
- (n) Gears : Gears shall be of suitable design (IS 2535 : 1978) and workmanship, so as to ensure satisfactory working of sluice valve.

#### **V COATING :-**

Immediately after casting and before machining all C.I. parts shall be thorough cleaned, and shall be coated by dipping in bath containing a composition heaving a tar base.

The coating shall be such that it shall not impart any tests or smell to water.

#### **Testing:-**

All C.I. sluice valves shall be tested in presence of representative of the Gujarat Hira Bourse at manufacturer's works only & testing certificates shall be furnished alongwith each lot of supply.

a) Hydraulic Test:- Each values shall be subjected to hydraulic tests as described in appendix B of IS:2906:1984.

Test pressure & Test duration of sluice valves.

| PN reating<br>of valves | Test<br>Map (Gauge) | Test Pressure<br>mm | Test Duration |
|-------------------------|---------------------|---------------------|---------------|
| PN 1.6                  | Body test           | 2.4                 | 5             |
|                         | Seat test           | 1.6                 | 2             |



b) Liquid penetrant Test:- The forged high tensile brass stems shall not show any sign of flaw when subjected to liquid penetrate flow detection testing accordance with IS : 3658 : 1981.

c) Atleast 15 days clear notice about readines of testing should be given to the Gujarat Hira Bourse to enable representative to witness various tests at manufacturer's work.

#### **I MARKING:-**

The following information shall be cast on each valve body in raised letters.

- a) ISI Certification Mark.
- b) The manufacturer's name or Trade Mark.
- c) The nominal pressure of valve.
- d) The size of valve.
- e) Heat number of cast.

### **28.0 VALVE CHAMBER :**

28.1 The size of the chamber shall be as required and as directed.

Necessary excavation shall be carried out for constructing the chamber, foundation of c.c. 1:3:6 shall be 25 cm. thick and shall extend 8 cm. beyond the outer faces of the chamber. The thickness of the wall shall be as required or as directed by the Engineer depending upon the depth of the chamber.

But in no case the thickness shall be less than 23 cm. The masonry shall be plastered by 20 mm. thick in C.M. 1:3 to a full depth inside the chamber and for a depth of upto 30 cm below the ground level on the outside of the chamber.

Providing and laying R.C.C. slab in 1:2:4 c.c. with required reinforcement and providing and fixing manhole cover and frame in position cutting the reinforcement and placing and fixing the same in position by using binding wires as directed by the Engineer. The weight of the manhole cover frame shall be not less than 200 Kgs. Necessary C.I. steps weighting not less than 5.30 Kgs. shall be provided at 0.37 meter c.c. on one side of the wall. The exposed surface of the R.C.C. slab shall be plastered with C.M. 1:3.

Brick Masonry - The bricks shall be table moulded good, sound, hard, square well burnt, with straight sharp edges. Their size shall be uniform. No bricks after 24 hours immersion in water should absorb more than 20 percent of their dry weight. Any brick which in the opinion of the Engineer are defective in quality, will be allowed to

go into the work. Resistance of bricks to crushing shall not be less than 500 lbs. to the square inch. No bricks shall under any circumstances be used except such as to fulfill in all respects the conditions above specified and should the contractors fail to supply the bricks of the quality and description specified, and in such quantities as may from time to time be necessary for the expeditious progress of the work, the Engineer shall be at liberty to purchase on account of the contractor, and bring to the work such and so many bricks as the Engineer may from time to time deem necessary or desirable and the contractors shall in such case be charged with all cost which the Engineer may incur in supplying such bricks, and shall be bound to use in the work bricks so supplied.

The work shall be of best description and workmanship. No bricks shall be used in it except as closures, and in case of the contractors failing to supply good bricks, bricks approved by the Engineer only shall be used. All bricks shall thoroughly immersed in water at least for 12 hours before being used, and the brick work shall be protected from the sun and kept well moistened for at least three days after completion. The bricks are to be evenly and truly laid, breaking joint, course by course and properly bent together in every part. The joints are to be closed and regular and in no case exceed three eighth of an inch thickness. The bond shall be english, except where otherwise specified.

All bricks masonry work shall be plastered both inside and outside. To receive cement plastering, the walls shall be prepared by racking out the joints to a depth of 1/2" and watered. The cement plastering shall consist of three parts of fine sand and one part of cement. A rendering of cement plastering of the required thickness properly gauged, shall then be applied in an even and uniform coat and shall be well and repeatedly wetted and trowelled until hard and glossy surface is obtained.

#### **29.0 FILLING WITH EXCAVATED EARTH :**

- 29.1 The earth to be used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken.
- 29.2 As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris, brick bats, mortar dropping etc. and filled with earth in layers not exceeding 20 Cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with the but ends of crowbars, where rammer cannot be used.
- 29.3 The plinth shall be similarly filled with earth in layers not exceeding 20 Cms. adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finishing level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 29.4 The finished level of filling shall be kept to shape intended to be given to floor.

29.5 In cases of large heavy duty flooring the consolidation may be done by power rollers, where so specified. The extent of consolidation required shall also be as specified.

29.6 The excavated stuff of the selected type shall be allowed to be used in filling the trenches and plinth. Under no circumstances black cotton soil be used for filling the plinth.

30.0 SNOWCEM, DISTEMPER, OIL PAINT :

30.1 GENERAL

a] Preparation of Surface & Priming coat :

The surface shall be thoroughly brushed free from mortar dropping and other foreign matter and sand papered smooth.

A priming coat of whitening shall be applied over the prepared surface in case of water-bound distempering and distemper primer or cement primer shall be applied in the case of oil bound distemper. No white washing coat shall be used as a priming coat for distemper.

b] Application :

After the primer coat has dried for at least 48 hours, the entire surface shall be coated uniformly with proper distemper brushes in horizontal strokes, immediately followed by vertical ones which together shall constitute one coat.

c] Scaffolding :

Where scaffolding is necessary it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be white or colour washed. A properly secured strong and well tied suspended platform (zoola) may be used for white washing. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the floors and walls. For white washing of ceilings, proper stage scaffolding shall be erected where necessary.

30.2 Snowcem :

Finishing wall with water proofing cement paint (snowcem) on undecorated wall surface (three coats) to give an approved brand and manufacture and required shape even shade after thoroughly brushing to surface to remove all dirt and remains of loose powdered materials.

The surface shall be thoroughly scrapped clean, finishing walls shall be completely cleaned before applying snowcem or water proof cement paint. The shed and quality must be approved by Engineer-in-charge of the work before starting the work. The snowcem shall be applied with the fine brush and allowed to set before second coat is

applied. The rate shall include necessary scaffolding, tools and plants and sufficient watering etc. complete.

The work shall be carried out to the entire satisfaction of the Engineer-in-charge of the work and in best in workmanship like manner as per specification of manufacturer or as directed.

**30.3. Oil Paint :**

All doors, windows, ventilators, shutters, railing, all fabricated items, motors, pumps, all interconnecting piping above ground level etc shall be coloured with three coats of approved make oil paint strictly as directed by Engineer-in-charge.

**30.4 Distempering :**

1] Distempering shall be of the oil or water bound type as specified.

2] Material :

Dry distemper or oil bound washable distemper of approved brand and manufacture for water bound and oil bound respectively conforming to IS : 428 shall be used. The proportions of the mix shall be as per the approved manufacturer's instructions.

a) The dry distemper shall be stirred slowly in clean warm water using 0.6 liter of water per kg. of distemper or as specified by the approved makers. The mixture shall be well stirred before and during use to maintain an even consistency.

b) Thinner as stipulated by approved manufacturer shall be used in case of distemper for oil bound type.

c) Dry distemper shall not be mixed in larger quantity than is actually required for one day's work.

**31.0 G. I. RALLING :**

31.1 The railing shall be fabricated from G.I. pipes generally conforming to IS . They shall consist of horizontal pipes welded at a spacing of not more than 450 mm to vertical balustrade pipes of 40 mm dia. The vertical pipes shall be spaced at 1 m c/c. The fabricated railing shall be installed using 6 mm thick M.S. base plate and 12 mm dia M.S.`J' bolts. The exposed faces shall be painted with 2 coats of enamel paint of approved quality.

**32.0 M.S.LADDER :**

32.1 The M.S. ladder shall be used where access to elevated tanks is essential for operation and maintenance. It shall be fabricated from M.S. angles and channel section. The span of the ladder shall be not less than 60 cms. The angles used shall not be less than ISA 25 x 25 x 6 mm. A chequered plate of thickness 6 mm shall be provided for

every step. For ease in climbing the pitch of ladder shall be restricted to 60 degree. The rise of the steps shall be restricted to 25 cm. All M.S. surfaces shall be coated with epoxy to prevent the corrosion. The railing for the ladder shall be fabricated from 25 mm GI pipes.

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SIGNATURE AND SEAL OF TENDERER

NAME :-

ADDRESS :-

DATE :-

## **CHAPTER - VII**

### **SPECIFICATION FOR MECHANICAL WORKS**

#### **1 Centrifugal Pumps :**

##### **1.1 General :**

- (a) This specification constitutes the technical documentation covering the design, manufacture, performance and inspection/testing requirements for centrifugal pumps.
- (b) The detailed specification / data sheets have been prepared, taking into consideration design that have successfully performed in similar duty conditions :

Tenderer is requested to fill the data sheet of pumps.

#### **2 Reference standards :**

- 2.1 The design, construction and testing of pumps shall be strictly as per API 610, latest edition and also as specified in this specification.

#### **3 Design and construction requirements :**

- a. Centrifugal pumps may be either single or multi stage, split vertically or horizontally, with foot or centre line support in accordance with the operating conditions.

- b. The materials of construction shall be as specified in the data sheets. In case of parts not covered by the data sheet, materials are to be selected/specified by vendor to suit the duty conditions and generally in accordance with appropriate material class.
- c. All the rotating parts of the pumps shall be balanced statically and dynamically.
- d. Impeller diameter or diameter corresponding to the operating design conditions shall not exceed preferable of the maximum possible diameter of the impeller for the type of pump offered.
- e. Casing and connecting flanges shall be designed for the maximum discharge pressure. Sufficient corrosion allowance shall be included in the design of casing thickness. Size, type and rating of all connections shall be clearly indicated on the data sheets. The ratings shall be as per ANSI 16.5.
- f. Pumps shall be provided with suitable means such as eye bolts or lugs to facilitate dismantling.
- g. Impellers shall be made in one piece, and shall be fitted with renewable wearing rings, held in place by an approved method with Brinell hardness of 50 BHN less than the casing wearing rings.
- h. Shafts shall be sized to transmit the full drive output, accurately machined throughout their entire length and properly finished at the bearing surfaces and shall be provided with sleeves securely locked to the shaft.
- i. Radial bearings shall be of the ball, roller or sleeve type and of manufacturers standard design. Suitable thrust bearings shall be provided as required.
- j. Stuffing boxes shall be of either conventional packed type or mechanical seal type as indicated in job specification. Stuffing boxes shall be provided with seal cages for the introduction of the cooling medium, if required.
- k. The design and material for the seals shall be suitable for the service condition and also to withstand maximum discharge pressure.
- l. Base plates shall be fully machined to receive the pump and the drive. Base plates shall be of drain rin type having raised lip and with tapped drain connections.
- 4. Inspection and testing requirements :
  - a. Unless otherwise specified, the inspector shall witness the inspection/tests as indicated below :
    - Visual inspection
    - Non destructive inspection

- Dimensional inspection
  - Hydrostatic test
  - Dynamic balancing
  - Performance test
  - Inspection of internal parts after shop test
  - Direction of rotation of the pump with respect to driver
- b. Material test certificate indicating chemical analysis, mechanical properties (including impact strength and hardness wherever specified)& details of heat treatment, if any, of main components like casing, impeller, shaft, sleeve, wearing ring etc shall be furnished by the manufacturer. If required by the Inspector, samples, of materials used in the pump construction shall be furnished.
- c. Repair of castings shall be carried out only after approval of inspection and repaired area shall again be checked by radiography or magnetic particle and the castings shall again be subjected to hydro test.
- d. During the performance test, bearings temperature, lubrication of bearing, operation of stuffing box and sealing devices and vibration shall be observed and checked by the inspector.
- e. All casings shall be visually inspected before machining for surface defects and irregularities. Casting shall be free from gross surface defects or irregularities likely to impair their strength. The quality standard for visual inspection shall be as per MSS-SP-55.
- f. Each pressure casting shall be hydrostatically tested with water at ambient temperature to 1.5 times the max. allowable casing pressure. Multistage pumps may be segmentally tested at appropriate suction pressure.

Cooling passages and jackets for bearings, stuffing boxes, oil coolers etc. shall be tested at 8 kg/cm<sup>2</sup>.

All hydrostatic tests shall be maintained for a min. period of 30 minutes, except that large and heavier castings may require a longer time.

- g. Pumps shall be operated in the shop with the shop driver for a period sufficient to obtain complete performance test data for full characteristics of the pump at constant speed.

During performance test, pumps shall operate with no undue heating of bearings, excessive noise or other mechanical faults. Test procedure shall be as per API 610.

5. Air Blower :

The Air Blower shall be required if the filters are to be given a mixed water and air wash. The blowers shall be of the twin Lobe type, to be provided with inlet filter and silencer and the entire unit shall be complete with water cooling system, driven by squirrel cage induction motors. These units shall be complete with reflux, stop and safety valves etc.

A spare pulley shall be provided for each unit so that the blower speed can be reduced by 10% to give reduced output.

6. TUBE MODULES :

PVC Tube Modules shall be as per following specifications

|                                  |   |  |
|----------------------------------|---|--|
| Type                             | : | In Profile Form to Form Blocks                         |
| Thickness of Profile/ Tubes      | : | 1.1 mm (min.)  |
| Flow Section shape               | : | Hexagonal Chevron                                      |
| Material                         | : | PVC, UV Stabilized                                     |
| Settling Area with 60 Deg. Slope | : | 11 M2/M3   |
| Hydraulic Radius                 | : | 1.50 CM (Approx.)                                      |
| Tube Cross Section               | : | 120 mm x 44 mm (Approx.)<br>or as per the manufacturer |
| Dry Weight                       | : | @ 75 Kg/M3   |
| Recommended Block                | : | < 0.6 M3   |
| Volume Supports                  | : | Min 60 mm (Width)<br>Max. 1000 mm (C/C Distance)       |

7. Weighing Scale : The weighing scale shall be of platform type, consisting of compound levers, platform goods receptacle and coupled to a dial type indicator. The design manufacture, testing erection and commissioning of the weighing scale shall conform to the relevant IS code.

The platform shall be capable of accepting concentrated loads and shall be provided with a locking arrangements which will permit replacements of the load continuously on its, without its weight being transferred to the leavers and the measuring system.

The weighing scale shall be used floor weighing alum blocks, chlorine drums and other such chemicals which may be used for the water treatment process from time to time and the scale shall be adequately designed for this. Three numbers of them having a weighing capacity of 2,000 kg. and the third one of upto 500 kg dial type with lighting arrangement.

8. Chlorinator :

|                     |   |  |
|---------------------|---|--|
| Required No.        | : | 2 Sets of 5.0 Kg./Hr. capacity each          |
| Type of Chlorinator | : | Vacuum Operated Solution Feed Manual control |
| Capacity            | : | 5.0 Kg/Hr.                                   |



Each Chlorinator shall consists of :

- 1) 1 - Vacuum Regulator.
- 2) 1 - Control Unit
- 3) 1 - Ton Container adapter
- 4) 1 - Dripleg with heater
- 5) 1 - Injector
- 6) Vacuum and Vent tubing
- 7) 1 - Instruction Manual

#### MANUFACTURE AND WORKMANSHIP :

##### FRAME :

- a) Frame shall be of unit construction and shall be so designed as to withstand the pressure of unbalanced water pressure head of 5 mm.
- b) Frames shall have a robust spigot of an appropriate length cast integral at the back for case of support in the water way and to provide case an effective seal.
- c) The back of the frame shall be as per site requirement.
- d) A cast iron side guide strip having a machined taper on the under side shall be fixed to the frame on each side by mild steel studs and extending over the height of the water way to provide effective guide throughout the travel of the door.
- e) A stopper shall be cast integral immediately below the waterway and central with it to limit the travel of the door.

##### DOOR :

- a) Door shall have reinforcement brids cast intergral at the back for strength. On reach side there shall be tapered sungs or gunmetal tape strips not less than three, machine to similar taper faced side guide strips on the frame.
- b) Two internally cast lugs drilled to take a mild steel bearing pin shall be provided on doors for use with rision spindles.
- c) A stopper to match that on the frame shall be cast integrally at the bottom.

##### FACE (DOOR) AND SEAT (FRAME) RINGS :

Facings shall be so secured by brass pins in the machined grooves of the frame and door and machined and hand finished, that with door fully shut a satisfactory water tight

seal is formed on the waterway. the contract between the fecting shall be sufficiently close at every point in their perimeter so as to produce a uniform bearing all round  
**WALL GUIDE BRACKETS :**

- a) Tensional Types : As per I.S. 3942-1965.
- b) Torsional Types :The number of brackets and couplings as per I.S. 3043-1965

**HEIGHT OF SLUICE :**

The overall height and the dimensions of the sluice frame and door shall be on accordance with table:2 of I.S. 3042-1965

**WORKMANSHIP :**

All casting shall be clean, sound and without defect of any kind. They shall be free from sand and no casting shall be burnt plugged, stopped patched or welded and no repairs of defects shall be permissible.

All foundry and machine work shall be done in accordance with beat modern practice and all component parts shall be carefully and accurately machined to jigs and templates so as to make them fully inter changeable on site without any additional work.

**MATERIALS :**

- a) Cast Iron : cast iron used for frame and door shall be a quality not less then Grade 20 of I.S. :210-1962.
- b) Mild Steel : Spindles, bolts and units shall be of mild steel shall conform to I.S.226-1962.
- c) Gunmetal : Leaded gunmetal shall be used face and rings/trim and spindle nuts. It shall have a tensile strength of 22 kg/sq.m and elongation of not less than 12 percent on a gauge length of 5 cm when tested in accordance with I.S. 2654-1964.

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## **CHAPTER - VIII**

### **SPECIFICATION FOR INTERCONNECTING PIPING**

#### **I. GENERAL**

1. All pipe work shall be in conformity with the requirements of the applicable drawings and this specification. Where specific details of fabrication are not shown on the drawings or specified therein, fabrication shall be in accordance with relevant I.S.
2. Piping shall also comply with applicable state, local or other Governmental laws and codes. In case of conflict with this specification the more rigid specification shall govern.
3. All work shall be performed in accordance with the best modern practice for this type of work and shall be of the highest quality workmanship.
4. Any deviation from this specification, must have the approval of Engineer-in-charge.

#### **II. RELEVANT APPLICABLE STANDARDS**

- |    |                          |   |
|----|--------------------------|---|
| 1. | IS - 1537 &<br>IS - 1538 | Centrifugally cast (spun) iron pipes &<br>fittings for water, gas and sewage. |
| 2. | IS - 1239                | G.I. Pipes & Fittings   |
| 3. | IS - 4984                | H.D.P.E. Pipes  |

4. IS - 8008 H.D.P.E. Fittings
5. IS - 7634 Code of practice for laying HDPE Pipes
6. IS - 3114 Code of Practice for laying Cast Iron Pipes
7. IS - 780 Cast Iron Sluice Valves
8. IS - 638 Rubber for flanged joints
9. IS - 1367 M.S. hexagonal bolts and nuts
10. IS - 6392 Steel Pipe flanges
11. IS - 7634 Testing of HDPE Pipes
12. IS - 1592-1980 Asbestos cement Pressure Pipes  
(Second revision)
13. IS - 6530-1972 Code of Practice for laying of Asbestos cement Pressure Pipes
14. IS - 5531 Parts I-III, 1977 (1st revision) Cast Iron specials for Asbestos Cement Pressure Pipes for water, gas and sewage.

### III. CAST IRON PIPING

#### A) Transportation and Stacking

The transportation of materials to the work site and stacking shall be done in a manner to cause minimum in-convenience to the traffic and other construction works. Pipes shall be protected during handling against impact, shocks and free fall, to avoid cracks and damage.

#### B) Lowering

The pipes shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy pipes shall be lowered by means of proper shear legs, chain pulley or as directed by Engineer-in-Charge.

#### C) Laying

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe-laying team cannot put the pipe into the trench and in place without getting earth into it, the Authority may require that before lowering the pipe into the trench, a heavy, tightly woven canvass bag of suitable size shall be placed over each end and left there until the connection is to be made to the

adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

The pipe shall be secured in place with approved backfill material tamped under if except at the end, Pipe and fittings which do not allow sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to ensure such space. Precautions shall be taken to prevent dirt from entering the joint space.

At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Authority.

**D) Joining**

Flange faces shall be in a plane perpendicular, true and square to the centerline of the pipe to which they are welded.

Wherever screwed flanges are used the pipe shall extend to within 1.5 mm to 3 mm of the face of the flanges but not beyond.

Bolt holes shall straddle normal centerlines in the vertical and horizontal planes unless otherwise specified.

The jointing material used between flanges of pipes shall be compressed fiber board or rubber (See IS:638-1955\*) of thickness between 1.5 mm to 3 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per Sq. M shall be not less than 112 g/mm thickness.

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

**E) Testing :**

The pipe line shall be tested to double the working pressure Pipe line shall be tested in suitable section before back filling. After all the lines are tested in section, a final test shall be performed before commissioning the system.

Test manifolds, connection piping and all other necessary appurtenances for testing shall be installed by contractor at the time of test. On completion of testing, the test appurtenances shall be removed.

Contractor shall use his own pumps for filling the line with water for test.

After satisfactory test, the contractor shall remove water from the pipe line and clean it after testing at his own cost, without flooding and adjoining areas.

F) Procedure of Test :

The pipe shall be completely filled with water and it shall be ensured that no air is left in the line. Pressure shall be applied with a calibrated pressure gauge. Upon reaching the test pressure it shall be maintained for a sufficient time to permit complete inspection of the system under test but in no case shall the time be less than 10 minutes.

If the pipeline fails to maintain the specified test pressure, contractor shall determine the location of the leak and shall repair the leak by replacing pipes, re-caulking joints, etc. to the satisfaction of Engineer-in-Charge and retest the same.

IV. M.S. Piping

A) Transportation and Stacking :

Refer Clause III-A above.

B) Lowering :

Refer Clause III-8 above.

C) Fabrication :

Layout, cutting and fitting-up :

- a. Templates shall be used in laying out headers, laterals, and other irregular details to ensure accurate cutting and proper fit-up.
- b. Machine cut bevels to form the welding groove are preferred, but smooth, clean, slag-free flame cut bevels are acceptable.
- c. In fitting up details preparatory to final welding, spacers shall be used while tack welding the pipe and connections in position so that a proper gap is made for full penetration of welds. The following are the recommended gaps :

For pipe size below 150mm - 1.5 mm weld gap

For pipe sizes 150 mm  
(inclusive) and above - 3.0 mm weld gap

- d. Only small tack welds which penetrate to the bottom of the welding groove shall be used and shall become a part of the finished weld. Tack welds lacking penetration are not acceptable and must be chipped out. Each weld shall be cleaned of all scale, slag, flux and other foreign matter before additional welding beads are applied.

- e. In general, permanently welded-in rings shall not be used. If back-up rings should be necessary or desirable, they may be used only upon specific approval of Engineer-in-Charge. If used, they shall be streamlined to minimize turbulence and resistance to flow through the pipe.

**Bending :**

- a. Completed bends shall have smooth surfaces and shall be free of flat spots and corrugations.
- b. Fabricated Pipe
  - i) Hot bending shall be done with the pipe filled with tamped sand. Following the bending operation, the bend shall be allowed to cool slowly in still air before the sand is removed. The minimum radius shall be six times the nominal pipe diameter.
  - ii) Cold bends to a radius of six times the nominal pipe diameter or greater may be made without subsequent stress relieving. No cold bending is allowed on pipe larger than 50 mm nominal diameter.

**Welding :**

- a. Welders and welding procedures shall be qualified in accordance with the requirement of the codes and IS:817-1966. Horizontal and/or vertical welding qualifications shall be shown on qualification papers.
- b. All welding shall have full thickness penetration and shall be done by the Electric Arc Process. Gas welding may be used with Engineer's approval.
- c. In multiple pass welding the slag shall be cleaned from each layer and any serious defects chipped out before the next layer is applied. Peening shall be done if necessary to prepare a bead for the next phase.
- d. The completed weld shall be cleaned of slag and spatter metal on all surfaces, and when possible the inside bead shall be ground smooth.
- e. No undercutting of pipe adjacent to the completed weld will be permitted.
- f. Finished welds shall project not less than 1.5 mm but not more than 3 mm from the outer surfaces of the pipe.

**Electrodes :**

Welding electrodes with a suitable coating shall be in accordance with IS specifications and of a recognized quality. Electrodes shall be preserved in an electrode oven and only those electrodes which are so preserved shall be used in the welding. The electrodes shall have to be approved by the owner.

D) Laying

Refer Clause III-C above

E) Joining

Refer Clause III-D above

F) Testing

Refer Clause III-E above

G) Procedure of Test :

Refer Clause III-F above

V. G.I.PIPING

A) Transportation and Stacking:

Refer Clause III-A above

B) Lowering :

Refer Clause III-B above

C) Laying and Fixing :

Screwed G.I. Pipes shall be jointed with screwed sockets, joints, using screwed fittings. Care shall be taken to remove any burr from the ends of the pipes. After screwing, white lead with a few strands of fine hemp shall be applied while tightening.

Compounds containing red lead shall not be used. All pipes above ground shall be fixed with G.I. holder bat clamps clear off the walls. If the pipes are fixed in chasses or embedded in wall, they shall be secured properly in position by grounding and pipe inside chase will be painted thickly with bituminous paint.

All underground pipes shall have a minimum cover of 600 mm or as directed by Engineer-in-Charge

D) Testing



Before any pipes are painted or covered up they shall be tested to required hydrostatic pressure.

In addition to the sectional testing of water supply piping, the contractor shall test entire installation on completion of the job to the satisfaction of the Engineer-in-Charge.

## **VI HDPE PIPING**

### **A) Transportation and Stacking :**

A Vehicle with a flat bed, free from nails and other projections which may not cause damage to the pipe, should be used while transporting these pipes.

Black Polyethylene (PE) Pipes may be stored either under cover or in the open. They are protected from ageing due to sunlight by the addition of appropriate type and quantity of carbon black. Coils may be stored either on edge, or stacked flatly one on top of the other.

Straight lengths should be stored on level ground.

Available storage space can be further saved by 'nesting' i.e. storing smaller diameter pipes inside pipes of relatively larger diameter.

### **B. Handling :**

Polyethylene is a tough, resilient material which is easy to handle. However dragging pipes/coils over rough surfaces should be avoided. Unlike other plastic materials, this material is not affected by low temperature and there is no need for special precautions in handling during cold weather, or even in freezing conditions.

### **C. Laying**

#### **a. Underground Installation :**

While trench work is in progress, extensive excavation should be discouraged and advance excavation, as far as possible, should be limited to about one day's pipe laying work. This reduces traffic hazards and lowers risk of soil caving in. Wherever, gradual curves are involved in pipe alignment, care should be taken to see that the curvature radius of the trench alignment is about 20 to 40 times the diameter of the pipes, depending on the size. These methods maximize benefits of the pipes, flexibility and thereby, reduce the occurrence of any sharp bends.

When laying smaller diameter pipes, considerable savings in time and labour can be effected by using longer lengths of pipes in coils. These longer lengths in coils are available in diameters from 20 mm OD to 90 mm OD.

In a trench, the pipe may be laid in a curvilinear pattern i.e. snaking the pipe in the trench. This curvilinear laying of pipe allows for thermal contraction/expansion, subsequent to back filling the trench without creating any additional stresses, during seasonal changes.

**Trench Preparation :**

Trench width at the crown of the pipe should be as narrow as is practicable. But it should not be less than outside diameter of the pipe plus another 300 mm to allow proper compaction of the side fill. Above the crown of the pipe, the trench may be of any convenient width.

Pipes, especially higher series of pipes, may be laid directly on the trimmed bottom of a trench. However, this should be done in uniform, relatively soft fine-grained soils free from large flints or stones or other hard objects. And where the bottom can readily be brought to an even finish to provide uniform support for the pipes over their length. In other cases, the trench should be excavated to a sufficient depth below the bottom of the pipe, to allow for the necessary thickness of the selected bedding material.

**Bedding and Side-filling :**

Clay is an unsuitable material for bedding or side-filling. Other soils excavated from the trench, such as free-draining coarse sand, gravel, loam and soils of suitable nature with adequate compaction fraction for providing support to the pipe are more suitable. Soils such as hard chalk, which break up when wetted, should not be used.

If the material excavated from the trench is unsuitable, then granular material like coarse sand, or sand and gravel from outside sources, should be used for bedding and backfilling.

The thickness of the bedding, under the barrel of the pipe should be of a minimum 100 to 150 mm depending upon the irregularity of the trench bottom. The bedding should be properly compacted to provide a uniform bed for the pipe. Bricks or other hard materials should not be placed under the pipe, even as temporary supports.

After the pipes have been laid and tested, additional material should be placed around the pipe and compacted in 75mm layers upto a level of at least 100 mm above the top of the pipe.

**Back-filling :**

Material excavated from the trench may be used for the remainder of the back-filling. It should be compacted in 300 mm layers. Alternatively, it should be in compliance with the special requirements of local or other authorities.

**b. Above ground Installation**

A high rate of linear expansion in exposed pipe section can be expected.

It is, therefore, suggested that thermal expansion should be taken care of by providing clamps rigidly fixed at fairly close intervals in case of above ground installation.

**D. Joining :**

**Welded Permanent Joints :**

These are effected by butt welding employing the fusion technique. Clean, leak-proof and permanent joints can be effected through the following steps :

1. Cut the pipes cleanly, as required for the joint to be made.
2. Bevel and clean the inner edge.
3. Bring the cut surfaces together, and check for alignment.
4. Heat the welding mirror to 210 degree C, either electrically or with a kerosene blow torch or other external heat source.
5. Verify the temperature of the mirror with the help of thermo chrome chalk. The chalk mark will turn from blue to black in about 3 seconds.
6. Bring the freshly cut surfaces, to be joined, into contact with the mirror.
7. The material will melt. Permit the weld rims to form.
8. Take the heated ends away from the mirror, and bring them together under slight pressure, to permit them to fuse.

**Detachable Flange Joints :**

- a. Slip the HD/MS sandwich flange over the pipe ends.
- b. Weld the collar (pipe end) to the pipes.
- c. Bring the flange faces together and tighten with bolt nuts.

**VII. VALVES :**

**A) General :**

1. Wherever practicable and except as otherwise shown on the drawings, valve stem shall be installed in a direction suitable for easy operation.
2. Where not otherwise specified on drawings, control valves shall be located and installed so as to provide the following clearance.
  - a) Below Valve - 300 mm minimum
  - b) Above Valve - Sufficient to remove bonnet with wedge

3. A minimum of 50 mm clearance shall be kept between the surface of insulation and the adjacent surface either insulated or uninsulated. Exceptions shall have the approval of the Engineer-in-charge.

**B) Cleaning of Valves**

Valves will be cleaned before installation. All possible precautions shall be taken to prevent contamination and valve shall be inspected immediately prior to installation. If a valve is found to be contaminated in anyway, it shall be cleaned as follows :

1. Remove all foreign particles by wiping with a clean lint less cloth.
2. Wipe interior of valve with a clean lint less cloth moistened with clean trichloroethylene.

If contamination is excessive :

Suspended the valve in a degreasing tank with hand wheel uppermost. Direct a stream of liquid trichloroethylene into the rim of the valve, through both ends and against all inside surfaces. Flush thoroughly to remove all foreign matter.

**VIII. GENERAL NOTES ON ERECTION OF PIPING**

1. All piping shall be erected as shown on the approved-for- construction drawings and in accordance with this specification.
2. Arrangement drawings shall show general location and will indicate special dimensions, location of valves, fittings, etc.
3. Special attention shall be given to the handling and erection of piping to prevent damage and ensure the continued cleanliness of such piping.
4. All assembled piping shall be installed in place without springing or forcing.
5. Piping connections to equipment shall be made in conformity with details on the drawings.
6. Mill weighting and grouting of pumps shall be done after the connected piping has been installed and properly anchored or supported.
7. Slopes of piping specified on drawings shall be maintained where no slope is required or where a required slope approaches the horizontal, piping shall be checked for sag

with a level not less than 1 Meter long equipped with a graduated bubble vial. All low points where liquid may be entrapped shall be removed.

8. After piping is erected in final position, it shall be cleaned, tested for tightness and dried out where required as described in this specification.
9. Necessary piping supports and expansion loops shall be provided.

**IX. GENERAL NOTES ON CLEANING OF FABRICATED PIPING**

1. All piping and fittings shall be cleaned thoroughly inside and outside, from loose scales and foreign materials by wire brushing or using a rotary cleaning tool, before erection.
2. All field fabricated piping shall be cleaned at the completion of fabrication. Care shall be taken to see that all burrs, welding icicles and weld spatter are removed by reaming, chipping, or other suitable means. All foreign material such as cement, mortar, sand, heavy oil film and loose scale shall be removed from the interior of pipe by thoroughly flushing with water with detergent where necessary. To avoid large branch lines from a larger diameter header line, special precautions should be taken to disconnect at branches or selectively blank them off. After thorough cleaning, the fabricated pipe is to be dried completely with dry oil free air and the ends plugged to prevent contamination.

**X. GENERAL NOTES ON CLEANING OF ERECTED PIPING**

1. A record shall be kept of cleaning of each line or section of erected piping. Cleaned lines shall be tagged.
2. Strainer baskets and similar items shall be removed or by passed before cleaning operations are started and replaced immediately after cleaning is completed.
3. Proper temporary drainage for flushing water shall be provided so that no damage is done to permanent facilities.

**XI. R.C.PIPES/HUME PIPES**

**1. Handling Pipes**

At every point of loading or unloading, pipes or castings must be handled by approved lifting tackle. Unloading by rolling down planks or any other form of inclined ramp will not be allowed unless the written consent of the Engineer to the method proposed has been obtained. Pipes are to be carefully stacked on site with timber packings under and between the pipes.

**2. Laying of Pipes**

- a) The pipes are to be laid up the gradients beginning at the lower end. No pipe is to be laid until the trench has been excavated to its required depth for a distance of 20M. in front of the pipe to be laid. (This distance may vary as directed by the Engineer).

All the pipes are to be laid perfectly true, both in line and on gradient. The pipes in a trench shall be all laid and fitted previous to the jointing being commenced.

- b) Properly fitted temporary wooden stopper shall be provided and constantly used to close the ends of all incompletd pipe lines. The stoppers are only to be removed when pipes are being laid and jointed.

### 3. Foundation for R.C. Pipes

- a) The foundation for the R.C.Pipes drain or sewer if required shall be formed of cradle block or full encasement of M 100 concrete of the shape and dimensions shown on the drawings.

- b) Encasing/Bedding

The pipes shall be provided with encasement/bedding etc. as specified in drawings.

### 4. Jointing of R.C. Pipes with Collar Joints

The R.C.Pipes shall be carefully laid in position over the concrete bedding or over the firm ground at the required level and their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with sufficient quantity of a special bituminous plastic compound. The collar then shall be slipped over the end of the pipe and the next pipe butted well against the plastic ring by suitable appliance approved by the Engineer so as to thoroughly appliance approved by the Engineer so as to thoroughly compress the plastic compound into the grooves, care being taken that the concentricity of the pipes and the levels are not disturbed during this operation.

The collar shall be placed symmetrically over the end of the two pipes and the space between the inside of the collar and the outside of the pipe filled with 1:1 mixture of cement and sand tempered with just sufficient water to have consistency of the semi-dry conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at 45 degree to the side of the pipe and of finished joints will be protected and cured for atleast four days or as directed.

Any plastic solution or cement mortar that may have been squeezed into the inside of the pipe shall be removed so as to leave the pipe perfectly clean.

### 5. Depth of Excavation of Trenches :

The depth for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of concrete and/or precast blocks are required to be placed below the pipe line, the depth to the bottom of the concrete and/or of the Block below the underside of the pipe line will be considered. The depth of the excavation for manhole shall be measured from the surface of the existing ground level to the bottom of foundation.

6. Measurement of Pipes

- a) All pipes will be measured according to the work actually done by them and no allowance will be made for any waste in cutting to the exact length required.
- b) A band, junction, or any separate piece of fitting which may have necessarily been cut for the exigencies of the work will be taken into account as if whole, provided that the cutting has been done properly and that portion used in the work in any circumstances. In measuring the lengths of the pipes laid, deduction shall be made for the lengths of channels between the inside face of the walls of manholes.

**XII. ASBESTOS CEMENT PRESSURE PIPES**

1. Handling Pipes

At every point of loading or unloading, pipes or castings must be handled by approved lifting tackle. Unloading by rolling down planks or any other form of inclined ramp will not be allowed unless the written consent of the Engineer to the method proposed has been obtained. Pipes are to be carefully stacked on site with timber packings under and between the pipes.

2. Excavation of Trenches

The depth for the trenches will be calculated from the ground surface to the bottom of beddings for the pipes and in case when a layer of concrete and/or precast concrete blocks are required to be placed below the pipes, the depth to the bottom of the pipe lines will be considered. The width and depth of the trench work should be as per relevant IS Standard.

3. Laying of Pipes

Before laying the pipes should be checked for any damage caused during transit. The pipes shall be carried to the work site and laid along the trench.

- a) The pipes are to be laid up the gradients beginning at the lower end. No pipe is to be laid until the trench has been excavated to its required depth for a distance of 20 M. in front of the pipe to be laid. (This distance may vary as directed by the Engineer).

All the pipes are to be laid perfectly true, both in line and on gradient. The pipes in a trench shall be all laid and fitted previous to the jointing being commenced.

- b) Properly fitted temporary wooden stopper shall be provided and constantly used to close the ends of all incompleting pipe lines. The stoppers are only to be removed when pipes are being laid and jointed.

4. Joining of Pipes

The Cast Iron Detachable (C.I.D.) joint comprises of a central collar, two flanges, two round rubber rings, bolts and nuts. The rubber rings placed on the pipe ends and compressed between collar and flange by means of steel bolts provide necessary sealing.

- a) Clean the pipe ends to be jointed and the components of CID Joints.
- b) Insert the flanges on pipe ends with help of wooden cone and place the rubber rings on pipe ends by rolling them upwards towards the pipes. Using a sight gauge bring rubber rings to the correct position.
- c) Place the central collar on the laid pipe and bring the other pipe or fittings to be joined close. Centralize the collar leaving a gap of about 5mm between pipe ends.
- d) Now position the rings to touch collar ends. Move the flange close. Insert bolts in the flange holes and tighten them. The bolts should be tightened uniformly to ensure a leak proof joint.

The same method shall be used for jointing of AC pressure pipes and CI fittings and specials (suitable for jointing with CID joints) like tees, bends, flange adapter, reducer etc.

- 5. Testing - Refer Clause III-E above
- 6. Procedure of Test - Refer Clause III-F above.

GENERAL MANAGER (TECH & ADMN)  
GUJARAT HIRA BOURSE  
SURAT

SIGNATURE AND SEAL OF TENDERER



NAME :

ADDRESS :

DATE :

## **CHAPTER - IX**

### **SPECIFICATION FOR ELECTRICAL WORKS**

#### **ELECTRICAL DESIGN CRITERIA**

1. SCOPE :

This part of design criteria defines the minimum basic requirement for electrical engineering, design basis or selection of various electrical equipment, equipment specifications and scope of work for electrical system.

2. SCOPE OF WORK :

The contractor's scope of work covered in this package shall include the complete design, system studies, details engineering, testing at manufacturer's work, procurement, transportation to site, supply, storage at site, installation, testing and commissioning and handing over the entire treatment scheme including the electrical system and equipment.

3. DESIGN BASIS :

3.1 Introduction :

This specification, together with the applicable project specification shall govern the design and engineering of electrical facilities.

- (i) The design shall be based on the following : -Safety to personnel and equipment during operation and maintenance.

Reliability of service

- Ease of maintenance
- Adequate scope for future expansion and modification
- Convenience of operation
- Electrical supply to electrical equipment and machinery within the design operating limits
- Maximum interchangeability of equipment –Automatic protection of all electrical equipment through selective relaying system
- Minimum fire risk
- A fail safe system

- (ii) The design basis detailed in this specification shall be followed in accordance with sound engineering practices.

**3.2 Codes & Standards :**

- (i) The design, engineering, supply of equipment, installation, testing and commissioning shall be in accordance with established codes, sound engineering practices, and must conform the statutory regulations applicable in India. Other standards may be allowed in particular cases where appropriate IS/IEC standards are not available subject to GUJARAT HIRA BOURSE's approval. However, contractor will not be allowed to form a basis for deviation from IS/IEC just due to country of origin of any equipment.
- (ii) The main codes and standards, which shall be considered as minimum requirements are as follows. Latest version of these shall be followed.
- Indian Electricity Act, 2003 with all amendments..
  - Indian Electricity Rules, 1956 with all amendments.
  - The Factory Act, 1948.
  - IS 5861 Voltages and frequency transmission and distribution system
  - IS 3961 Recommended current ratings for cables
  - IS 3043 Code of practice for earthing
  - IS 3716 Insulation co-ordination application Guide
  - IS 732 Code of practice for electrical wiring installation.
  - IS 2274 Code of practice for electrical wiring installation with system voltage exceeding 650 V.
  - IS 6665 Code of practice for industrial lights
  - IS 3646 Interior illumination Part I & Part-II
  - IS 1944 IS 1161 Code of practice for lighting of public thorough fares

- IS 1554 PVC insulated (heavy duty) electric cable for working voltages up to and including 1100 volts.
- IS 1646 Code of practice for fire safety of buildings  
(General) Electrical installation Equivalent to IEC/IS specifications shall also be acceptable.

In the event of conflict between this specifications and other document listed, the following order of priority shall govern:

- (i) Design Criteria and data sheets.
- (ii) Equipment specification.
- (iii) Codes and Standards.

### **3.3 POWER SYSTEM DESIGN :**

#### **A. Utilization Voltages and Frequency :**

- (i) In accordance to IS 585, voltages are classified as follows :
  - Upto and including 250 V                      Low Voltage
  - Above 250 V and upto and                      Medium Voltage  
including 650 Voltage
- (ii) The following voltage levels shall be used to provide electrical power for various purpose. The rated frequency of supply shall be 50 Hz.
  - MV motors                                      415V +/- 10%, 50Hz +/- 3%
  - Normal lighting system                      240 V +/- 10%, Single  
phase 2 Wire, 50Hz +/-3%

#### **B. Voltage Drops :**

The system design shall ensure that the voltage drop at the affected bus does not exceed 15% in case of startup of the largest motor or re-acceleration of a group of motors. The voltage available at the motor terminals during startup, must be sufficient to ensure positive starting or reacceleration of the motor (Even with the motor fully loaded if required) without causing any damage to the motor. Voltage drop in supply cable feeding lighting distribution board/panel on maximum design load shall be limited to 1% and in supply cables feeding, lighting points with all lighting points connected to a circuit switched on, it shall be limited to 2%.

#### **C. Power Factor :**

The Contractor shall maintain power factor of electrical distribution network to the level of 0.98 to unity.

The bidder shall provide a Automatic Power Factor Control Panel of reputed brand of adequate capacity. The bidder shall get approve the APFC Panel with GHB Authority.

#### 4.0 ELECTRICAL EQUIPMENT/SYSTEM SPECIFICATION :

The equipment shall conform to corresponding IS standard, specifications and particular specification attached with this document and to Indian/IEC standards and shall be suitable for installation and satisfactory operation in the service conditions mentioned in specifications. All equipments shall be tropicalised. All equipment shall also be withstanding the maximum short circuit fault current at the point of installation for a time greater than the maximum fault clearing time.

##### 4.1 Motors :

Motors upto and including 160 KW shall be suitable for 415 V. For heavy duty drives such as compressor fan/agitator/crusher etc. high starting torque motors (Min. 150% of rated torque) shall be provided. Motors above 30 KW rating shall have anti-condensation heaters and a separate terminal box shall be provided.

##### 4.2 Cables and Wires :

All LV and MV cables shall conform to IS specification. LV/MV voltage cables shall be XLPE insulated, armoured with PVC overall sheathed aluminium conductor cables. The power cable shall be 3 core armoured cables for motors. Each motor shall have two separate earthings. 1.1 KV Grade cables shall be PVC insulated sheathed, armoured cable with aluminium conductor. The control cables shall be PVC insulated PVC sheathed armoured cable with copper conductors. The power and control cables shall have the following minimum cross-sectional areas :

|                      |   |
|----------------------|---|
| a. Medium voltage    | Motive Power Wiring<br>upto 20A: 4sq.mm Multistranded FRLS copper wire<br>upto 32A: 6sq.mm Multistranded FRLS copper wire<br>Lighting wiring: 2.5 sq.mm multistraded FRLS copper wire |
| b. MV control cables | 2.5 mm <sup>2</sup> (Copper).(See note)   |
| c. Lighting          | 2.5 mm <sup>2</sup> (Copper)  |

Note : Minimum one spare core shall be provided in each control cable.

The cables shall be sized based on the maximum continuous load current it carried, the voltage drop, system voltage, system earthing and short circuit withstand criteria. Besides the derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall have to be taken into account. A derating factor of minimum 0.6 shall be considered for sizing all cables. Contractor shall consider a lower derating factor, if required.

##### 4.3 Control Stations :

Each motor shall be provided with a local control station in the field, and remote control in control room.

The enclosure shall have suitable protection for site conditions. All control stations shall have minimum enclosure protection of IP-55.

The control station shall include the following equipment as per individual requirement :

- Start/Stop push button,
- Suitable cable glands.

Stop push button shall be lockable and have stay put feature. Ammeter is not required in local push button station but the same shall be provided with remote/local selector switch in M.C.C.

#### 4.4 Lighting System :

Plant lighting inside plant & outer surfaces of walls of plant, outdoor lighting for clarifier, filter house and sludge drain chambers House and street lighting within the battery limits is in contractor's scope. Lighting system shall include normal, lighting. Normal lighting shall be on 230 V AC +/- 10%.

Work shall be carried out in accordance with attached Erection specification for Lighting. Lighting system shall be designed with illumination levels as per good engineering practices. However, minimum illumination level shall be maintained as listed below. This system consists of lighting transformers to reduce fault levels, main distribution board, lighting and power panels, fixtures, junction boxes, 3 pin 5A/15A convenience socket outlets, cable glands etc. Lighting transformer feeders shall be sized for full transformer capacity.

All outdoor lighting shall be manually controlled only. Taller structures shall have aviation obstruction lighting as per statutory regulations.

Lighting and power panels shall be provided with miniature circuit breakers for the control and protection of circuits. Wherever felt necessary 3-way junction boxes can also be used for tapping of lighting circuits. A minimum of 25% of the miniature circuit breaker of each board shall be left as spares. MCBS shall not be loaded more than 80% of rated capacity. The maximum load on any individual lighting circuit shall not exceed 1000 W.

Wiring for lighting and convenience outlets shall be carried out with PVC armoured cables run along the column/platform and structures. The armoured cable will enter lighting fixture/JB through single compression gland. Minimum illumination level required shall be as per details given in detailed lighting specifications. The maintenance factor shall not be more than 0.7.

| Area                            | Illumination level in Lux |
|---------------------------------|---------------------------|
| - Building stairs/corridors     | 100                       |
| - Process Area (Indoor/outdoor) | 100                       |

- Large tanks & reservoirs 15
- For reservoirs only 24 AC/DC should be used as per electricity rules.

#### 4.5 Sizing of earth rods and conductors :

This shall be designed to cope with the conditions imposed. The earth conductor shall be adequately sized to carry the maximum earth fault current resulting in the network, without undue temperature rise. All joints shall be protected to prevent corrosion.

The following are the guide lines for carrying out the earthing work :

All the electrical equipment operating at or above 250 volts shall have two separate and distinct connections to earth grids.

GI disconnecting plates shall be installed at various places in the plant.

Connections between GI earth electrodes, disconnecting plates and various equipments shall be done by GI earthing strips/G.I. stranded wire rope. (IS 2141-1979 IS 4826-1979) GI strips shall be used for main earthing grid.

Following is the minimum sizes of earthing conductors to be used for various connections :

| <u>Equipment</u>                                  | <u>Size of GI Earth Conductor</u> |
|---|-----------------------------------|
| - Main Earth Grid                                 | 40 x 5 mm GI strip                |
| - 3.7 KW motor                                    | GI wire No. 8 SWG                 |
| 5.5 to 30 KW                                      | 20x3mm GI strip                   |
| Above 30 KW                                       | 25x6mm GI strip                   |
| - Steel structural columns, tanks, loading racks. | 40 x 6 mm strip                   |
| - Pipe racks, vessels and heat exchangers.        | 20x3mm GI strip                   |
| - Lighting, power and instrument panels.          | 20x3mm GI strip                   |
| - Receptacles and local control stations.         | 8 SWG solid                       |
| - Lighting poles                                  | 20x3mm GI strip                   |

#### 5.0 ERECTION INSTALLATION, TESTING & COMMISSIONING :

**The tenderer shall avail approvals of all electrical wirings from concerned Electrical Inspector of the area prior to energizing the cables, switchgears, motors etc as required under law.**

Works shall be carried out in accordance with attached :

- Electrical installation equipment-specification for erection, testing and commissioning specification.
- Electrical installation cabling - General specification for cabling specification.
- Electrical installation lighting - General specification for lighting specifications.
- Electrical installation grounding - General specification for Grounding Specifications.
- Other specifications of this tender documents.

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SIGNATURE AND SEAL OF TENDERER

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## SPECIFICATIONS FOR ELECTRICAL EQUIPMENTS

### 1.0 MCC:

- 1.1 The MCC shall be located in the MCC room of the chemical house. The MCC shall have degree of protection of the enclosure IP-52. The MCC shall be draw out type. The lighting board shall be draw out type.

The MCC shall be free standing, metal enclosed fixed compartmentalized, modular type, dust and vermin proof suitable for indoor installation. The switchgear shall be assembled out of vertical panels of uniform height not exceeding 2450 mm. The maximum height of the operating handle/switches shall not exceed 1800 mm and the minimum not below 300 mm.

- 1.2 The switchgear shall be designed to ensure max. safety during operation, inspection, connection of cables relocation of outgoing circuits and maintenance with the energize bus system and without taking any special precautions. The switchgear shall permit max. interchangeability and shall be extensible on either side.
- 1.3 The switchboard shall be sheet steel clad with the frame fabricated out of 14 SWG cold rolled sheet steel and doors/covers of 16 SWG cold rolled sheet steel having integral base frame for each vertical panel. All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized and passivated or cadmium plated high quality steel bolts, nuts and washers secured against loosening.



- 1.4 The switchgear shall be suitable for bottom cable entry. Each MCC panel shall have a separate cable alley of 150 mm minimum width. Motor starter and switch fuse units shall be in Multifier arrangement in single fixed execution. All auxiliary devices for control, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, metering instruments shall be mounted on the front side of the respective compartment. Components requiring frequent inspection during operation shall be provided with an anti-corrosive heater rated for 240 AC +/-10% supply with a switch, fuse and a thermostat.
- 1.5 Main bus bars shall be of high conductivity having uniform current rating throughout the length. Horizontal and vertical bus bars shall be sized depending upon the max. expected current and to limit the max. operating temperature at specified design ambient temperature to 85 deg. C for normal operating condition and upto 200 deg. C for short circuit condition considering installation in poorly ventilated area.

Adequately sized auxiliary copper ( Cu. ) bus bars running horizontal in a separate enclosure shall be provided for space heaters, control supply and meter requirements. Necessary tee off connections shall be used for distributing auxiliary supply to each vertical panel. All bus bars shall be colour coded and designed to withstand specified short circuit current for one second.
- 1.6 Copper earth bus shall be adequately sized and provided throughout the length of the switchboard with provision for interconnection to earthing grid. All non-current carrying metal parts of the mounted equipment shall be earthed. Doors and moveable parts shall be earthed using flexible copper connections.
- 1.7 Inside the switchboard, the wiring for power control, protection and instruments circuits shall be done with PVC insulated copper conductors having 660/1100 V grade insulation. Min. size of control wire shall be 1.5 mm<sup>2</sup> copper for circuits having fuse rating of 10 Amps. or less. For higher fuse rating control circuits, min. 2.5 mm<sup>2</sup> copper conductor shall be used.
- 1.8 'Elemex' type terminals shall be acceptable for wires upto 10mm<sup>2</sup> size and for conductors larger than 10 mm<sup>2</sup> bolted type terminal with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A min of 10% spare terminals shall be provided on each terminal block.
- 1.9 All motor starter upto and incl. 10 H.P. shall be D.O.L. type and star-delta or auto transformer type above 10 H.P unless otherwise specified.
- 1.10 All switches shall be load break, heavy duty, air lock type with the operating handle mounted on the compartment door complete with necessary interlock and defeat mechanism. All fuses shall be non-deteriorating HRC cartridge pressure filter, link type the connector shall be air lock type having AC-3 duty rating.
- 1.11 Thermal overload relays shall be three element positive acting ambient temperature compensated type with adjustable setting range and built in protection feature against

single phasing. Bimetal relays shall be manually reset type with the reset push button provided on the cubicle door.

- 1.12 All indicating instrument shall be moving iron flush mounting type of 96 x 96 mm sq. pattern. However 72 x 72 mm instruments may be acceptable for out going feeders in the MCC. All control/selector switches shall be rotary back connected type having a cam operated contact mechanism with pistol grip handle for circuit breaker control and knob type handle for other applications. All motor starter feeders shall have stop push buttons and trip indication lamps. Incomer to MCC shall have a 415/110 V PT with primary fuse, secondary MCB alongwith a voltmeter and a selector switch. The incomer to MCC shall have KWH meter with protection fuses etc. to record energy consumed in the plant including lighting for the plant. A separate KWH meter may be used the lighting consumption.
- 1.13 All metal parts shall be thoroughly cleaned degreased and made free from rust. After application of the primer, the switchboard shall be spray painted with two coats of final paint of synthetic enamel.
- 1.14 A centrally located engraved nameplate shall be provided for the switchboard. Each module shall have engraved nameplate bearing data as per approved drawings. Nameplate or polyester adhesive stickers shall be provided for each equipment mounted on the switchboard.

Atleast 10% spare of each rating of outgoing feeders subject to a minimum of one feeder of each rating shall be provided in the switchboard.

## 2. Local Push Button Station :

Each motor shall be provided with a pedestal mounted control station in the field near the motor. The local control station shall have die-cast Aluminium enclosure of IP-55 protection. The control station shall include START/STOP push buttons, cable gland and ammeter if specified. Stop push button shall have stay put features. All push buttons shall be shrouded type rear connected with 2 NO + 2 NC momentary contact and shall be complete with necessary inscription plates. Outdoor control stations shall have necessary canopies. Local push button station shall include start/stop push button and glands only. Ammeter is not required in local push button station.

## 3. Power and Control Cables :

### 3.1 Scope :

This specification covers requirements of PVC insulated 1.1 KV grade power and control cables.

### 3.2 Codes and Standards :

The design manufacture and performance of cable shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed.

3.3 The equipment shall conform to the latest applicable Indian standards.

(a) IS - 1554 (All parts) : PVC insulated electric cable (Heavy duty)

(b) IS – 694-1990 : PVC insulated electric flexible cable (Light duty)

(c) IS - 3961 : Recommended current rating for cables.

(d) IS - 7098 (Part II)-1988 : XLPE cables.

3.4 Design Requirements of Cables :

Cables shall be capable of satisfactory performance when laid on trays, in trenches, conduits, ducts and when directly buried in the ground.

Cables shall be capable of operating satisfactorily under power supply system voltage variation of +/-10%.

Cables shall normally be laid under the following conditions :

(i) In air Ambient temperature of 50 deg.C

(ii) In ground Ground temperature of 40 deg.C

(iii) Depth of laying 700 mm (Approx.) in ground

(iv) Thermal resistivity 120 dec. C cm/watt

(v) Conduits Space factor of not more than 60%

(vi) In trays Single layer, touching each other.

Cables for control circuit shall incorporate stranded copper conductors with a minimum size of 2.5 sq.mm.

Cable shall be supplied in non-returnable drums made of seasoned wood

For control cables having more than 5 Cores, the method of identification of cores shall be in numerals (1, 2, 3 etc.)

The contractor shall furnish technical data of each type and size of the cable giving the current rating, derating factor, bending radius etc.

3.5 Tests :

- (i) All routine tests shall be conducted.
- (ii) Acceptance tests shall be conducted.
- (iii) Test reports shall be furnished.

4. Specifications for 440V 3Ph Motors :

- 4.1 All medium voltage induction motors shall meet the following specific requirements in addition to requirements as per latest edition of IS:325
- 4.2 Motors shall be squirrel cage type in standard frame sizes rated for continuous duty and designed for direct-on-line starting across full line voltage. Motors shall be capable of withstanding occasional bus transfer/re-acceleration at a voltage not exceeding 150% of the rated voltage. All motors shall be suitable for starting under specified load conditions with 75% of the rated voltage at the terminals. Motors rated 30 KW and above shall be would using dual coated wire with high temperature index as per I.S. 4800 Part-13 and applying Dr.Beck's Epoxy Gelcoat on overhung portion of the winding.
- 4.3 Motors shall be designed to allow three consecutive starts from cold condition, two consecutive starts from hot condition and four uniformly distributed starts in one hour. Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. Motor starting time shall be less than its hot thermal withstand time.
- 4.4 Starting current shall generally be limited to six times the rated current for single phase motors.

|                                 |                            |
|---------------------------------|----------------------------|
| For 3 Ph upto & including 10 HP | 3 times full load current  |
| For 3 Ph upto & including 15 HP | Twice full load current    |
| For 3 Ph above 15 HP            | 1.5 time full load current |

Starting torque, minimum torque and pull out torque shall be compatible with the speed torque curve of the driven equipment with due regard to pulsating loads with minimum acceptable values as 110%, 90% and 175% respectively of the rated torque. For heavy duty motors, high starting torque (min 150%) motors shall be provided with starting time preferably less than ten seconds.

- 4.5 Motors shall be provided with class "B" only insulation and the permissible temperature rise above the specified ambient temperature shall be limited to the values applicable for class "B" insulation. The windings shall be tropicalized and adequately braced. The ends of the windings shall be brought out in a terminal box with six terminals with suitable links to connect them in Delta. However, motors rated upto 2.2 KW may be connected in star with three terminals.
- 4.6 The terminal box shall be capable of withstanding the full internal short-circuit conditions with the specified system fault level. The fault duration shall be taken as 0.25 secs. for motors rated 55 KW and above. For motors rated below 55 KW, the fault energy to be considered shall depend upon the back up fuse rating. The terminal box shall be located on the right hand side viewed from the driving (coupling) end. It shall be rotatable in steps of 90 deg. to allow cable entry from any direction. The terminal box shall be of sturdy construction and large enough to facilitate easy connection of cables. Following sizes of aluminium conductor, PVC insulated armoured cables shall be applicable for design of terminal box and related accessories. The power cable shall be 3 core armoured cables for motors. Each motor shall have two separate earthings.

| Motor rating   | Size of phase conductors (mm <sup>2</sup> ) | Size of Earth conductors (if used) (mm <sup>2</sup> ) | No.and size of entry ET-IS:1653 |
|----------------|---|---|---------------------------------|
| 3.7 KW         | 4   | 4   | 19 mm                           |
| 5.5 KW         | 6   | 6   | 25.4 mm                         |
| 7.5 KW - 11 KW | 10  | 10  | 25.4 mm                         |
| 15 KW          | 16  | 16  | 31.8 mm                         |
| 18.5 KW        | 25  | 16  | - do -                          |
| 22 KW          | 35  | 25  | - do -                          |
| 30 KW          | 50  | 25  | 38 mm                           |
| 37 KW          | 70  | 35  | - do -                          |

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( \* where applicable as per data sheet)

- 4.7 Motors shall be suitable for either direction of rotation. Bearing shall be chosen to provide a minimum operating life of 40,000 hours and shall preferably be capable of grease injection from outside without removal of covers with motors in running condition. Pre-lubricated bearings wherever used must provide 4 to 5 years of trouble-free service without any replacement or re-lubrication. Motors vibrations shall be within the limits of IS:4729 unless otherwise required for the driven equipment.

- 4.8 Motors shall be totally enclosed fan cooled (TEFC) type minimum degree of protection for rotor enclosure, terminal box and bearing housing shall IP-55 as per IS : 4691. Vertical motors shall be provided with fully covering plain canopies. In addition to the two earth terminals on the motor body, an earth terminal shall be provided inside the terminal box.
- 4.9 All motors rated above 30 KW shall be provided with 240V +/-10% anti-condensation heater. These heaters leads shall conform to the provisions of applicable standards for motors installed in hazardous areas. The heater shall be brought out to a separate terminal box in IP-55 enclosure suitable for two core 4 sq.mm. aluminium conductor armoured cable.
- 4.10 Generally four pole motors shall be preferred. The min. value for product of efficiency and power factor shall be as per IS:8789. For ratings not covered in IS:8789, product of efficiency and power factor shall be as agreed between the owner and vendor.
- 4.11 Internal and external parts of the casing and all metal parts likely to come in contact with the surrounding air shall be protected with anti-acid paint. All external surface shall be given a coat of epoxy based paint.

## 5 Specification for Lighting Fixtures and Accessories :

### 5.1 Scope :

The specification covers the requirements of lighting fixtures for incandecent lamps, fluorescent lamps and high pressure sodium/mercury vapour lamps (HPSV / HMPV) and associated accessories. Equipment shall include lighting distribution boards, lighting fixtures, poles, switches, receptacles, conduits wires and miscellaneous hardware necessary for complete lighting work.

### 5.2 Code and Standards :

- 5.2.1 The design, manufacture and performance of equipment shall comply with all currently applicable statutory regulations and safety codes in the location where these fittings will be installed.

The fittings shall conform to the latest applicable Indian Standards, British Standards or IEC Standards, some of which are listed below :

IS : 1913 General and safety requirements for electric lighting fittings.

IS : 1777 Industrial lighting fittings with metal reflectors.

IS : 4012 Dust proof electric lighting fittings.

IS : 3528 Water proof electric lighting fittings.

IS : 2149 Luminaries for street lighting.

IS : 1947 Specification for flood light.

IS : 5077 Specification for decorative lighting out-fits.

IS : 1534 Ballasts for use in fluorescent lighting (Part I) fixtures.

IS : 1569 Capacitors for use in fluorescent lighting fixtures.

IS : 2215 Starters for fluorescent lighting fixtures.

IS : 2183 HPMV lamps.

IS : 1950 Vitreous enamel reflectors for discharge lamps.

IS : 1391 Air-conditioners.

#### 5.2.2 Lighting Fixtures :

The fixtures shall be suitable for operation on a nominal supply of 240 volts, single phase, 50 Hz  $\pm 3\%$  AC with a voltage variation of  $\pm 10\%$ .

All fixtures shall be designed for continuous operation under atmospheric conditions specified without reduction in lamp life or deterioration of materials and internal wiring.

#### 5.2.3 Ballast :

Lighting fixture ballasts shall be designed, manufactured and supplied in accordance with the relevant standards and shall function satisfactorily under site conditions specified. The ballasts shall have a long service life and low power loss.

Ballasts shall be mounted using self-locking anti-vibration fixings and shall be easy to remove without removing the fittings.

The ballasts 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. Ballasts which produce a humming sound shall be replaced free of cost by the supplier. HPMV lamp ballasts shall be provided with taps.

For multi lamp fittings, a separate choke shall be provided for each lamp.

**5.2.4 Starters :**

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 electrode and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamp and without the use of any tool.

**5.2.5 Lighting fixture capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.**

Each capacitor shall be suitable for operation at 240 volts  $\pm 5\%$  single phase 50 Hz, with a suitable value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.98 lag. The capacitors shall be hermetically sealed preferably in a metal container to prevent seepage of impregnating materials and ingress of moisture.

**5.2.6 Lamp holders :**

Lamp - holders for fluorescent tubes shall be spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance of lamp holding quality. They shall hold the lamp in position under normal condition of shock and vibration.

**5.2.7 Reflectors :**

Lighting fixture reflectors shall generally be manufactured from sheet steel or aluminium of not less than 20 SWG. They shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely mounted to the housing by means of positive fastening devices of a captive type.

**5.2.8 General :**

- (i) Each fixture shall be complete with a four way terminal block for the connection and looping of incoming and out-going supply cables. Each terminal shall be able to accept two 6 mm<sup>2</sup> solid aluminium conductors.
- (ii) Each lighting fixture shall be provided with a grounding terminal suitable for connecting 2.5 mm<sup>2</sup> stranded tinned copper grounding conductor.
- (iii) All metal or metal enclosed parts of the housing shall be so banded and connected to the ground terminal so as to ensure satisfactory grounding continuity throughout the fixture.
- (iv) On completion of manufacture, all surfaces of the fixtures shall be thoroughly cleaned and degreased. The fixtures shall be free from scale, rust, sharp edges and burrs.



- v) The enamel finish shall have a minimum thickness of 2 Mils for outside surfaces and 1.5 Mils for inside surfaces. The finish shall be non-porous and free from blemishes, blisters and fading.
- (vi) All light reflecting surfaces shall have optimum light reflecting coefficient such as to ensure the overall light output as specified.
- (vii) All reflectors and louvers shall be furnished to the same standard as the fixture housing.

### 5.3 Tests :

The following routine tests shall be conducted as per the relevant Indian Standards.

- (a) Each fixture shall be tested at 1500 volts r.m.s. 50 Hz for one minute and no flash over or break down shall occur between current carrying parts and ground.
- (b) Insulation resistance of each fixture shall be tested at 500 V DC and the insulation resistance so measured shall not be less than 2 megohms between all current carrying parts and ground.
- (c) Each fixture complete with its proper lamp/lamps shall be shown to operate satisfactorily at its normal voltage and frequency.
- (d) Each fixture shall be examined visually to ensure that it is complete in all respects and satisfactorily finished.
- (e) Type and routine test certificates shall be submitted for tests conducted as per relevant IS/BS for the fixture and accessories.

### 5.4. Drawings and Data :

As part of the proposal, the Bidder shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories and following drawings/data for the respective lighting fixtures :

- (i) Dimensional drawings
- (ii) Mounting details cable entry facility and weights
- (iii) Light distribution diagrams (zonal & isekandera)
- (iv) Light absorption and utilization factors
- (v) Lamp output v-s. temp, curves.

**5.5 Specific Requirements :****(i) Illumination Levels :**

The following minimum levels of illumination shall be provided in the respective areas :

| Area                              | Illumination Level |
|-----------------------------------|--------------------|
| (a) Building stairs/corridors     | 100 lux.           |
| (b) Process area (indoor/outdoor) | 100 lux.           |
| (c) Large tank and reservoir      | 15 lux             |

**5.6 Lighting Fixtures and Layout :**

- (a) It shall be the responsibility of the tenderer to workout a detailed layout for the lighting fixtures offered by him, in order to provide the specified levels of illumination. The tenderer shall be responsible for measuring the levels of illumination after installation and establish compliance with the specification. The final layout of the lighting fixtures shall be furnished for the approval before commencement of installation. The minimum No. and types of lighting Fixtures shall be as under.

[1] Illumination in areas other than plant, building etc shall be in Developer Scope.

[2] Minimum 10 Nos. of 2 x 40 Watts tube light fixtures (indoor type with reflector) and minimum 20 Nos. of 1 x 40 Watts tube light fixtures (indoor type with reflector) complete in all respects will be required for filter house lighting.

However, the layout/detailed drawing for the complete plant lighting (inside and outside) must be prepared and got approved from the Gujarat Hira Bourse.

- (b) Lighting fixtures for the pump-bay shall be industrial type complete with reflector. All other indoor areas shall be illuminated using fluorescent tube fixtures of the industrial / decorative type, complete with reflectors.
- (c) All lighting fixtures shall be supplied completed with lamps and all necessary accessories for their satisfactory operation.
- (d) Lighting fixtures shall be any of the following makes such as Phillips, Crompton, GEC make and equipped with all components required for their satisfactory performance. Florescent 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.

(e) Receptacle units - Lighting Systems :

Decorative and industrial type receptacle units approved make of 5A, and 15A rating with switches confirming to IS : 3854 and sockets confirming to IS : 1293 shall be supplied and installed.

(f) Plant wiring:

All plant wiring shall be carried out using casing capping made from exclusively extrusion process using special compounded PVC resin having flat surface of casing with curved arrangement to grip the capping for fitting and holding. Casing can be screwed on surface by screw easily. No screw will be visible from outside. The wiring shall be done using copper conductor PVC wire confirming to IS-1554 with concealed plate type switches and switch boards (Make-M.K./C.P.L./Ellora). The copper conductor PVC insulated earth wire shall run through-out for light and power points.

The provision made under quality control act/order shall be followed.

(g) Each fitting shall be controlled individually.

6. Specification for Earthing and Lightning Protection :

6.1 Scope :

This specification covers requirements of earthing and lightning protection system. The specification is intended to cover complete supply, installation, testing and commissioning of the earthing and lightning systems.

6.2 General Information :

The design, supply and performance of the system shall comply with all currently applicable statutory regulations and safety codes in the locality where the systems will be erected and commissioned.

The earthing and lightning system shall be installed in conformity with the requirement of Indian Electricity Act 2003 as amended and the Indian Electricity Rules formed thereunder Indian Standard code and practice and other statutory regulations, that may be relevant to the erection.

Unless otherwise specified, the equipments, materials and accessories provided by contractor shall conform to the latest applicable Indian Standards or IEC Standards some of which are listed below :

IS : 3043 Code of Practice of earthing.

IS : 2039 Code of practice for protection of building and allied structures against lightening.

### 6.3 Earthing System :

Two separate and distinct earth leads shall be used for earthing each equipment/structures enclosing the power conductor and one earth lead for metallic structure adjacent to electrical installation.

Metalic frames of all electrical equipment rated above 250 volts, must be earthed by two distinct connections with earth system.

Earthing cables crossing other metallic structures such as conduits, pipe lines etc., shall be minimum 300 mm away from such structures.

All underground connections and joints in earthing system shall be brazed/welded. Connections with equipments/structures shall be bolted type.

Conducting petroleum jelly shall be applied to contact surfaces of all bolted joints and joints shall be covered with bituminous compound and taped.

When G.I. conductors are connected to aluminium conductors the contact surfaces of G.I. shall be tinned to prevent bimetallic corrosion.

Neutral connection shall never be used for the equipment earthing.

Earthing conductors shall be protected against mechanical damage.

All motors can be connected to the earth grid by providing pads.

Earthing conductors running along the structures, wall etc. shall be cleated at every 750 mm interval.

Minimum size of earth conductor shall be in accordance with IS:3043. However, sizes of earth conductors for equipment shall be at least half the size of power conductor, limited to maximum of 120 mm of aluminium.

All earth lead connections shall be as short and direct as possible and shall be without link

### 6.4 Earth Pits and Main Grid :

- 6.4.1 Adequate number of earthing pits and electrodes shall be used in conjunction with earthing grid.

The minimum spacing between two adjacent earth pits shall be five (5) meters and shall be kept sufficiently away from structures to clear footings.

- 6.4.2 The main grid loop for a building shall be installed outside foundation of the building, buried in back fill. It shall be installed at a minimum depth of 1500 mm outside the building wall. The main earth loops (MEL's) in plant areas shall be generally routed along cables when equipments are located away MEL's suitable sub-loops may be run upto them for deriving connections for individual equipment.

6.5 Lightening Protection :

Tall structures shall be protected against lightening strokes by suitable lightening protection system to be fabricated and installed.

Down comer shall not be taped in between for equipment earthing.

Cable sheaths, metal conduits, casing etc. shall not be connected to lightening protection system.

Down-comer shall be as short as possible. Each down comer shall be provided with a testing point located at a height of about 1000 mm from ground level.

A minimum 2 meter separation shall be maintained between any other electric conductor and lightening protection system.

Earthing and lightening protection system shall be blended to each other to prevent side flashover, if adequate clearance between two system cannot be maintained.

6.6 Indoor Equipment Earthing :

- 6.6.1 Each floor of building shall have its own earth bus embedded in concrete.

- 6.6.2 Earthing grid embedded in the floor slab shall have a minimum concrete cover of 50 mm.

- 6.6.3 Earth buses on different floor and main grid shall be connected by a latest two conductors of main grid conductor size.

- 6.6.4 Every alternate column (steel or RRC) of the building, housing electrical equipments shall be connected to main earthing grid.

- 6.6.5 Earthing conductors shall be welded at intervals of 1000 mm along their run of stye structure and shall be at interval of 750 mm along the wall.

**6.7. Outdoor Equipment Earthing :**

6.7.1 Wherever earthing conductor crosses the trenches, funnels railway, track, etc., it shall be run below the trench etc.

6.7.2 Equipment structures shall be earthed at two diagrammatically opposite points.

**6.8 Earthing & Lightning Protection System:**

6.8.1 Sizes and number of earth leads for earthing various items and other technical particulars shall be as specified by the contractor.

6.8.2 Earthing conductors shall be shown diagrammatically. Exact location of earthing conductors, earth electrodes test pits, and earthing connections may be changed to suit the site conditions.

6.8.3 Earthing conductors in the building, running parallel to walls and columns shall not be less than 150 mm away from the wall/ columns.

6.8.4 Suitable earth risers shall be provided if the equipment is not available while carrying out earthing connections.

6.8.5 However, if earthing conductor passes through walls, galvanized iron sleeves shall be provided for the passage of earthing conductor. Water stop sleeves shall be provided. water stops shall be provided wherever earthing conductor enters the building from outside.

6.8.6 Whenever the Conductors are to be buried, the contractor shall co-ordinate with other civil contractors to ensure that the conductors are installed before concreting.

6.8.7 All connections shall be low resistance, so that contact resistance shall be minimum.

**6.9 Testing of Earthing System :**

6.9.1 Gujarat Hira Bourse may ask to carry out earth continuity tests, earth resistance measurements and other tests in presence of the Engineer-in-charge which in his opinion are necessary to prove that the system is in accordance with design specifications, Indian code of practice and Indian Electricity Rules. Contractor shall have to bear the cost of all such tests. The earth resistance of the sub-station earthing system shall not exceed 1 ohm.

6.9.2 The lightning protection vertical air terminations and/or horizontal air termination conductors shall remain in their installed position even during severe weather conditions.

6.9.3 All joints in the down conductors shall be of welded/brazed type. All metallic structures in the vicinity of down conductors shall be bonded to the down conductors.

- 6.9.4 The test joint for down conductors shall be directly connected to the earthing systems.
- 6.9.5 The earth resistance shall be checked, recorded and the resistance shall be improved in case it is higher than acceptable limits.
- 6.9.6 The contractor shall carry out all rectifications repairs or adjustment work found necessary during testing and commissioning.

**6.10 Earthing Conductor :**

The complete scope for collection of data, design of the system as per relevant national/international standards, preparation of layout drawings, installation and approval to the satisfaction of electrical inspector, are in scope of works under this tender specification. Earthing conductor sizes as given in electrical design criteria are for the purpose of guidance. Contractor shall satisfy himself for the size of the earth conductor required.

**Notes :**

- 1. Conductors above ground shall be galvanized Iron to prevent atmospheric corrosion.
- 2. Conductors buried in ground or embedded in concrete shall be Galvanized steel.

Fault clearing time for sizing earthing conductor shall be taken as one (1) second and plant earthing system shall be designed such that overall earthing resistance is less than One (1) ohm.

**3. Lightning Protection :**

The need for lightning protection for buildings and allied structures shall be assessed as per IS : 2039 and if found necessary, lightning protection shall be provided as per the same standard.

**GENERAL CONDITIONS FOR EQUIPMENT ERECTION AND COMMISSIONING**

- 7.1 In accordance with the specific installation structions, as shown on manufacturer's drawings or as directed by the GUJARAT HIRA BOURSE's Representative, the Contractor shall unload, erect, install, site test and place into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in manufacturer's drawings or as stipulated by the Gujarat Hira Bourse. No equipment shall be permanently bolted down to the

foundation or structure until the alignment has been checked and found acceptable to the Gujarat Hira Bourse.

- 7.2 The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials, such as bolts, wadges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.
- 7.3 Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.
- 7.4 The Contractor shall engage the manufacturer's erection Engineers to supervise the erection of the relevant equipment referred to in the Technical Specification. The Contractor shall erect and commission the equipment as per the instructions of the Erection Engineer(s) and shall extend full co-operation to him.
- 7.5 The Contractor shall move all equipment into the respective building through the regular doors or floor opening provided specifically for the equipment. The Contractor shall move the equipment from the storage site to the crane, attach to the crane hook and install in final location. The Contractor shall make his own arrangements for the lifting of equipment.
- 7.6 Where assemblies are supplied in more than one section, the Contractor shall make all the necessary mechanical and electrical connections between sections including the connections between bus bars / wires. The Contractor shall also carry out the necessary adjustments/alignments isolators and their operating mechanisms. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expense.
- 7.7 The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels/desks have been erected and aligned. The blocking materials/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels/desks have been completely installed and no further movements of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Gujarat Hira Bourse.

#### 8.1 SPECIFICATION FOR ERECTION, TESTING & COMMISSIONING OF ELECTRICAL EQUIPMENTS AND ACCESSORIES :

##### 8.1.1 Scope :

This specification is intended to cover complete installation, testing and commissioning of electrical equipments i.e. motor control centres, control panels/ switchgears, motors, push button stations etc. complete.



**8.1.2 Codes and Standards :**

- i. The installation, testing and commissioning of all electrical equipments shall comply with all currently applicable statutory regulations, fire insurance and safety codes in the locality where the work will be carried out. Nothing in this specification shall be construed to relieve the Contractor of his responsibility.
- ii. Unless otherwise specified, the work, material and accessories shall conform to the latest applicable Indian, British or IEC Standards, some of which are listed below :

IS : 3072 Installation and maintenance of switchgear.  
IS : 900 Installation and maintenance of Induction motors.  
IS : 3106 Selection, installation and maintenance of fuses.  
IS : 1886 Installation & maintenance of transformers.  
IS : 1180 Distribution Transformers.  
IS : 4029 Guide for testing three phase induction motors.  
IS : 335 Insulating oil for transformers & Switch-gears.  
IS : 5124 Installation and maintenance of A.C. Induction Motor starters upto 1.1 KW.  
IS : 226 Specification for structural steel.  
IS : 5216 Guide for safety procedure and practices in electric work.  
IS : 3202 Climate proofing of electrical equipment.  
IS : 2274 Code of practice for electrical wiring installations.  
IS : 6665 Code of practice for industrial lighting.  
IS : 1866 Code of practice for maintenance of insulating oil.  
IS : 1653 Rigid steel conduits for electrical wiring.  
IS : 2667 Fittings for rigid steel conduits for electrical wiring.

**8.1.3 Good workmanship shall be in accordance with best engineering practice to ensure satisfactory performance and service life.**

**8.1.4 Detailed Requirement of Installations :**

**a. Switchgear, Control Panel etc.**

All alignment, leveling, grouting, anchoring adjustments shall be carried out in accordance with manufacturers instructions and/or as directed by the purchaser.

All modules and internals shall be cleaned preferably with vacuum cleaner.

All connections and fixing of equipments in switch-gear.

In some cases, minor modifications may have to be carried out at site in the wiring and mounting of the equipment to meet the requirements of the desired control scheme and the contractor shall have to do the same at no extra cost.

**b. Motors :**

The installation of Motors shall be carried out in accordance with manufacturer's instructions and/or as directed by the purchaser.

Checking and cleaning of bearings and charging/ filling of lubricants, wherever necessary.

Cleaning of core the winding, varnishing out the windings and measurement of air gap for motor assembly at site if demanded.

Motors shall be run on un-coupled condition for few hours before coupling them with the drive equipment.

Motors shall be coupled with drive, adjusted and shall be tested on load.

**c. Miscellaneous Items :**

The contractor shall install miscellaneous items such as motor starters, local start/stop push bottom stations etc. The equipment will be generally wall, column or stand mounted. The exact location will be as shown in the final drawings.

All supports or brackets needed for installation shall be fabricated and painted by the Contractor.

All welding, cutting, chipping and grinding as and when necessary shall be carried out by the Contractor.

**d. Installation of Cables :**

Cables shall be laid in accordance with layout drawings and cable schedule etc. to be supplied by Contractor and approved by the A.N.P. Medium voltage and control cables shall be separated from each other by adequate spacing or running through independent pipes.

The Contractor shall install and commission the cables in accordance with the drawings and instructions issued by the Gujarat Hira Bourse's representative. Cables shall be laid directly buried in earth, on cable racks, on cable trays, in conduits, on walls etc. as per the requirements.

All cables routes shall be carefully measured and cables cut to required lengths, leaving sufficient length for the final connection of the cable to the terminals of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables.

Cables shall be laid in trenches at requisite depths. Before cables are placed, the trench bottom shall be filled with a layer of sand. This sand shall be covered with

150 mm of sand, on top of the largest diameter cables, the sand shall be lightly pressed. A protective covering of approved type of brick shall be laid. The remainder of the trench shall then be back filled with soil, rammed and leveled.

As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-charge. Any cable which proves defective shall be marked and replaced with a new cable.

When cable rises from trenches to motor, push button, lighting panels etc. it shall be taken in GI pipes for mechanical protection upto a minimum of 150 mm above grade etc. The top of the pipe shall be filled with PUTTI after pulling of cable for sealing purpose.

Straight through joints if required shall be made by using epoxy resin type torpplain or M-seal.

Cables shall be neatly arranged and dressed in the trenches in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated.

All cables will be identified close to their termination points by cable numbers as per cable schedule. Cable numbers will be punched on AL strips [2 mm thick] securely fastened to the cable wrapped round it.

Each underground cable shall be provided with identifying tags of lead securely fastened every 20 m of its underground length with atleast one tag at each end before the cable enters the ground, at each bend or turning and the road crossing.

In unpaved area, cable trenches shall be identified by means of cable marker. These posts shall be placed at location changes, in the direction of cables and at interval of not more than 50 m.

A minimum clearance of 300 mm shall be maintained between cable trench and parallel runs of underground piping. Cables which enter building below ground level shall pass through the building foundation in G.I. pipes. Space between the cable and pipe shall be sealed so as to be liquid tight. Sealing compound used shall be impervious to liquids that may be in the ground.

Following guide shall be used for sizing the pipe size :

- |                       |          |
|-----------------------|----------|
| i. 1 cable in pipe    | 53% full |
| ii. 2 cable in pipe   | 31% full |
| iii. 3 or more cables | 43% full |
| iv. Multiple cable    | 40% full |

At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

All cable entry places to the buildings shall be suitably sealed as instructed by the Engineer-in-charge.

e. Tray and Supports for Cables :

Armoured cables which run exposed above ground shall generally be run in cable racks or cables trays except individual cables or groups of upto two or three running along structures may be attached directly to the structures. In the cable trenches below the switchgears, cable racks and trays shall be used for supporting cables. Cable trays shall be ladder type of steel construction with ladder runs of 450 mm centres or the trays may be GI perforated type. Lengths shall preferably be 6 meters [approx. depending on fabrication facilities] in widths of 150, 300 and 450 mm as per design requirements for greater width, trays may be bolted together. Side heights shall be sufficient to provide mechanical protection for the cables.

Cable trays shall be supported at every 300 mm or less longitudinal run [based on maximum uniform loading of 35 kg. per meter length for 3 meter span] shall be so routed that there is no danger of mechanical damage.

They shall be kept separate as far as possible from major piping and where practicable at elevation above the top level. Routings shall follow the major structure axes.

Where more than one level of cable trays is required, levels shall have a minimum of 450 mm clear space between top of cable layer and bottom of next higher load tray. Top level shall also have 450 mm clearance to any overhead construction running immediately over and parallel to it. This is to allow adequate access to all cables. A 300 mm clearance is satisfactory for short obstruction of 300 mm or less.

Cable trays and inaccessible portion of supporting steel shall be painted if necessary, before laying of cables. The painting shall be done with one coat of red lead paint and two coats of aluminium white paint.

Cable laid in horizontal trays shall be fixed to the tray at intervals not exceeding 1 meter where cables are run individually or structures strapping intervals shall not exceed 600 mm. Vertical runs shall have strapping at intervals.

Outdoor cable trays shall be galvanized and the cable fixing straps, bolts, nuts, washers etc. shall also be galvanized.

f. Cable Termination :

Cable termination shall include the following :

- a. Making necessary holes in the bottom/top plates for fixing cable gland/box.
- b. Fixing cable gland/box, connecting armour clamp to cable armour.

- c. Dressing of cables, pouring compound etc. wherever necessary to make termination complete.
- d. Putting cable lugs, crimping them on to cores of cables, taping bare conductors upto lugs, wherever necessary.
- e. Terminating to equipment terminals.
- f. Supply and fixing of cable and core identification ferrules.  
Wherever purchaser has not provided M.S. plates for fixing cable tray supports, contractor shall install approved concrete fasteners for fixing cable tray supports.
- g. Conduits & Pipes :  
Contractor shall supply and install conduits, pipes as specified and as shown in drawings prepared by him and approved by purchaser. All accessories/fittings required for making installation complete shall be supplied by contractor.

Flexible metallic conduits shall be used to termination to equipment which are likely to be disconnected at periodic intervals.

Conduits or pipes shall run along walls, floors and ceilings on steel supports embedded in soil, floor, wall or foundation, in accordance with relevant layout drawings. Under ground position of conduit installation to be embedded in the foundation or structural concrete shall be installed in close coordination with co-lateral work. Exposed conduit shall be neatly run and evenly spaced.

Exposed conduit shall be adequately supported by racks, clamps, straps or by other approved means. These fittings shall be of same material as conduits.

Each conduit run shall be marked with its designation as indicated on the drawings. Identification shall be made where possible

When one or more cables are drawn through a conduit, cables shall fill not more than 50% of the internal cross sectional area of the conduit.

The entire system of conduit after installation shall be tested for mechanical and electrical continuity throughout and permanently connected to earth by means of earthing clamp efficiently fastened to the conduit.

For jointing purpose, contractor shall have available at site, dies for threading, pipe or conduit. All such threaded ends shall be cleaned after threading and anticorrosive paint applied.

## **8.2 Specification for Erection, Testing and Commissioning Illumination System :**

### **8.2.1 Scope :**

This specification covers complete installation, testing and commissioning of indoor and outdoor illumination system.

**8.2.2 Code and Standards :**

The wiring, installation and commissioning of complete illumination system shall comply with all currently applicable statutory regulations, fire insurance and safety codes in the locality where the work will be carried out. Nothing in this specification shall be construed to relieve contractor of his responsibility.

**8.2.3. Unless otherwise specified, the work, material and accessories shall confirm to the latest applicable Indian, British or IEC standards, some of which are listed below :**

|                 |   |
|-----------------|---|
| IS : 2274 & 732 | Electrical Wiring installation  |
| IS : 1653       | Specification for conduits  |
| IS : 694        | PVC insulated [light duty] electric cables for working upto 1100 V          |
| IS : 3961       | Part V Recommended current ratings for PVC insulated [light duty] cables    |
| IS : 2208       | HRC cartridge fuse links  |
| IS : 1293       | 3 pin plugs and socket outlets  |
| IS : 3854       | Switches for domestic and similar purpose                                   |
| IS : 5133       | Part I Steel & cast Iron boxes for the enclosure of electrical accessories. |
| IS : 5216       | Guide for safety procedures and practices in electrical work                |
| IS : 6665       | Code of practice for industrial lighting                                    |
| IS : 1913       | General safety requirements for electric light fittings.                    |
| IS : 3202       | Climate proofing of electrical equipments                                   |
| IS : 3387       | Accessories for rigid steel conduits  |
| IS : 3480       | Flexible steel conduit for electrical wiring.                               |
| IS : 2509       | Rigid non-metallic conduits   |
| IS : 3419       | Fittings for rigid non-metallic conducts.                                   |
| IS : 2667-1964  | Fittings for rigid steel conduits for electrical wiring.                    |

**8.2.4 Good workmanship will be in accordance with best engineering practices to ensure satisfactory performance and service life.**

**8.2.5 General Requirements :**

Except as specifically approved by the site office, installation of conduits and lighting fixtures shall be taken only after all major services such as piping, structural work etc. in that particular area have been completed.

Location of lighting fixtures, switches and receptacles shall be located to suit site condition.

Except as noted mounting height of various lighting equipment from finish floor level shall be as follows :

- |                               |         |
|-------------------------------|---------|
| i] Lighting Panels            | 1200 mm |
| ii] Lighting control switches | 1000 mm |
| iii] Receptacle with switch   |         |
| a] For indoor                 | 500 mm  |
| b] For outdoor                | 1000 mm |

All cables and conduits from lighting panel upto first lighting fixture shall be identified with aluminium tags giving circuit reference number.

Lighting panel number shall be indicated when more than one panel for an area is to be provided.

A number of lighting panels shall be marked separately for supplying power to the space heaters mounted in the various switchgear panels and motors.

Steel surfaces exposed to weather shall be thoroughly cleaned for removal of rust and shall be given a primary coat of zinc chromate and two finishing coats of paint. All metal parts not accessible for painting shall be made of corrosion resistant material.

Cable/Conduit separators shall be provided at an interval of 500 mm for horizontal runs and 750 mm for vertical runs.

Cable/Conduits shall be kept, wherever possible atleast 300 mm away from pipes, heating devices and other equipments.

For the purpose of calculating connected loads of various circuits a multiplying factor of 1.25 will be assured to account the losses in the control gear.

Contractor shall supply junction boxes, pull boxes, terminal blocks, glands, conduits and accessories [elbows, tees, bends etc.] and supporting anchoring, materials to make the installation complete.

Contractor shall work in co-ordination with the civil contractor when opening sleeves are required in walls and floors. Holes made by contractor shall necessarily be patched in a good and approved manner.

All types of wiring concealed or unconcealed shall be capable of easy inspection. In all types of wiring due consideration shall be given for neatness and good appearance.

In hazardous areas, the grounding wire shall run along the conduits throughout the installation and all conduits and fixtures shall be effectively grounded. Conduits shall be grounded at the ends adjacent to switch at which they originate.

Wherever specified, lighting system shall be installed to provide necessary illumination in case of an emergency. Emergency lighting cables shall run in a separate conduit system.

Exposed outside surface shall be painted as with red lead primer and two coats of Aluminium paint.

Before a complete installation or an extension to an existing installation is put into service, installation tests stipulated in I.S.2274 and other codes of practices shall be carried out by contractor in the presence of Gujarat Hira Bourse's representative.

#### **8.2.6 Working in Conduits :**

Individual lighting circuits inside building shall be wired with 250/440 V grade copper conductor of approved make PVC insulated flexible wires/cables. The circuit wire shall be colour coded as follows :

White - Phase or DC positive wire  
Black - Neutral or DC negative wire.

Full wires in a conduit shall be drawn simultaneously. No subsequent drawings are permissible. Necessary pull wires shall be provided by the Contractor.

Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run.

Wiring shall not be spliced at any place other than junction boxes with approved type connectors of terminal strips and for lighting fixtures, connections shall be Tee off through suitable round conduit or junction box.

For vertical run of wires in conduit, wires shall be suitably supported by means of wooden plays at each pull junction boxes.

#### **8.2.7 Testing and Commissioning :**



After completion of the work, complete illumination system shall be thoroughly checked and tested by contractor in presence of the Gujarat Hira Bourse's representative as per check list.

The contractor shall provide all tools, materials, labour and supervising personnel for carrying out the test.

The contractor shall carry out all rectifications, repairs or adjustment work, found necessary during testing and commissioning.

The contractor shall record the test results and furnish test reports/results [4 copies] for approval.

On successful commissioning of the system and carrying out necessary rectification work, the purchaser will take over the installation either wholly or in parts as the case may be.

GENERAL MANAGER (TECH. & ADMN.)  
GUJARAT HIRA BOURSE  
SURAT.

SIGNATURE & SEAL OF TENDERER/CONTRACTOR :-

NAME :-

ADDRESS :-

DATE :-

## **CHAPTER - X**

### **SPECIFICATIONS FOR INSTRUMENTATION**

#### **APPLICABLE NATIONAL/INTERNATIONAL STANDARDS**

|           |   |   |
|-----------|---|---|
| AGA       | American Gas Association, Gas Measurement Committee                       |   |
| ANSI/ASME | American National Standards Institute/American Society of Mech. Engineers |   |
|           | B 1.20.1  | Pipe Threads  |
|           | B 16.5  | Steel Pipe Flanges and Flanged Fittings   |
|           | B 16.20   | Ring Joint Gaskets and Grooves for Steel Pipe Flanges                           |
| ANSI/FCI  | American National Standards Institute/Fluid Controls Institute            |   |
|           | 70.2  | Control Valve Seat Leakage Classification                                       |
| API       | American Petroleum Institute  |   |
|           | RP 520  | Sizing, selection and installation of pressure relieving systems in refineries. |
|           |   | Part-I - Sizing and selection   |
|           |   | Part-II - Installation  |
|           | RP 521  | Guide for pressure relieving and depressurizing systems                         |
|           | RP 526  | Flanged steel safety relief valves  |

|           |  |   |
|-----------|--|---|
|           | RP 527   | Seat tightness of pressure relief valves  |
|           | MPMS   | Manual of Petroleum measurement standards   |
|           | RP 551   | Process measurement instrumentation<br>Part -I Process Control and Instrumentation          |
|           | RP 552   | Transmission Systems  |
|           | S 2000   | Venting atmospheric and low pressure storage tanks  |
|           | S 670  | Vibration, Axial-Position and Bearing Temperature<br>Monitoring Systems                     |
| ASTM      | American Society for Tests and Materials   |   |
| BS        | British Standards  |   |
|           | BS-1042  | Measurement of Fluid Flow in Closed Conduits  |
|           | BS-5308 Part-II  | Specification for PVC insulated cables  |
|           | BS-7244  | Breather Valves   |
| DIN-43760 | Temperature Vs. Resistance curves for RTDs   |   |
| DIN-19234 | Electrical Distance Sensors; DC interface for distance sensors and<br>signal converter |   |
| DIN-50049 | Document on Material Testing   |   |
|           | IEC  | International Electro technical Commission  |
|           | IEC 79   | Electrical apparatus for Explosive Gas atmosphere   |
|           | IEC 85   | Thermal evaluation and classification for electrical<br>insulation                          |
|           | IEC 332  | Test on bunched wires or cables<br>Part III Cat. A  |
|           | IEC 529  | Classification of degree of protection provided by<br>enclosures                            |
|           | IEC 534-2  | Industrial Process Control Valves -Flow capacity  |
|           | IEC 584-2  | Thermocouples - Tolerances  |
|           | IEC 751  | Industrial Platinum Resistance Thermometer<br>Sensors                                       |
|           | IEC 801  | Electromagnetic compatibility for industrial process<br>measurement and control equipment   |
| IS        | Indian Standard  |   |
|           | IS-5   | Colours for ready mixed paints  |
|           | IS-319   | Specification for free cutting brass bars, rods and<br>sections                             |
|           | IS-1239  | Mild Steel tubes, tubular and other wrought steel<br>fittings                               |
|           | IS-1271  | Specification of Thermal Evaluation and<br>Classification of Electrical Insulation          |
|           | IS-1554 Part-  | IPVC insulated (heavy duty) electrical cables – working<br>Voltage upto and including 1100V |
|           | IS-2074  | Ready mixed paints, air drying, red oxide - zinc  |

|          |   |
|----------|---|
|          | chrome  |
| IS-2147  | Degree of protection provided by enclosures for low voltage switch gear and control gear                                    |
| IS-2148  | Flame proof enclosures for electrical apparatus   |
| IS-3624  | Specification for Pressure and Vacuum gauges  |
| IS-5831  | PVC insulation and sheath of electric cables  |
| IS-7358  | Specification for Thermocouples   |
| IS-8784  | Thermocouple compensating cables  |
| ISA      | Instrument Society of America   |
| S-5.2    | Binary logic diagrams for process operations  |
| S-7.3    | Quality standard for instrument air   |
| S-75.01  | Flow equations for sizing control valves  |
| ISO 5167 | Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits |

NACE National Association of Corrosion Engineers - MR-01-75

NEC National Electric Code

NEMA National Electrical Manufacturer's Association  
ICS-6 Enclosures for industrial control and systems

NFPA National Fire Protection Association

NFPA-496 Purged and pressurized enclosures for electrical equipment

OSHA Occupational Safety and Health Authority

Any other national and international codes as applicable subject to approval of GUJARAT HIRA BOURSE.

## **1. GENERAL:**

The Contractor shall obtain all instruments from manufacturers of international standing.

The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application.

All instruments shall be capable of carrying their full load currents without undue heating. They

shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by MCB's in each unearthed phase of the circuit placed as close as practicable to the main connection.

Analogue signals shall be 4-20 mA according to BS 5862:Part I 1986 or its latest edition. They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument inclosure.

Analogue signals shall be so connected that the failure of a remotely transmitted signal to another panel can not affect other readings on instruments operated by the same signal.

The contractor shall furnish technical details / catalogues / drawings for the instruments and panels offered for monitoring and control of the plant, as per the operation philosophy specified, to client/consultant for their approval prior to procurement of the same. Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the client / consultant, necessary test certificates shall be submitted for approval of client / consultant before clearing the material for despatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust-proof cases including those mounted in panels. All equipment shall be suitable for its environment.

Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless otherwise stated.

Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales. Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% to 70% of the full scale range.

After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.

The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.

The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 m above platform.

Lockable enclosure shall be provided for the field mounted instruments wherever required.

All field instruments, and cabinets / panel-mounted instruments shall have tag plates/name plates permanently attached to them.

In general, Instrumentation System shall be designed as per good engineering practice.

## **2. POWER SUPPLY TO PACKAGE:**

A) Power Supply shall be made available by the bidder at the following voltage levels, unless otherwise specified.

- For Instruments, Control Systems, Analysers: 230V AC  $\pm$  10%, 50 Hz  $\pm$  3 Hz
- Solenoid Valves, Relays, Lamps : 24V DC
- Input Interrogation Voltage : 24V DC
- Panel/Cabinets Lighting : 230V AC  $\pm$  10%

Contractor shall make provision for a separate feeder in the Plant MCC of suitable current rating to provide 230V AC  $\pm$  10%, 50 Hz  $\pm$  3Hz supply to Instrument Panel(s).

**24V DC required for Input Interrogation, SOVs, relays and lamps etc., same shall be generated by the bidder using dual redundant power supply. Power shall be suitably conditioned by providing UPS / Isolation Transformer-Voltage Stabilizer-CVT to prevent damage to instruments against power fluctuation / disturbances.**

B) Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

## **3. EARTHING :**

Bidder/Contractor shall provide separate earth bus bar connections for shield and panel electrical earthing. Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits for instrument earth and signal earth (minimum 2 nos. of each type) shall be provided by the vendor.

## **4. ENCLOSURE :**

All instruments enclosure mounted in the field shall be weatherproof to IP-65 / NEMA4 as a minimum.

## **5. INTERLOCKS / LOOPS :**

All plant interlocks shall be carried out using PLC / electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P&IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop.

The system shall be designed fail safe and shall meet the following requirements, as a minimum :

- a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.
- b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.

The system shall be designed using PLC / electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum :

- a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
- b) The relays shall be plug-in type and their plug-in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
- c) Each relay shall have three numbers of 'NO' and three numbers of 'NC' contacts as a minimum each suitable to drive the connected. Out of these, one 'NO' and one 'NC' contacts shall not be used.
- d) Each shutdown/interlock logic shall be individually protected using separate switch-fuse unit and shall have a lamp for indicating power healthy status.

Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

## **6. INSTRUMENT CONTROL PANEL / CONTROL DESK (ICP) :**

The Control Panel shall be free standing & enclosed cubicle type with backdoors. Instruments to be mounted on control panel shall be as per this bid document as a minimum.

Control panels shall be prefabricated type, Sourced from Approved Vendors.

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 2 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. The instrument panel shall have dimensions as per system requirement. However, the Control panel height shall not exceed 2100 mm.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part-I.

Control Panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the Instrument panels. These shall be dispatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Instrument panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

No process fluid of any kind, except instrument air, shall enter the instrument cubicle. All cable entry shall be from the bottom of the panel. Also power supplies greater than 230 V shall not enter the LCP.

The internal layout of the panel/cabinets shall be designed considering proper approach for each item for maintenance. Following point must be taken into consideration while deciding the internal layout :

- a.) All wiring inside the panels shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance adjustment, repair and removal. No raceway shall be more than 70% full.
- b.) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring.
- c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals : Min. 50 mm.
- d.) Distance between terminal strip and top and bottom of cabinet : Min. 75 mm.
- e.) Distance between two adjacent terminal strips : Min. 100 mm.
- f.) Distance between cable gland plate and the bottom of strips : Min. 300 mm.
- g.) 20% spare terminals shall be provided as a minimum.

Overall height of Control Panel shall not exceed 2100 mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800 mm and 1300 mm from floor level.

Control Panel shall be provided with fluorescent type lighting fixtures controlled from totally enclosed door operated switches for internal illumination of the panel cabinets.



Contractor shall provide with necessary cooling fans and cut-outs covered with appropriate filters for necessary air changes to limit temperature rise within panel to 5 deg C over ambient temperature.

Contractor shall consider necessary power conditioning unit (UPS / Voltager Stabilizer-CVT etc.) to prevent power fluctuation and surge to damage the instruments as well as other electronic components.

For cases where PLC is to be mounted, panel shall be designed suitably as per PLC manufacturer's recommendation. Necessary marshalling boxes may be considered if required as per design.

Control room shall be provided with minimum 2 Nos. of 1.5 M.T. capacity split type A.C. (Air-conditioners) fixed with all necessary arrangements of Hitachi / LG / Samsung make.

### **Mounting**

All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

### **Earthing for Instruments**

The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

Minimum two numbers of Dedicated Earth Stations to be provided each for Instruments / Panel Earthing and for Signal (Electronic) earthing. The earth station shall be of maintenance free pipe in pipe technology having earth electrode of 50 mm dia. and length of 3000 mm.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit as specified above.

### **Frame Earthing**

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar.

Connection of the earth bar to the station earth shall be carried out by Contractor.

### **Space Heater**

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

### **Interior Lighting and Receptacles**

Each panel shall be provided with either a CFL lighting fixture rated for 11 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacle with a switch and neon indication. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

### **Labels**

All the equipment mounted on the front facia of Instrument panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

### **Switches and Miniature Circuit Breakers (MCBs)**

Each instrument panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs. All such major MCBs will be provided with an auxiliary contact to be used for providing MCB tripped alarm.

### **Intra-panel (i.e. Panel Internal) Wiring**

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 600 volt grade, multi stranded copper flexible conductor insulated with FRLS Grade PVC and designed for a minimum conductor temperature of 70 degrees centigrade. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Purchaser and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.

Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always & hence easily readable.

### **Terminal Blocks**

Terminal blocks for power connection shall be 600V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type and all other input signal terminals will be clip on shrouded type.

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal blocks.

### **Cable Supports**

All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

### **Terminal / Identification**

Every terminal plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

### **Painting of System Cabinet/ Control Desk**

All sheet steelwork shall be painted using seven tank processe in accordance with the following procedure:

- i. The pre treatment shall be hot process with running water for rinsing.
- ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.
- iv. The control panel shall be powder coated. Thickness of coating shall be around 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder

coating.

7. **LOCAL CONTROL PANEL / CONSOLE (LCP) :**

Filter Consoles consisting of required I/O's and other necessary equipments will be provided, one between two or three filter beds.

Bidder may also consider to provide local console near intake unit and Clear Water pump house or other such suitable locations as per his design consisting required I/O's as per requirement.

Panel specifications shall be as described above for Instrument Control Panel.

8. **ALARM ANNUNCIATOR :**

- (i) Microprocessor based alarm annunciators shall be provided, **if specified in detailed specifications for instruments**, for generating audiovisual alarms for each abnormal condition. Alarms shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exist. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment. Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment. The sequence of alarm should be user selectable by dip switch.
- (ii) The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a future alarm condition occurs.
- (iii) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.
- (iv) Isolation facilities shall be provided for the hooter using an MCB
- (v) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

- i. Top line : Location
- ii. Middle Line : Parameter
- iii. Bottom Line : Status

e.g. RESERVOIR  
LEVEL  
HIGH

The annunciator will be split / integral architecture type and the facia will have Super Bright LEDs. Alarm annunciator shall be provided on instrument control panel for annunciation of alarms in control room. A minimum of 20% spare windows with alarm modules shall be

provided in alarm annunciator.

The technical particulars of alarm annunciator are as follows:

|       |                       |   |
|-------|-----------------------|---|
| (a)   | Technical Particulars |   |
| i.    | Type                  | : Microprocessor based, split type / integral type with alarm windows mounted on the front door and electronic modules inside the panel |
| ii.   | Mounting              | : Flush with panel  |
| iii.  | Construction          | : Modular   |
| iv.   | Inputs                | : Potential free, NO/NC contacts  |
| v.    | Size of windows       | : 60 mm X 26 mm   |
| vi.   | Operating sequences   | : First up (user selectable dip switch)   |
| vii.  | Bulbs per channel     | : 2 (Cluster LEDs)  |
| viii. | Push Buttons          | : For Reset, Accept and Test  |
| ix.   | Hooter                | : Required, electronic type   |
| x     | Power supply          | : 24 V DC/240 V AC  |
| xi.   | Power supply status   | : Required indication   |
| xii.  | Weather protection    | : IP-52 of IS 13947   |
| xiii. | No. of Windows        | : as per requirement  |

**In case if hard wired annunciator is not specified in detailed specifications for instruments, then visual alarm at HMI and audio alarm through panel mounted hooter along with rest push button shall be provided for all the required alarms as per specifications / approved P&ID / process requirement.**

#### **9. RECEIVING INDICATORS/CONTROLLERS :**

All indicators/controllers, where specified in tender specifications / detailed specifications for instruments, shall be electronic (microprocessor based) programmable indicator and shall be mounted on the control panel located in the control room.

Notes :

Indicating instruments shall indicate various process parameters as per following measuring units, in general :

|                   |   |   |
|-------------------|---|---|
| Flow              | M <sup>3</sup> /Hr or MLD or LPS        | as per process requirement              |
| Level             | m                                       | Meters                                  |
| Pressure          | Mt. head of water or Kg/Cm <sup>2</sup> | as per process req.                     |
| Temperature       | C                                       | Degree Celsius                          |
| Concentration     | ppm or mg/l                             | Parts per million or Milligram per ltr. |
| Current           | A                                       | Amperes                                 |
| Voltage           | V                                       | Volts                                   |
| Power             | W                                       | Watts                                   |
| Electrical Energy | Whr                                     | Watt-hours                              |
| Frequency         | Hz                                      | Hertz                                   |
| Speed             | r.p.m.                                  | Revolutions per minute.                 |

Multiplying factors for flow scales shall be specified on manufacturer's name plate.

Subminiature recorder shall have 100 mm. Strip chart with chart speed of 25 mm/hr. Microprocessor based recorder shall have strip chart of 250 mm. Approx. and chart speed of 50 mm./hr. with a provision to change speed at site.

## **10. PUSHBUTTONS AND SWITCHES**

Pushbuttons, where applicable, for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Illuminated pushbuttons where applicable / used shall be of a design that allows easy replacement of the lamps from the front of the panel.

If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer – In charge before manufacture.

Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

## **11. INSTRUMENT CONNECTIONS:**

Electrical cable entry shall be ½" NPT(F). Suitable cable gland shall be used.

End connections shall meet the following unless, otherwise specified:

Threaded end connection shall be NPT as per ANSI / ASME B.1.20.1

Flanged end connection shall be as per ANSI / ASME B16.5

## **DETAILED SPECIFICATIONS FOR INSTRUMENTS**

Instruments as per following details and specifications shall be provided by vendor as a minimum. Quantities mentioned, if any, are indicative and minimum only and contractor shall provide all necessary instruments described in this section or as required for proper operation of the plant as described else where in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations.

**a) ULTRASONIC TRANSMITTER. – LEVEL / LOH & ROF / OPEN CHANNEL FLOW METER**

Ultrasonic level measurement shall be accomplished by the use of non-contact, echo-time measuring equipment operating at ultra-sonic frequency.

Level transmitter shall consist of a sensor incorporating both transmitter and receiver along with integral controller where as open channel flow meter shall have a separate control unit. Control unit shall be programmable and shall have IP-65 protection as a minimum. The equipment shall be provided with automatic temperature compensation.

The sensor shall be suitable for mounting in the open, or within an enclosed tank, and shall be with environmental protection to IP-67 as minimum. The sensor / transducer range shall be as required to cover Liquid Depth + Free Board + Blanking Distance as a minimum.

The control units shall incorporate:

Facilities for calibration and shall have an output of 4-20mA proportional to selected measurement parameter of level or flow as per user selection / program.

4 digit or other suitable as per mfr std. LCD read out of selected measurement parameter in suitable engineering units.

The overall accuracy of the level/flow measurements shall be within 1.0% or better of the instrument span.

Where ultrasonic equipment is specified for measuring flow in open channels, the micro-processor based control unit shall be incorporating necessary algorithms for converting level to flow and shall provide a 4-20 mA output proportional to flow.

The contractor shall provide a canopy for the sensor and the control unit exposed to sunlight to provide protection from direct sunlight.

**Ultrasonic Transmitter for Level Measurement:**

Ultrasonic transmitter shall be provided to measure liquid level of tanks/sump like treated water / backwash suction sump, backwash tank (ESR), dirty water sump, and alum/PAC solution preparation & dosing tanks. The purpose is to monitor tanks/sump levels locally and at ICP at main control room as well as provide low level trip for safety of pumps against dry running, start/stop of pumps in auto mode through suitable logic to be decided during detailed engineering, low/high level alarm annunciation at alarm annunciator at control room, etc. The

brief specifications in addition to above specifications shall be as under:

|                          |   |   |
|--------------------------|---|---|
| Type                     | : | Ultrasonic, Programmable                            |
| Mode of Operation        | : | Level   |
| Accuracy                 | : | $\pm 0.25\%$ of range OR 6 mm, whichever is greater |
| Resolution               | : | 0.1 % of range OR 2 mm, whichever is greater        |
| Outputs                  | : | 4-20 mA analog output proportional to level         |
| Local Digital Display    | : | Level in Engg. Units                                |
| Power                    | : | 110/230 V ac $\pm 15\%$ , 50/60 Hz OR 24 V DC       |
| Control Unit Protection  | : | IP-65 as a minimum                                  |
| Operating Temp.          | : | -20 <sup>0</sup> to 50 <sup>0</sup> C               |
| Proc. Temp. Compensation | : | Required, Built-in temp. sensor in transducer       |
| Sensor MOC               | : | PVDF or equi. suitable                              |
| Transducer Protection    | : | IP-68   |
| Transducer Cable Length  | : | 10m minimum   |

**Ultrasonic Diff. Level Transmitter for Loss of Head / Rate of Flow Measurement:**

Ultrasonic transmitter shall be provided to monitor choking of filter bed by measuring differential water level across the filter (Loss of Head) and Flow Rate over weir at outlet of each Filter Bed (Rate of Flow) for alarm and auto / semi-auto backwash operation of filter bed as per the backwash logic furnished by the bidder. Loss of Head and Rate of Flow shall be displayed at each filter console. Bidder may provide a two channel ultrasonic instrument capable of providing analog output (4-20mA) equivalent to Loss of Head (Diff. Level) and Rate of Flow and in-built alarm contacts for High Loss of Head and Low Rate of Flow at user adjustable set levels to be fed to local PLC at respective filter console or alternately two single channel ultrasonic level transmitters with necessary calculations through PLC can be provided with provision of local display of LOH and ROF through local indicators at filter console associated to a particular bed for local display along with the user adjustable LOH/ROF alarm contacts through local panel mounted indicators to be fed to local PLC at respective filter console. The LOH / ROF readings shall be monitored locally and and “Filter Bed-XX Clogged, Start Backwash” alarm annunciation at ICP at control room shall be provided thorough the respective filter console, etc.

The brief specifications in addition to above specifications shall be as under:

|                         |   |   |
|-------------------------|---|---|
| Type                    | : | Ultrasonic, Fully User Programmable, microproc. based   |
| Mode of Operation       | : | Differential Level / Level / Flow   |
| Accuracy                | : | $\pm 0.25\%$ of range OR 6 mm, whichever is greater   |
| Resolution              | : | 0.1 % of range OR 2 mm, whichever is greater  |
| Outputs                 | : | 2 nos., 4-20 mA analog output, one proportional to diff. Level and other for flow or both proportional to level for LOH and ROF calculation through PLC through programmable logic) |
| Programming Device      | : | In-Built in controller or Hand-held   |
| Local Digital Display   | : | LOH and ROF in Engg. Units  |
| Power                   | : | 110/230 V ac $\pm 15\%$ , 50/60 Hz OR 24 V DC   |
| Control Unit Protection | : | IP-65 as a minimum  |



|                          |   |   |
|--------------------------|---|---|
| Operating Temp.          | : | $-20^{\circ}$ to $50^{\circ}$ C               |
| Proc. Temp. Compensation | : | Required, Built-in temp. sensor in transducer |
| No. of transducer        | : | Two   |
| Sensor MOC               | : | PVDF or equi. suitable                        |
| Transducer Protection    | : | IP-67/68                                      |
| Transducer Cable Length  | : | 15m minimum or more as required               |
| Communication Port       | : | Preferred, RS 485 Modbus RTU / Profibus       |

**Ultrasonic Transmitter for Parshal Flume / Open Channel Flow Measurement:**

Ultrasonic transmitter shall be provided to measure each parshal flume / open channel / weir flow as provided for the treatment plant in Inlet and Outlet of the Plant. The brief specifications in addition to above specifications shall be as under:

|                          |   |  |
|--------------------------|---|--|
| Type                     | : | Ultrasonic, fully user Programmable, microproc. based  |
| Mode of Operation        | : | Flow   |
| Accuracy                 | : | $\pm 0.25\%$ of range OR 6 mm, whichever is greater    |
| Resolution               | : | 0.1 % of range OR 2 mm, whichever is greater           |
| Outputs                  | : | 4-20 mA analog output proportional to flow Programming |
| Device                   | : | In-Built in controller or Hand-held                    |
| Local Digital Display    | : | Flow in Engg. Units                                    |
| Power                    | : | 110/230 V ac $\pm 15\%$ , 50/60 Hz OR 24 V DC          |
| Control Unit Protection  | : | IP-65 as a minimum                                     |
| Operating Temp.          | : | $-20^{\circ}$ to $50^{\circ}$ C                        |
| Proc. Temp. Compensation | : | Required, Built-in temp. sensor in transducer          |
| Sensor MOC               | : | PVDF or equi. suitable                                 |
| Transducer Protection    | : | IP-68  |
| Transducer Cable Length  | : | 10m minimum  |

Flume Flow (Instantaneous and Totalised) readings shall be continuously displayed locally (inst flow only) at ICP (Control Panel) in main control room on panel mounted indicators/totalizers. The instrument should be competent to perform open channel measurements for all kind of flumes & weirs.

**b) INSERTION TYPE ELECTROMAGNETIC FLOWMETER**

The insertion type electromagnetic flow meter shall measure the flow of backwash water at common header of backwash water line from backwash tank. The brief specifications shall be as under:

|                      |   |  |
|----------------------|---|--|
| Type                 | : | Instertion type, electromagnetic               |
| Service Pipe MOC     | : | MS / DI / CI                                   |
| Flow Meas. Range     | : | from 1m/s up to 5 m/s flow velocity            |
| Power Supply         | : | 24V DC or as per mfr std.                      |
| Output               | : | 4-20 mA proportional to flow                   |
| Accuracy             | : | ± 3% of range or better                        |
| Fluid Conductivity   | : | >20 µS/Cm                                      |
| Enclosure Protection | : | IP-65 as a minimum                             |
| Electrode MOC        | : | SS316L   |
| Sensor Tip           | : | PVDF or equi. as per mfr std.                  |
| Wetted Parts         | : | Non-corrosive                                  |
| Housing              | : | Die Cast Alu. or other suitable as per mfr std |
| Weld Stub / Nipple   | : | SS316L   |

Backwash water flow (Instantaneous and Totalised) readings shall be continuously displayed at ICP (Control Panel) in main control room on panel mounted indicators/totalizers.

### **c) RECEIVING INDICATORS MOUNTED AT ICP/LCP:**

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel located in the control room. Multiplying factors, shall be specified on manufacturer's nameplate, if applicable. Specifications, as applicable are as follows:

#### **Process Indicator:**

|                       |   |  |
|-----------------------|---|--|
| Type                  | : | Microprocessor based, programmable   |
| Input                 | : | 4-20 mA  |
| Display               | : | 4 ½ Digit, 7 Segment LED display   |
| Display Units         | : | % or Engg. Units, user programmable at site  |
| Alarm Setpoint        | : | Two nos., pot. free relay contact rated at 5A @230V<br>AC resistive load, adj. over entire range |
| Transmitter Supply    | : | Required, 24V DC @30mA   |
| Retransmission Output | : | Required, 4-20 mA in 600 ohm load  |
| Accuracy              | : | ± 0.25% of FSD   |
| Terminals             | : | suitable for up to 2.5 sq.mm. wires  |
| Mounting              | : | panel flush mounting   |
| Power                 | : | 110/230 V AC, 50 Hz  |

**Flow Indicator cum totaliser** shall also have following in addition to above:

|                      |   |  |
|----------------------|---|--|
| Totalising Counts/Hr | : | User Programmable at site  |
| Totaliser Display    | : | 6/8 Digit Digital Display with Battery Backup to retain totalized data in the event of power failure for a minimum period of 24 hours. |

**d) PRESSURE SWITCH**

- (a) Electro-mechanical pressure switch shall be provided on the discharge header of backwash pumps to monitor the pump operation and at air compressor vessel / holding tank for auto start / stop of compressors and high / low alarms. Pressure switch shall also be provided on main header of air pipe at the end of filter house at the farthest location where maximum pressure drop is envisaged to monitor adequacy of air pressure in header for operation of pneumatically operated filter valves with adequate pressure indication at each filter console.
- (b) The pressure switch shall have a manually adjustable set point and differential switching level. The switch shall be provided complete with impulse tubing, two-valve manifold with drain cock, fittings etc.

**Particulars of Pressure Switch**

|      |                       |   |                   |
|------|-----------------------|---|-------------------|
| i.   | Switch type           | : | Micro switch      |
| ii.  | Set pressure          | : | Adjustable        |
| iii. | Accuracy              | : | $\pm 1\%$ of span |
| iv.  | Switch Contacts       | : | 2 NO + 2 NC       |
| v.   | Switch Rating         | : | 24 VDC, 2A        |
| vi.  | Wetted parts material | : | SS 316            |

**e) PRESSURE GAUGES:**

All pumps, compressors and air blowers shall have PG at their discharge lines. Pressure Gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with black engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of SS304, Bourdon Element / Socket of SS316, movement parts of SS, weather proof to IP-65, offering accuracy of +1% of FSD. Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of Diaphragm type Pressure Gauge, Diaphragm / Lower Chamber Wetted Parts shall be of SS316, Upper Chamber of SS304 / SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

**f) FLOAT/BUOYANCY SWITCHES:**

All dewatering pumps shall be provided with high & low level switches for auto operation and process pumps not specified with interlocks for auto operation shall be provided with low level switch for auto trip to prevent dry running as a minimum. Low level switches shall also be provided at treated outlet chamber to prevent dry running of backwash pumps. Switching element shall be a micro switch with switching ball of PP or equivalent non corrosive material. Contact shall be 1NO + 1NC and contact rating shall be minimum 2A rated at 230V AC resistive load.

**g) PROGRAMMABLE LOGIC CONTROLLERS SYSTEM FOR WTP**

General Requirements for PLC system

Water Treatment Plant is required to be automated using latest PLC System as specified in this section of the tender. The automation includes all the machinery and processes of WTP as explained.

Entire backwash operation of filter beds right from sensing of bed choking to initial backwash operation and complete cycle as per process design shall be completed automatically through local PLCs to be provided at each filter console. Further the plant pumps / process equipment, shall operate in auto mode and necessary instrumentation for the same shall be included in the scope of contractor for which contractor shall provide PLC at ICP at control room or may provide local control panels at appropriate locations with micro PLC.

Filter consoles shall be provided at each bed or at least one between two beds for local operation and monitoring of plant. All valves of a bed shall be possible to operate automatically as per logic for auto backwash operation or locally through associated filter console selector switches. It shall be possible to operate/monitor valves for filter beds associated to that particular LCP and also operate/monitor any of the air blowers for backwash operation. Monitoring (indicating lamps) of valve/blower status shall be provided at LCP. Valves shall be monitored for full open

and full close position and electrical drives for motor on, off and trip status. Separate indication lamps, Green indication lamps for Valve close / motor off status and Red indication lamps for Valve open / motor on status shall be provided. Indication Lamps for Trip shall be Amber.

All the valves of a filter bed shall be wired directly at the associated local filter console only. Distributed I/O or wiring of valve cable/signals in a console not associated to that particular bed is not acceptable.

LOH/ROF level indication of associated bed shall be displayed at each Filter Console LCP. Backwash tank water level sufficient for backwash operation shall also be indicated at each LCP as a Lamp indication. It shall be possible to operate the valves and air blowers locally through selector switches at filter beds from filter consoles. Indicating lamps shall be cluster LED type only. Each LCP shall be provided with necessary on/off push buttons / selector switches for operation of valves of particular bed/s with respective LCP and the air blowers. All valves should be able to operate in the following modes:

1. In Auto Mode: - Entire filter backwash shall be in auto mode with all valves / backwash blowers shall operate in fully automatic mode through PLC.
2. Semi-Auto Mode: - Where the operation of the valves/blowers is controlled from the local filter console through push button/selector switches by operator.
3. In Off Mode:- Valve/Blower shall be operated manually

Each Filter Console shall be provided with following as a minimum for each of the associated filter bed to achieve the above objective:

- a) Selector Switch for Auto – Off – Semi-auto mode selection
- b) Open / Close Selector Switch or Open & Close Push Buttons for operation of each filter bed valve.
- c) Open and Close Indication Lamps for monitoring position of each bed valve.
- d) On / Off Selector Switch or On & Off Push Buttons for each of the back wash air blowers for blower operation
- e) On, Off and Trip Indication Lamps for monitoring status of each air blower.
- f) Air Pressure Adequate Indication Lamp (Green), which if ON shall indicate sufficiency of air pressure for operation of pneumatic valves and OFF state shall indicate vice versa.
- g) Backwash Water Adequate indication lamp (Green) through necessary level switch to be provided in back wash tank when backwash water level is above the middle level of tank liquid depth.
- h) Backwash Water Inadequate – Start Filling indication lamp (Amber) through necessary level switch to be provided in back wash tank when backwash water level is at or below middle level of tank liquid depth. This signifies that water may or may not be sufficient for complete wash of one bed.

- i) Backwash Not Possible indication lamp (Red) through necessary level switch to be provided in back wash tank when backwash water level is at low level tank liquid depth.
- j) Filter Bed Clogged Indication Lamp (Red) on reaching the condition when LOH exceeds design / set level and ROF is below the set level indicating the choking of bed requiring backwash.
- k) Filter Bed In-Line or Standby selector switch. When in standby, the filter inlet valve shall remain closed isolating the filter bed (filter outlet valve shall remain open). When taken in-line, the filter inlet valve shall open and the bed shall operate as per process logic depending in the selection of operation mode.
- l) LOH and ROF indication

The scope of PLC in general is to control working of entire water treatment plant including Rapid Gravity Filter Units by way of allowing operation of all pneumatically operated filter bed valves in auto mode for auto backwash or in semi-auto mode through selector switches at LCP depending on the mode of operation selected and similarly operating the clarifier de-sludging valves as well. Monitor, display & data logging and control, as applicable, various process parameters of the plant like that of inlet & outlet parshall flume flow and other flow meters as applicable, display/control/alarm, as applicable, the status of operation of all pneumatically actuated valves of the plant, status of level in tanks/sumps for which level instruments are provided, status of operation of electrical drives (on, of and trip) etc. Annunciation shall be provided for various alarm conditions like quality parameter, flow, loss of head/rate of flow of each filter unit, limits for backwash, drive trip status, valve failure status, process equipment status, low and high level of various sumps, low level of particular alum/poly solution tank in use at that time etc. It shall be possible to carry out backwash operation of each filter bed in fully automatic mode by sensing the required inputs from LOH/ROF indicators, fully automatic operation of all pumps / blowers / air compressors / process equipment with necessary interlocks, as applicable, by providing necessary instrumentation for auto operation, and also operation of valves and electric drives through various LCPs by selecting suitable mode of operation through PLC based panel. The purpose is to minimize human intervention and increase reliability and ease in operation of entire treatment plant.

The PLC shall have necessary communication port for communication with necessary field instruments specified like LOH/ROF instruments, analyzers, etc. as applicable.

Instrument Panel / PLC Panel shall be free standing, floor mounting cabinets of Rittal / BCH / Enklotek / equi. make. LCP shall be, either free standing, floor or wall mounting type, cubicle type or with operator console as designed by the vendor. Bidder shall refer panel specifications provided in this tender.

Contractor / PLC Supplier shall provide a copy of all working programs/ application program / programming codes on Compact Disk or suitable permanent media including necessary licenses where applicable (for softwares specified for supply in this specifications), as well as a printed program listing. It is clearly to be noted that all the software/ programs/ programming codes shall be the property of Surat Mahanagar Seva Sadan (SMSS). All the application programs handed over to SMSS shall not be password protected or requisite password shall be furnished.

## **PROGRAMMABLE LOGIC CONTROLLERS (PLC) SYSTEM SPECIFICATIONS**

### **Codes and Standards**

PLC shall comply with International standards such as NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE

### **DESIGN AND CONSTRUCTION REQUIREMENTS**

PLC H/W & S/W shall be from the same family and should be sourced from approved Vendors only.

Programmable logic controller (PLC) shall be microprocessor based with 32 bit or other suitable processor and be fully programmable and capable of performing control relay logic, including timing, counting, sequencing, and interlocking to provide the required functionality.

The PLC shall be high performance processors suitable for real time process application. High inherent reliability, self checking, error-recovery and troubleshooting features shall be some of the features of PLC.

The PLC shall have a modular / modular chassis design which allows for ease of future expansion. The processor module shall be easily removed from the I/O chassis for service or repair. The I/O chassis shall have slots for installing I/O cards, communications, or other special function modules. All I/O cards and modules shall be capable of being installed in any open slot in the chassis or shall be DIN rail mounted. Module and channel level diagnostics should be standard feature.

The PLC shall have a suitable power supply and can be easily serviced or replaceable. The system shall be capable of being powered on 120VAC / 230VAC / 24V DC as per mfr. Std..

The PLC shall be rated to operate from 0 to 60 Degrees C, with a humidity rating of 5 to 95% (non-condensing). All module circuit boards shall be encased and protected such that, when properly installed, they are not exposed to accidental contact by personnel or other objects.

The PLC shall be of high quality and reliability with replacement processors, power supplies, chassis, I/O and specialty modules that are readily available on an urgent or emergency basis. All PLC products shall be fully supported and spares shall be available for purchase for up to ten (10) years from the date of the original system purchase.

After completion of the automation and actual plant operation starts working on PLC System the concerned staff likely to run plant is required to be fully trained by the executer for the operating features and preventive maintenance aspects and preliminary trouble shooting methods of the offered system. This training at site shall be of one duration which shall be attended by 4-6 persons of client to be deputed from various levels.

### **Basic Processor Functions**

Real-time control of output points for turning on and off digital devices such as motor starters and solenoids.

Read the status of real world digital inputs from limit switches, float switches, and other field devices.

Real-time control of analog process control variables.

Read the status of real world analog set points and feedback values.

Perform timing, counting, sequencing, and interlocking functions for pump/equipment control.

Process local alarm handling functions

### **Math and Advanced Functions**

Four function math in floating point or signed integer format

Convert to/from BCD

Data comparison and manipulation

Scaling from integer data into engineering units such as flow, level and pressure

Full PID Instructions for control of process control variables such as flow, level and pressure.

ASCII instruction set for interfacing to ASCII devices

Compute Instruction which executes a mathematical expression and can be used for totalizing functions

Trigonometric and Exponential math functions

Real-Time Calendar Clock for time stamping alarms and events.

Automatic restart of the system on resumption of power shall be provided.

The processor shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost. It shall also have the capability of EEPROM backup which automatically reloads the memory on a power cycle. The processor shall have the ability to automatically control the process on a power cycle, provided there are no major or unrecoverable processor faults.

Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up.

Further, the instrument diagnostic data shall be analyzed by PLC and necessary alarm / reports shall be generated for calibration / fault / maintenance need of the instrument, if such data transfer facility is provided for in the instrument.

### **Specific Requirements for PLC**

(a) Expandability in future : 20% of installed capacity



- (b) Weather Protection : IP-20 for PLC hardware and shall be IP 54 of IS 13947 when mounted in ICP/LCP
- (c) Power Supply : 230V AC / 24V DC
- (d) Interrogation Voltage : 24V DC
- (e) CPU, communication module and power supply module : Required, high performance 32 bit or Suitable CPU Module having modular configuration suitable for real time process application. CPU shall be of same family for all locations. Communication: Modbus, Ethernet, Profibus ports / modules shall be provided as required.
- (f) Scan time : 0.5 Milliseconds or better for 1K Word instructions or to suit requirement
- (g) Key Switch for Processor : Key / Pass word protection as per mfr. Std.
- (h) Mounting : Inside the main instrument / local Instrument control panel with viewing glass on the door
- (i) I/O Capacity of CPU : 20% expandability in future over present I/O requirement
- (j) Inputs and Outputs : Discrete Input Card: Solid-state input circuits rated for 10-30VDC operation, available in 8 or 16 or 32 point configurations and shall source current to the field device. Each input point shall have a status LED which indicates the ON or CLOSED condition for that field sensor or switch.

Discrete Output Cards: Solid-state output circuits rated for 24VDC operation, available in 8 or 16 or 32 point configurations and shall be able to operate a control relay. Each output point shall have a status LED which indicates the ON condition of the output. The control Relay-contact shall be rated for 5A @240VAC or 5A @125VDC. The control relay shall have a LED indication to show the status of the control relay.

Analog Input / Output Cards: Shall capable of reading in 0 to 20mA or 4 to 20mA signal. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum

- k) System Loading : Max. 60% under worst loading conditions
- (l) Power supply to sensor / : Required

- transmitters
- (m) Type of input : NO/NC – Contacts field selectable from programmer.
- (n) Outputs : Relay outputs for driving MCC starter coils, SOVs, driving motorized valves etc.
- (o) Spare I/O (Wired) : Min. 1 no. or total 10% of each type of I/O, whichever is higher, wired to terminal block with minimum 2 point I/Os of each type of digital signal and 1 point I/O of each type of applicable analog signal available as spare at each panel / location.
- (p) Accessories : One set of Licensed Software, for Application Programming (Ladder Programming S/W supporting LD/IL/ST AND SFC language as per IEC 61131) shall be supplied.
- (q) Interposing Relays : Shall be provided for all the Digital Output (DO) including spare DO & for Digital Input where ever required
- (r) Interface (Hardware and Software) for SCADA connectivity in future : Required (plug and play) ready to use type for future connectivity / upgradation for SCADA
- (t) HMI at Main Control Room (MCR) : Not required
- (u) Type of protocol on communication port for future SCADA connectivity : The offered PLC shall be provided with suitable open protocol communication port (Modbus, Ethernet, etc.) for connectivity with main control room PLC or SCADA station in future.
- (v) Tests : Functional test (simulated) for complete system, Test for monitoring function, Voltage variation test (at  $\pm 10\%$  of rated voltage).

Factory acceptance test (to be witnessed by Purchaser / purchaser's representative  
Simulation test for all logic / loops (to be witnessed by Purchaser / purchaser's representative  
Vendor to submit all Test Certificates for purchaser / consultant's review.

The I/O cards shall have optical isolation between digital and field side circuitry and some of the common features of the I/O modules shall be as follows:

- 1) Filters for noise rejection.
- 2) Surges withstand facility as per standards.
- 3) All the modules shall be of addressable type.

## **Communications**

- (a) Minimum one port or more as required for program upload / download, online editing, data acquisition and man machine interface.
- (b) One RS 232C/RS485 port for connecting devices over network for data acquisition from Energy analyzers/soft starters /temp. scanners etc.

### **Programming Software**

The programming software should help in maximizing performance, save on project development time and improve productivity.

The programming software should be able to operate on latest Windows-XP / Windows 98, or Windows-NT operating system.

The programming software shall have Online editing features which is used to modify the application program while the process is still operating.

Features like drop and drag editing to copy instructions or part of a program from within a project or across projects to save project development time.

Make system backup copies while the system is online.

Upload and down load programs to the PLC

### **Uninterruptible power Supply**

UPS of suitable capacity as per following specifications for 60 minutes back-up shall be supplied for entire load of instrument control panel including PLC (but excluding field instruments) and essential / critical instrument supply for necessary shut-down in case of power failure.

- (a) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non linear load.
- (b) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.
- (c) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.
- (d) The UPS shall incorporate a DC under voltage trip circuit to Electromechanically trip the

UPS output in order to protect the batteries.

- (e) The noise level of the unit shall not exceed 60 dB(A) at 1 m from the UPS cabinet.
- (f) The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non linear loads. It shall be suitable for load power factors 0.7 lag to 0.9 lead.
- (g) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than  $\pm 4\%$  with a recovery of less than 4ms. The load crest factor shall not be less than 3:1.
- (h) Indicators shall be provided for the following
  - i. UPS status
  - ii. PS alarm conditions
- (i) The UPS shall provide volt free contact outputs for the following purpose:
  - i. Warning, (viz., low battery voltage)
- (j) The UPS shall have an overloaded capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.
- (k) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.
- (l) Terminals shall be shrouded to prevent accidental contact

The Uninterruptible Power Supply (UPS) System with SMF Lead Acid battery shall conform to the minimum following specifications:

- i. Input
  - Input Voltage : 230 V,  $\pm 5\%$
  - Frequency : 50 Hz  $\pm 5\%$
  - Nominal DC input (Battery) : Bidder to design and submit calculations
- ii. Output
  - Output : 230 V AC, applicable KVA with 25% margin as per Load Calculation (Shall be min. 2KVA capacity)

|                   |   |              |
|-------------------|---|--------------|
| Regulation mode   | : | $\pm 1\%$    |
| Load power factor | : | 0.8 to unity |
| Duty              | : | Continuous   |
| Ripple on DC      | : | $< 2\%$      |

iii. General

|                        |   |   |
|------------------------|---|---|
| Principal of operation | : | Shall be solid state, pulse with Modulation (PWM) |
| Cable entry            | : | Bottom  |
| Cooling method         | : | Forced air  |
| Type of Battery        | : | Sealed Maintenance free                           |

**I) INSTALLATION MATERIALS:**

Vendor shall supply all erection hardware required for the installation of complete instrumentation forming part of this tender.

This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping / tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

**A) CABLES:**

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between Control Room and the Unit. Specifications for cables for analog signals, digital signals and instrument power cables shall be as follows:

**Cables for analog signals:**

Cables shall be of 660V/1100V grade, single or multi-pair cables, annealed, tinned, high conductivity 1.5 sq.mm stranded copper conductor, PVC insulated two cores twisted into pair, laid up collectively, individual pair shielded and overall shielded with aluminium mylar tape, ATC drain wire running continuously in contact with aluminium side of the tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for analog signals. Multi pair cables shall be of 6 pair or 12 pair.

**Cables for digital signals:**

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq.mm stranded, tinned copper conductor, PVC insulated, overall shielded with aluminium mylar tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC,

conforming to IS:1554 & IEC:189 Part II shall be used for digital signals.

**Cables for instrument power supply:** Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 2.5 sq.mm, stranded, tinned copper conductor, PVC insulated, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part I & II shall be used for instrument power supply.

**Laying of Cables:** Cables shall be laid on trays, in trenches, conduits, ducts as necessary. Instrument cables shall not be buried in ground as far as possible. Cable joints in instruments signal and power supply cables shall not be permitted. In case if some of the instrument cables are to be buried in the ground, it shall be as per standard/good engineering practice and shall be subject to client's/consultant's approval.

The contractor shall also supply necessary materials such as junction boxes, glands, lugs etc. required for termination of cables. Each cable shall be terminated to individual panel/terminals box. Cable glands shall be of Nickel plated Brass and of Double Compression Weather proof type.

A distance of minimum 300 mm shall be maintained between the cables carrying low voltage AC & DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HT & LT cables.

Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by contractor. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedule. Identification tags shall be securely fastened to the cables at both ends.

## **B) CABLE GLANDS:**

Cable glands shall be nickel-plated brass and shall be of double compression type suitable for armoured cables.

Flame proof gland wherever required shall be with Ex(d) certification.

## **C) INSTRUMENT VALVES (MINIATURE TYPE) AND MANIFOLDS:**

Body rating shall be as per piping class or better. Valve body and Trim material shall be SS316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

## **D) PIPE AND TUBE FITTINGS:**

Tube fitting shall be flareless compression type and of three piece construction of Swagelok / Parker Hannifin make.

Ferrule shall be os SS in general.

Socket Weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rsating shall be 3000 lbs. Weld neck fittings shall be used where socket weld is not allowed by piping class.

For air service instrument brass fittings suitable for use on copper tubes conforming to ASTM B 68 / B 68M shall be used. It shall be manufactured from Bar Stock or equi and shall be nickel plated.

#### **E) CABLE TRAYS:**

All brach cables/tubes, cables on various civil units/structures shall run on cable trays only

Cable trays shall be made out of galvanized mild steel sheets of 2.5 mm thickness. The width shall be so selected that 40-50% space is available for future use.

Suitable cable clamps shall be supplied for binding cables / tubes at every 500mm.

#### **F) JUNCTION BOX:**

Junction Box material shall be Cast Aluminium (LM-6) only and shall be weather proof to IP-65. Flame proof junction boxes shall be supplied with Ex(d) certification in addition.

The boxes shall have terminals suitable for a minimum of 4 mm<sup>2</sup> cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2nos., whichever is higher, spare entries of each size. Spare entries shall be provided with plugs.

#### **13. INSPECTION :**

Contractor shall submit test and calibration certificates for various instruments for review and approval prior to dispatch. Factory inspection for instruments is not required.

Contractor shall offer FAT for PLC system at the manufacturer's / system integrator's works. The system shall be inspected for the workmanship, correctness of wiring and operation with necessary simulation.

GENERAL MANAGER (TECH. & ADMN.)  
GUJARAT HIRA BOURSE  
SURAT

SIGNATURE AND SEAL OF TENDERER

NAME :

ADDRESS :-

DATE :-

## **CHAPTER - XI**

### **OPERATION AND MAINTENANCE**

#### Details regarding the Operation & Maintenance of Raw Water Treatment Plant

The contractor will be responsible for smooth, efficient and satisfactory operation and maintenance of proposed 10 MLD capacity water treatment plant on round the clock basis for a period of 60 calendar months from the effective date of the contract (excluding three months of performance trial period)

**Bidder shall give a detailed package for O&M services with nos. & categories of highly skilled/semiskilled manpower for O&M of the plant.**

**Bidder shall give itemwise/stagewise periodic maintenance charts in the reference.**



Below are guidelines and requirements of Operation & Maintenance Aspects.

**A. Operation Activities:**

1. To operate and maintain the raw water treatment plant, instrument(s) and equipment(s) in accordance with the aim and purpose of treatment of raw water so that, the turbidity of filtered water does not exceed, in any case, the desired limits prescribed in guarantee data. The plant and equipment(s) covered under the above contract will be totally attended to, by the contractor including any "Trouble shooting" to ensure smooth, efficient and trouble free operation.
2. In given condition of raw water quality, it is desired that filter water from plant should be clear, sparkling, devoid all suspended matter and other foreign material, without any algae and color, having un-objectionable odor and acceptable appearance meant for potable / drinking water purposes and in accordance to Guarantee Data
3. The contractor will monitor the performance of the raw water treatment plant; conduct the analysis of the raw water inlet and water quality after treatment. Contractor shall initiate and take adequate action(s) to ensure smooth, efficient and satisfactory performance/ running of the plant on 24 hours round the clock basis.
4. **Measurement of Water Quality Parameters:** All necessary tests required shall be carried out by the shift chemist (contractor) under the guidance and supervision of M/s.Gujarat Hira Bourse chemist / plant-in-charge. Number of tests to be carried out is decided by the department, according to quality requirements at raw water, in-process water and treated water quality. Necessary laboratory chemicals / reagents for testing of quality parameters only shall be provided by M/s.Gujarat Hira Bourse free of cost. Laboratory equipments of M/s.Gujarat Hira Bourse shall be allowed to be used / operate to contractor shall maintained by contractor throughout the contract period. However, necessary calibration of all the lab equipments will be carried out by M/s.Gujarat Hira Bourse.
5. **Dosing of Various Chemicals as process input:** In accordance to the quality parameters observed for the raw water, various dosing of chemicals shall be decided by the shift chemist (contractor). The contractor (Operating staffs under the guidance of Plant – In-charge) shall determine operating parameters, select settings (chemical dosages etc.) and generally optimize the process, and working of the treatment plant. “Unless raw water quality demands so, excessive chemical dosing i.e. doze more than normal / optimum should be avoided, otherwise it will be highly criticized and penalty as deemed fit may also be imposed by the competent authority of M/s.Gujarat Hira Bourse. All chemicals like PAC, Chlorine, poly(if required) will be supplied by M/s.Gujarat Hira Bourse free of cost to contractor at the doorstep of storage of plant. However, necessary appropriate stacking and unloading will be carried out by contractor. Please note that procurement of above process inputs shall not be allowed to the contractor. Various process inputs including chlorine dose are to be formulated based on required tests and subject to raw water characteristics.

6. Operation of Allied Equipments: Operation of allied equipments like start / stop of backwash pump, air compressors, air blowers, dirty water sump pump, chlorinator and operation of all such related equipments / accessories etc. shall be included in the scope of contractor.
7. Chlorine toner/ cylinder will be provided at the doorstep of the go down by Developer. The contractor will carry out disconnecting and removal of empty toner and reconnection of filled toner. Contractor shall operate these plants during contractual period. Loading un-loading, connection, removal of chlorine toner for this plant shall be contractor's responsibility.
8. Chlorination system shall be operated by contractor such that appropriate or required level of Free Residual Chlorine is maintained at each stage of water treatment process. Level of FRC to be maintained shall be decided by M/s.Gujarat Hira Bourse. Also, while operating the chlorination system, any abnormality observed / noticed (which leads to any hazards or accidents due to chlorine leakage etc.) shall be intimated to Engineer – in – charge immediately.
9. Filter beds and associated equipments are the key components of WTP, so, performance of individual units for critical parameters like Turbidity and FRC must be monitored and recorded in each shift in performance monitoring book. Performance monitoring book shall be provided by M/s.Gujarat Hira Bourse in printed form. On monthly basis, unit wise performance analysis needs to be submitted to the Engineer –in – charge. Any irregularity observed in this activity shall be highly criticized.
10. Above gadgets being the heart of treatment process, it needs to be monitored physically on round the clock basis. Above equipments to be maintained free from floating materials, algae etc.
11. Sand layer of filter bed must be kept free from any foreign materials, sticky materials, mud balls etc. Sand level in each filter bed must be maintained up to the desired level. Required sand to maintain sand level shall be provided by M/s.Gujarat Hira Bourse.
12. All minor and major spares and consumables other than chemicals, PAC & Chlorine shall be provided by Contractor during Operation & Maintenance period.

**B. Maintenance Activities:**

Contractor is expected to operate and maintain the raw water treatment plant, instruments and equipments in accordance to the aim and purpose of treatment of raw water so that the quality of treated water is maintained strictly in accordance with Guarantee Data. The plant covered under the above contract will be totally attended to, by contractor including any "Trouble Shooting" to ensure smooth, efficient and trouble free operation.

1. The contractor shall prepare and implement an effective plant maintenance programme in consultation with Developer. M/s.Gujarat Hira Bourse will not provide any skilled or unskilled work force. It is an absolutely contractor's responsibility to look after all sorts of maintenance whether preventive, predictive or breakdown. For the sake of convenience, Developer has prepared and got

- sanctioned the annual maintenance and disinfection program, which needs to be adhered without fail.
2. Predictive maintenance on every front and area of plant will always be appreciated and expected from contractor.  
The activities include followings:
    - ❖ Maintenance of the all equipments, electrical / mechanical / electronic / instrumentation / equipments / pipelines etc. (All pipes within Water Treatment Plant)
    - ❖ Cleanliness of plant and surroundings.  
Above activities includes:
  1. **OVERALL MAINTENANCE OF ALL EQUIPMENTS:** Overall maintenance of all equipments electrical / mechanical / electronic / instrumentation / equipments / pipelines. All spares / parts / consumables like oil and grease etc required shall be arranged by Contractor. Tools and tackles necessary for the efficient maintenance shall be arranged by contractor. The good workman ship should also be ensured supported by fundamental technical knowledge. Therefore, qualification as mentioned must be met with for various categories of staff.
  2. **DAY TO DAY OVERHAULING AND CLEANING, TROUBLE SHOOTING:** The maintenance activities also include day to day overhauling and cleaning, trouble shooting of all above-mentioned equipments.
  3. **BREAKDOWN:** Whereas good overhauling and maintenance of equipment shall ensure long trouble free operation, therefore, breakdown shall be viewed seriously. Where spare (extra or standby) equipments have been installed, breakdown more than 7 days shall attract strict actions. All other equipments are expected to run continuously trouble free. Any serious effect on the day to day activities of plant hampering quality and/or quantity of treated/filter water due to lack of poor operation and maintenance shall be viewed seriously and actions as deemed fit shall be initiated by competent authority of M/s.Gujarat Hira Bourse and shall be binding on part of contractor.
  4. **MAINTENANCE PROGRAM:** The contractor shall prepare and implement an effective plant maintenance program (Preventive, predictive etc.) in consultation with Head of Department – Engineering & Maintenance – (Mechanical / Electrical), M/s.Gujarat Hira Bourse. It is an absolutely contractor's responsibility to look after all sorts of maintenance whether preventive or breakdown. Maintenance schedule will be mutually prepared in consultation with Gujarat Hira Bourse after finalization of the order.
  5. **REPLACEMENT OF AN ITEM:** If due to poor Operation & Maintenance or so, any item is causing frequent troubles and demanding frequent repairs, same item will be needed to be replaced instead of repairing by contractor at his own cost.

Maintenance of Buildings & site

The contractor shall be responsible for:

- a) The maintenance of electrical, ventilation, plumbing & drainage installation.
- b) General building maintenance & housekeeping.
- c) Full maintenance of the site services, cabling, and earthing system.
- d) The building services and housekeeping maintenance shall be undertaken on all building and services installation.
- e) In order that plant is maintained neat and clean inside and outside, the contractor shall ensure that all unwanted or redundant items are removing from the building and site. Depending on their condition such items shall either be placed into storage or disposed off site as per instruction of Engineer-in-charge.

6. **CLEANING /HOUSE KEEPING OF COMPLETE PLANT:** The contractor shall ensure proper cleanliness of the all equipments electrical /mechanical /electronic /instrumentation /equipments in plant, in general. He shall also be responsible to ensure proper house keeping of the plant. The scope of work also includes cleaning /house keeping of complete plant area including floor, railing, doors, windows, light fittings and ceiling, walls, slabs etc. in a professional way. Continuous wipe off with water shall be carried out for at least once a day, particularly in area vicinity to the settle water, filter bad and filter water sump. (That shall ensure quality). Such “Once a day wipe out area” shall be strictly followed. Further, other general house keeping should be carried out, at least once a day compulsorily or as per direction of Head of Department of Administration & Housekeeping of GUJARAT HIRA BOURSE. All material/accessories like brushes/acid /phenyl, naphthalene balls etc. shall be brought by the contractor. In nutshell contractor shall ensure house keeping of plant to be of high standard.

7. **SAFETY:** The contractor shall be responsible for safety on site during the O & M of the works by the contractor.
- The contractor’s duties with respect to safety shall include the following:
- a) Utilize safety awareness procedures in every element of operation.
  - b) Gives emphasis to site including:
    - i) Safe working and safety procedures as per rule and regulation of government regarding use of safety-wares etc. ii) Cleanliness of the chlorination plant as a whole.
    - iii) Awareness of hazardous condition and accident reporting and necessary compliance.

**(C) DATA / RECORD KEEPING & GENERAL ADMINISTRATION:**

- 1) **PLANT MAINTENANCE REPORT:** Contractor shall furnish monthly PLANT MAINTENANCE REPORT about proper functioning of all electrical /mechanical /electronic /instrumentation /equipments of plants to concern Officer in charge. He shall clearly spell out all ‘running’ and ‘out of order’ equipments with detail reasoning thereof and expected time period of sorting out of the problem.
- 2) The contractor will be responsible for keeping up-to-date record of document(s)

including History Card for equipment(s) and maintaining day-to-day logbook relating to various analyses performed.

- 3) The contractor shall maintain and update logbook(s) / register(s), in which details of operational parameter(s) are recorded in each shift and at regular interval say hourly or as decided mutually. The developer shall provide all necessary logbook(s) / register(s).
- 4) The Contractor will prepare and submit a daily report of plant performance and will assist the M/s.Gujarat Hira Bourse in preparing the necessary document(s) for their purpose and record(s).
- 5) The contractor shall have to issue uniform with logo/ name of the contractor as decided by the department and identity card with photographs to all the staff employed for operation and maintenance otherwise, they will not be allowed to enter in the premises of Water Works.
- 6) INSURANCE: Contractor shall take insurance against injury/death to his workmen or related persons.

7) **MEN POWER/STAFF PATTERN:**

The contractor shall provided experienced managerial, technical, supervisory, administrative & non- technical personnel & labour necessary to operative & maintain the plant property, safely and efficiently on a continues 24 hours basis for full term of the O & M contract period.

1. The qualification and capability of the contractor's personnel shall be appropriate for the task they are assigned to perform. The staff provided shall be fully trained in the operation of water works before being giving responsibility for operating any part of the plant. If in the opinion of the engineer, any member of the contractor's staff is considered to be insufficiently skilled or otherwise inappropriate for the task he is required to perform, the contractor shall replace him with a person with the appropriate skills and experiences for the task, to the approval of the engineer.
2. The CV/Resumes of the contractors personal shall be submitted to the engineer for acceptance at least 7 days before the anticipated commencement of the O & M period. Any change of personnel shall be promptly informed to the engineer within a day's time. Normal time duty hours for the contractors' operation & maintenance personnel may be modified as necessary and the contractor and agreed by the engineer who will ensure that an adequate number of the contractor's staff, fluent in Gujarati as well as Hindi is on duty at plant 24 hours per day, 7 days per week, including all holidays.

(1) Following staff is required to be employed by the contractor: -

**Tenderer to quote:-**

| <b>Post</b>     | <b>Nos.</b> | <b>Min. Qualification</b>        | <b>Experience</b>  |
|-----------------|-------------|----------------------------------|--|
| Plant-In-Charge | 01          | M.Sc.[Chemistry/<br>Environment] | Min. 2 Year(s)   |
| Electrician     | 01          | I.T.I. in Electrician<br>Trade   | Min.2 Year(s)  |
| Fitter          | 01          | I.T.I. in Fitter<br>Trade        | Min 2 Year(s)  |
| Plant operator  | 03          | 10th Pass                        | Operating experience   |
| Helper          | 03          | VIII pass                        | A person with sound<br>health, skill and hard<br>working attitude. |

- As per agreement the No. of staff in each shift should always remain, present otherwise penalty towards absence of any staff shall be levied and recovered from the Contractor.
  - The contractor shall make the arrangement of reliever for weekly off/Holiday etc.. Absence on any ground like weekly off or Holiday shall not be considered.
  - The presence of staff in each shift should be marked in muster (to be brought by the contractor) to be maintained at office of shift in charge at Water Works, which shall be considered as final. The contractor's staff must mark their presence in this muster only. The contractor may maintain a separate register for his own purpose.
  - Please note that computer system is to be operated and maintained by the contractor's staff and therefore it is in the interest of the contractor to employ plant in charge/ shift chemist who is proficient in the computer operating system.
  - The above staff for one day i.e. 24 hours & 365 days is required for normal operation & maintenance. The contractor has to call respective Maintenance Engineer for rectification of fault at any time of the day, during contract period.
  - Relaxation in qualification and number of staff shall not be allowed under normal circumstance. The above staff shall be distributed in three shifts as per normal agreement between contractor & M/s.Gujarat Hira Bourse. Contractors shall make the arrangement of reliever for off/ holidays etc.
- (2) The staff of contractor will always remain in contact with the Engineer in-charge/ Electrical Supervisor In charge/ Chemist of the shift at Water Works of M/s.Gujarat Hira Bourse and follow their instructions.
- (3) Unsatisfactory and inefficient running of the plant, supported by the reason(s) that are under control of contractor will be highly objected. In such case(s) Competent Authority decision will be final and binding to the Contractor.

- (4) Contractor will comply with all statutory rule(s) and regulation(s) and all inter-disciplinary measure(s) as followed by M/s.Gujarat Hira Bourse.
- (5) M/s.Gujarat Hira Bourse will not be responsible for any accident/ injury to the staff of the contractor. Further, M/s.Gujarat Hira Bourse will not provide any insurance or medical facility to the staff of contractor.

#### CONTRACTORS SCOPE OF SERVICES ALSO INCLUDES:

The contractor would be responsible for smooth, efficient & satisfactory operation & maintenance and repairing, replacement of parts, any work related to Water Works on round the clock basis.

- The scope of the contractor includes operation, maintenance & replacement of spare for pump sets & respective delivery piping/ piping network for lubricating / cooling of each vertical turbine pump sets etc.
- The scope of work also includes providing necessary tools & tackles for day-to-day O & M maintenance, preventive maintenance and break down maintenance.
- Also minor and major repairs to the equipment involved in the plant have to be carried out by the contractor during the O & M period.
- The scope of the contractor includes operation, maintenance & replacement of gear mechanism for valve. Also operation, maintenance of chain pulley block of HOT crane at booster house & chlorination building.
- The scope of work includes attending of all type of cable faults including end terminations of cable, changing of lugs or changing LT cable, etc. Items to be procured for repairing/ replacement will be in the scope of Contractor
- The scope of work includes O & M of capacitor bank within WTP, penal etc, etc. All these capacitor banks must be kept in working condition to keep supply co. power factor more then 0.98 by the contractor. Any spares required to keep these capacitor bank in working condition is in the scope of Contractor.

#### DOCUMENTS RECORDS / LOG BOOK:

The contractor will be responsible for keeping up to date records of documents including History Card for equipment and maintaining every day log book relating to various operational parameters like pumping hours, chlorine dose and other reading required are recorded in every shift at regular interval e.g. hourly or as agreed mutually by M/s.Gujarat Hira Bourse.

- Logbooks, registers and all necessary stationery required for maintaining records for O & M shall be given by M/s.Gujarat Hira Bourse.

GENERAL MANAGER (TECH. & ADMN.)  
GUJARAT HIRA BOURSE  
SURAT

SIGNATURE AND SEAL OF TENDERER

NAME :

ADDRESS :-

DATE :-

**SCHEDULE LIST TO BE SUBMITTED WITH THE TENDER**



### **SCHEDULE-1**

Equipment Specifications

Bidder to quote in detailed with flow chart and operational chart.

| <b>Sr. No.</b> | <b>Unit (s)</b> | <b>Details</b> |
|----------------|-----------------|----------------|
|----------------|-----------------|----------------|

### **SCHEDULE-2**

Pipe Line Schedule

The bidder to fill in the following pipeline schedule.

| <b>Sr. No.</b> | <b>From</b> | <b>To</b> | <b>Flow Cumps</b> | <b>Size (mm)</b> | <b>MOC</b> |
|----------------|-------------|-----------|-------------------|------------------|------------|
|----------------|-------------|-----------|-------------------|------------------|------------|

### **SCHEDULE-3**

Valve Schedule

| <b>Sr. No.</b> | <b>Location</b> | <b>Type</b> | <b>Size</b> | <b>MOC</b> |
|----------------|-----------------|-------------|-------------|------------|
|----------------|-----------------|-------------|-------------|------------|

### **SCHEDULE-4**

Electrical Load Calculations

The following schedule to be filled in by the Bidder for all drives.

| <b>Sr. No.</b> | <b>Equipment</b> | <b>KW Installed</b> | <b>No. of Drives<br/>W S T</b> | <b>BKW</b> | <b>Hrs/day</b> | <b>KWH per day</b> |
|----------------|------------------|---------------------|--------------------------------|------------|----------------|--------------------|
| <b>Total</b>   |                  |                     |                                |            |                |                    |

### **SCHEDULE-5**

Chemical Schedule

| <b>Sr. No.</b> | <b>Chemical</b> | <b>Flow</b> | <b>Unit</b> | <b>Dosage</b> | <b>Unit</b> | <b>Quantity kg/day</b> |
|----------------|-----------------|-------------|-------------|---------------|-------------|------------------------|
|----------------|-----------------|-------------|-------------|---------------|-------------|------------------------|

### **SCHEDULE-6**

PLC SCADA

| <b>Sr. No.</b> | <b>Equipment</b> | <b>Rating</b> | <b>Details</b> |
|----------------|------------------|---------------|----------------|
|----------------|------------------|---------------|----------------|

**APPROVED LIST OF VENDORS**

## MECHANICAL EQUIPMENTS

**All equipments shall be IS approved and bear IS Specification.**

| <b>Item Description</b>      | <b>Approved Vendors</b>   |
|------------------------------|---|
| Pumps                        | WPIL, Kirloskar, Beacon, KSB, Mather & Platt, KMB, MBH, Jhonson |
| Gate Valve                   | Jash, I.V.Company, VASS, BDK, Kirloskar Bros.                   |
| Sluice Valves                | Kirloskar, I.V.C., IVI,VAG                                      |
| Butterfly Valves             | Audco, L&T, Kirloskar, Fouress, Inter Valve, IVC,VAG            |
| Knief Gate Valves            | Jash / Vass (Dezurick) / Wag                                    |
| Sampling Pumps               | Tullu, Kirloskar, Crompton MBH                                  |
| Air Blowers                  | Kay International, Swam Pneumatic, Everest                      |
| Agitators / Stirrer / Mixer  | Remi, Mixrite, Schurtek, Fiber & Fiber                          |
| Air Compressor               | Ingersol Rand, Kirloskar  |
| PVC tube module              | MM Aqua/Cooldeck  |
| <b>CHLORINATORS</b>          |   |
| Chlorinator                  | Pennwalt, Mettito, Chlorotech                                   |
| Chlorine Pressure Gauge      | WIKA, GLUCK   |
| Chlorine Booster Pump        | Grundfoss, Sumo (Japan), KSB, KBL                               |
| NRV/Diaphragm Valve          | DPP, Parch  |
| <b>PIPES</b>                 |   |
| G.I. / M.S. Pipes            | Any make bearing ISI mark                                       |
| Cast Iron Pipes and Fittings | Keshrom, Kejriwal, IISCO, Electrosteel                          |
| HDPE Pipes                   | JISL, Supreme, Raliance   |
| Gear Box                     | Radicon, Elecon   |
| Hosting Equipment            | Morris, Indef, WH Brady, Hercules.                              |
| <b>OTHERS</b>                |   |
| Weighing Scale               | Avery, ACME, AVON, J.K. Scale                                   |
| Cement                       | Ambuja, Ultra Tech  |
| CRS Steel                    | Sail-HCR, Tiscon-CRS, Rashtriya Ispat (Vizag), Electrotherm     |
| Paint                        | Asian, ICI  |
| Glazed Tiles / Ceramic Tiles | Johnson, Somani, Bell Ceramics.                                 |

## ELECTRICAL / INSTRUMENT EQUIPMENTS

**All equipments shall be IS approved and bear IS Specification.**

| Item Description                        | Approved Vendors   |
|---|--|
| Motors                                  | Siemens, Crompton Greaves, Kirloskar, Bharat Bijlee                    |
| Cables                                  | CCI, Universal, RPG, KEI, Torrent, Finolex, Havells, Polycab, Ultracab |
| <b>MCC Components:</b>                  |  |
| Switch gear                             | Siemens, L&T., Schneider, GEC-Alstom, HH Elcon, ABB, Control Swichgear |
| ACB                                     | Siemens, L&T., Schneider, GEC-Alstom, ABB,                             |
| H.R.C. Fuses                            | Siemens, L&T, B.L., E.E., GEC-Alstom, Schneider                        |
| Contactor                               | Siemens, L&T, Schneider, ABB, BCH, Telemecanique.                      |
| Timer                                   | Siemens, L&T, BCH  |
| Relays                                  | Siemens, L&T, BCH, ABB, Schneider, GEC Alstom, Ray rolle, Easun        |
| Meters Static                           | A.E., I.M.P., Meco, L&T, Rishline                                      |
| Selector Switch                         | Jyoti, Kaycee, Salzer, Siemens   |
| C. T. (Cast Resin)                      | Kappa, Jyoti, ABB, Silkana, Gilbert, Ashmor, Precise.                  |
| Push button Station                     | Pushtron (Shrenik) with Components of Siemens, L&T, BCH, Technik,      |
| Indicating Lamp                         | AEP, IMP, Vaishno, L&T, GEC, Siemens, RAAS Control, Binay, Teknik      |
| Cable Jointing Kit                      | Raychem, Mseal, Denson   |
| MCB                                     | MDS, EE, Neptune, Versatrip, Sicke, Siemens, L&T, Indokopp, MG         |
| KWH Meter Static                        | Simco, Jaipur Meter, GEC, BEC, IMP                                     |
| <b>LIGHTING Materials</b>               |  |
| Wire and Accessories (I.S.I. Marked)    | Finolex, Universal, Incab, Anchor, Havell's, RR cabel, Ravin, KEI.     |
| Switch & Plugs                          | Philips, Anchor, Jainex or ISI mark to be got approved prior to supply |
| Fittings: (Indoor & outdoor luminaires) | Philips, Crompton, Bajaj.  |
| Ballast                                 | Philips, GE, Crompton Greaves, Bajaj, Asian Electonics, Opal           |
| Fluorescent Lamp                        | Osram, Philips, GE.  |
| Lamps CFL                               | Philips, GE, Osram   |
| Control Panel                           | CPRI Approved (To be got approved prior to supply)                     |
| Electric Actuator                       | Auma, Marsh, Rotork  |

## INSTRUMENTATION

| Item Description  | Approved Vendors  |
|---|---|
| Ultrasonic Type Level / Diff. Level / LOH & ROF / Open Channel Flow Transmitter | ABB, E+H, Krohne, Siemens   |
| Electro Magnetic Flow Meter (Insertion type)                                    | ABB, E+H, Yokogawa  |
| Ultrasonic Portable flow meters (For Pipe Line)                                 | Siemens, E + H, Yokogawa  |
| Differential Pressure / Pressure / Temperature Transmitter                      | ABB, Emerson, Honeywell, Siemens, Yokogawa  |
| Pressure Switch   | Dag Process Instruments, Danfos, Indfos, Orion, Switzer   |
| Float Level Switch  | Nivelco, P+F, Punetechtrol  |
| Electric Actuators  | Auma, Marsh, Rotork   |
| Solenoid Operated Valve   | Asco, Janatics, Rotex, Schrader   |
| Air Filter Regulator  | ABB, Divya, Janatics, Placka, Shavo Norgren   |
| Limit Switches  | Tata Honeywell, Siemens, BCH  |
| Programmable Logic Controller (PLC) System                                      | ABB, Honeywell, Rockwell (Allen Bradeley), Schneider, Siemens   |
| LT / Instrument Power & Control Cables / Signal (Analog) Cables                 | CCI, Finolex, Fort Gloster, Havells, Torrent, Universal, Associated Cables, Associated Flexibles & Wires, Brooks Cables, Delton, Havells, Uday Pyro |
| Alarm Annunciator   | Aplab Ltd., Minilec, IIC, equi. reputed   |

|   |   |
|---|---|
| Instrument Valves and Manifolds,<br>Tube Fittings, Pneum. Brass Fittings        | Excel Hydropneumatic, Industrial Enterprise,<br>Festo, Multimetal Industries, Placka, SMC,<br>Technomatic, Janatics |
| Indication Pilot Lamps (LED Type)   | Teknic, Schneider, Siemens, equi. reputed   |
| Push Button/ Selector Switch (with<br>NO/NC Element)                            | Teknic, Schneider, Siemens, equi. reputed   |
| Receiver Indicators (Panel Mounted)   | ABB, Masibus, Nivam, Nishko, Electronet   |
| Reocorder   | ABB, Honeywell, Yokogawa  |
| Jar Test, Autoclave, Laboratory oven,<br>Bacteriological Incubator, Water Still | Hach, Orbit, Lab Hosp, ASI  |

**Note:** 1. Incase of any material not mentioned in above list and required for the execution of work, prior approval is required before using this material for the job.

2. Incase of more than one make out of above vender list is suggested by the bidder the selection of brand will be rest with the GUJARAT HIRA BOURSE.

GENERAL MANAGER (TECH. & ADMN.)  
GUJARAT HIRA BOURSE  
SURAT

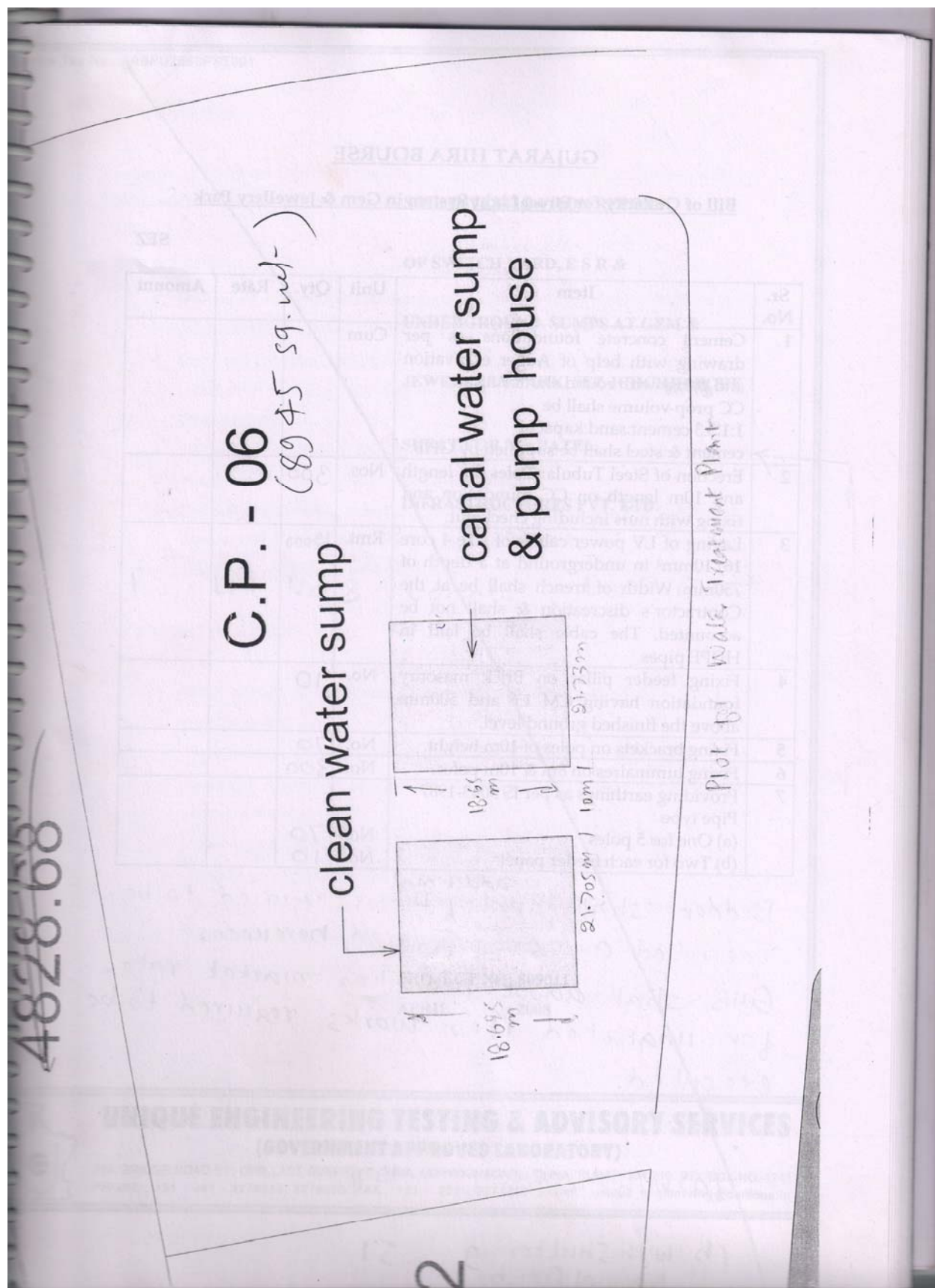
SIGNATURE AND SEAL OF TENDERER

NAME :

ADDRESS :-

DATE :-









Service Tax No.: AABFU2563PST001

## INTRODUCTION:

Authority of M/s Patel Infrastructures Pvt. Ltd. has authorized the work of soil investigation for their project of Gem & Jewellery Park at

## SOIL INVESTIGATION REPORT

## FIELD TESTS:

OF SWITCH YARD, E S R &

UNDERGROUND SUMPS AT GEM &

JEWELLERY PARK, SEZ-ICHCHHAPORE

SURAT FOR M/s PATEL

INFRASTRUCTURES PVT. LTD.

## LABORATORY TESTS:

- Moisture content & unconfined compression test on selected samples of standard penetration test.
- Field Density, Moisture content and Dry Density of undisturbed samples.
- Cone Penetration Test (CPT) on selected samples of standard penetration test.
- Swell Test for selected samples.
- Specific Gravity Test for Undisturbed samples.
- Shrinkage Limit / Free Swell Test / Differential Swell test for selected samples.
- Test for other properties of selected samples.

PROJECT NO: 809011

APRIL : 2008



## UNIQUE ENGINEERING TESTING & ADVISORY SERVICES (GOVERNMENT APPROVED LABORATORY)

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#### INTRODUCTION:

Authority of M/s Patel Infrastructures Pvt. Ltd. entrusted the work of soil investigation for their project of Gem & jewellery Park at Ichchhapore – Surat.

#### FIELD TESTS:

- Drilling 03 nos. of 150 mm dia. bore hole with casing whenever required up to maximum depth of 10.0 M from ground level.
- Carry out Standard penetration Test (SPT) at every 2.0 M interval alternate to undisturbed sampling or continuous SPT at 1.0 M depending on cohesive & non-cohesive formation.
- Collecting disturbed soil sample at every meter interval or as per the stratification of soil and recording depth at which soil changes.
- Collecting undisturbed samples (UDS) at 2.0 M interval alternate to S P Test or continuous UD Sample at 1.0 M interval if subsoil is cohesive.
- Observation of ground water table using drilled holes.

#### LABORATORY TEST:

- Water content & unconfined compression test on selected samples of standard penetration test.
- Field Density, Moisture content and Dry Density of undisturbed samples.
- Grain size Analysis of SPT samples, UD samples and disturbed samples covering each soil strata.
- Atterburg's Limit for samples as per above.
- Specific gravity Test for Undisturbed samples.
- Shrinkage Limit / Free Swell Test / Differential Swell test for selected samples judged to be expansive soil.
- Test for shear properties of selected samples.
  - a) Unconfined compressive Strength on saturated cohesive soils.



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- b) Triaxial Shear Test under UU / CU condition with or without Pore pressure measurement as per in situ conditions. Normally Soft cohesive saturated samples will be consolidated at average Overburden pressure.

#### DRILLING:

Drilling of 150 mm  $\phi$  borehole is carried out by shell and Auger method above water table. Water is added while drilling but stopped at enough height above the U D sampling or S P Test levels to avoid disturbance.

Drilling below water table is made by percussion method. Casing is required to be lowered if the boreholes do not retain its shape. Care is taken that ground water level is maintained during the drilling and particularly before testing or sampling levels. In no case casing is allowed to advance below the bottom of borehole. Chiseling is carried out if required while drilling.

Drilling of 150 mm  $\phi$  borehole is carried out by rotary drilling machine. Bentonite slurry is used as fluid. Care is taken before conducting S P Test or Collecting U D Samples that the bore is cleaned properly.

The location of exploration is as per the sketch.

#### STANDARD PENETRATION TEST:

The Standard Penetration Tests are carried out as per I. S. 2131: 1981. In general the tests are conducted at 2.0 M interval alternate to the undisturbed sampling or as dictated by soil strata existing.

Before testing, the borehole is cleaned properly and Split Spoon Sampler is centrally seated in borehole. In case of SPT to be conducted below water table care is taken that casing position is above the borehole depth. The water level in borehole is maintained above or at least at the water table.

A standard hammer of 63.5 Kg. is dropped from a height of 75 cms. and the no. of blows for penetration of Split Spoon Sampler for 0-15, 15-30 and 30-45 cms. are noted in Table - 3. Standard Penetration Test value  $N_6$  is considered for 15-45 cms. penetration values. Sample for moisture content is collected in moisture cans. For non-plastic silts and



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fine Sands  $N_6$  value is corrected for effective overburden pressure and dilatancy Correction is added for tests conducted below water table Results are shown in Table – 3.

#### **DISTURBED AND UNDISTURBED SAMPLES:**

Disturbed samples from shell or from Split Spoon Sampler is collected in polythene bags with proper levels such that we shall get the data of 0.5 Mt. interval or change in strata.

Undisturbed samples in 38 mm  $\phi$  Shelby tubes are Collected alternate to Standard Penetration Test at 2.0 Mt. interval. The sampling tube is connected to the rod by jarring link in case of 38 mm  $\phi$  Shelby tube or otherwise in case of 75 or 100 mm  $\phi$  tube, 'A' drill rods are connected by suitable adopter with ball check valve. Two or three undisturbed Samples are collected at same depth in case of 38 mm  $\phi$  tube to get sufficient sample for physical property tests. Before lowering the sampler, the bore is cleaned properly and sampling tube is lightly oiled from inner and outer side.

Sampling tube is pushed into the borehole by pressure hammering as per the soil stiffness. The sampling tube is immediately waxed after covering with aluminum foil.

In case of medium to coarse, non-cohesive, sand samples, where sampling is unsuccessful, Standard Penetration Test is carried out on cleaning the borehole.

#### **LABORATORY TEST:**

Disturbed, undisturbed and S P Test samples from the filed are brought to the laboratory with care and are grouped according to observations in the fields. On completion of shear, compressibility, permeability etc. tests on U D samples, these samples are placed in oven along with the S P Test samples and disturbed samples. Samples are selected such that each soil strata is adequately represented by the physical properties. The representative samples are dried in oven for 24 hours at  $110 \pm 5^\circ\text{C}$ .



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#### PHYSICAL PROPERTIES:

The moisture cans collected from S P T samples from the field are weighed and placed in oven for drying to determine natural moisture content (NMC). Results are tabulated in Table – 3.

U D samples are extracted using screw type extractor and samples are prepared as per the required sizes of the test to be performed. Before extracting from tube, weight and volume of sample are noted. Average bulk density is calculated in laboratory and samples are placed in oven to get the field moisture content for computing the dry density. Results are tabulated in Table – 4.

Specific gravity with specific gravity bottle / pycknometer is calculated as per I. S. 2720 (part – 3, section 1&2): 1980. Results are tabulated in Table –4. From the results of dry density and specific gravity the saturation of sample in % is calculated which is a useful data for deciding the condition of triaxial shear test

Grain size analysis is made by I. S. sieves and sieving is done on timer switch electrically operated sieve shaker I.S sieves commonly used are 4.75 mm, 2.00 mm, 1.00 mm 425 microns, 250 microns and 75 microns. For the coarse grain soil a graph of partial size v/s cumulative % finer is plotted. For fine grain soil wet analysis is made on plummet balance, modern version of hydrometer. Mechanical digital single pan balance of 1 kg capacity with 0.1 gram least count is used. Results are tabulated in Table – 5.

Liquid limits and Plastic limits tests are carried out with distilled water as per I. S. 2720 (part – 5): 1985. The samples are tested at a minimum of 24 hours after the addition of water. For liquid limit test cone penetration method is adopted but occasionally value is checked on Casagrande standard.

For the foundation soil sample shows sample shows high plasticity are checked for swelling and shrinkage. Firstly for rough estimate, free test as per I. S. 2720 (part – 40): 1977 is being carried out and getting positive indication of swelling. Shrinkage limit test is carried out as per I. S. 2720 (part – 6): 1972.



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### SHEAR PROPERTIES:

Shear tests are carried out by three methods.

- 1) Unconfined compressive strength as per I. S. 2720 (part – 10): 1973 for the saturated plastic soil undisturbed samples and cores of SPT samples.
- 2) Triaxial shear test is carried out on sample size of 38 mm  $\phi$  and 76 mm in height on motorized 30-speed load frame with digital display arrangements for load and pore-pressure. The confining pressure  $\sigma_3$  is applied to the cell by oil-water constant pressure system. The tests are carried out for the condition.
  - a) Unconsolidated undrained (UU) test without pore-pressure measurement as per I.S. 2720 (part – 11): 1971.
  - b) Consolidated undrained (CU) test with or without pore-pressure measurement as per I.S. 2720 (part – 11): 1981.

The condition decided on type of sample and water table condition or designers specifications.
- 3) Direct box shear test is carried out on non-plastic medium to coarse sand soil as per I.S. 2720 (part – 13): 1986.

The graph for triaxial shear test is plotted by modified method where X-axis represents  $\frac{1}{2}(\sigma_1 + \sigma_3)$  and Y-axis represents  $\frac{1}{2}(\sigma_1 - \sigma_3)$ .



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# DISCUSSION:

## **Bore Hole 1 & D.C.P.T (C-1 & C-2): (SWITCH YARD)**

The location of proposed switch yard for G.H.B Ichhapore was explored for geotechnical data. The exploration revealed.

1. Ground Water Level is 3.0 mt below Ground Level.
2. The soil profile Shows:  
0.0 to 4.0 mt: Top CI-CH soil high swell potential for 0.0 to m3.0 mt  
 $w = 35 \pm 1\%$ ,  $\gamma_d = 1.38 \text{ g/cc}$ ,  $c = 7 \text{ T/mt}^2$ ,  $\phi = 10^\circ$ ,  $N_s = 8$   
4.0 to 6.5 mt: Soil is ML group of silt non plastic  $w = 20$  to  $26\%$ ,  
 $\gamma_d = 1.55 \text{ g/cc}$ ,  $N_s = 6$  to  $12$ ,  $N_c > 20$ .
3. Foundations for light weight structures can be placed at 3.0 mt below soft wet zone. If actual excavation shows soil as drier 20-25 % foundation can be placed on such a layer with minimum depth of 2.0 mt below ground. The subsoil on wetting could swell if stress downward on foundation is less than  $10 \text{ T/mt}^2$ . A 300 mm sand cushion on geofilter  $300 \text{ g/mt}^2$  P MP woven will be advisable for site.
4. The design SBC will govern design for at 2.4 mt or below. For soil in stress below will have net design bearing capacity of  $15 \text{ T/mt}^2$  with Factor of safety = 2.5
5. Drainage of water over area will give more durability to structure.

## **Bore Hole 2 & D.C.P.T (C-3): (ESR)**

6. Ground Water Level is at 4.0 mt below Ground Level.
7. The soil profile shows major change beyond 7.0 mt from cohesive soil to non cohesive sand.  $N_c$  at 2.70 mt is 15 which increases to 40 at 7.0 mt. depth.
8. The log of bore hole data shows:  
0.0 to 4.5 mt: Cohesive soil 0.0 to 2.0 mt potentially highly  
expansive,  $N_s = 10$ ,  $w = 28\%$ ,  $\gamma_d = 1.45 \text{ g/cc}$ ,  $C_u =$   
 $7 \text{ T/mt}^2$ ,  $\phi = 10^\circ$ ,  $\text{SBC} = 18 \text{ T/mt}^2$ .  
4.5 to 8.5 mt: SM group of non plastic silty sand  $N_s = 12$  to  $13$   
under submerged state,  $w = 20\%$ ,  $\gamma_d = 1.8 \text{ g/cc}$ ,  
 $P_o = 80 \text{ kPa}$ ,  $R_d = 60\%$ ,  $\phi > 30^\circ$ ,  $q_{p40} = 360 \text{ kPa(wet)}$   
&  $240 \text{ kPa}$  under submerged state.



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8.5 to 10.5 mt: SM silty sand  $N = 25 \pm 2$ ,  $w = 17\%$ .

9. Depth of foundation for elevated reservoir for site is best placed at 2.8 mt below Ground Level. The soil 2.8 to 4.5 mt is cohesive overlaying silty fine sand -medium deuce.
10. Design bearing capacity will be governed by SBC which for the soil properties in (8) is net  $18 \text{ T/mt}^2$ .
11. A sand cushion of 200 mm or geofilter grade PP-300  $\text{g/mt}^2$  is advisable. The fabric shall be laod as separator of soil & PCC & raised 1.0 mt all around.

**Bore Hole 3 & D.C.P.T (C-4 & C-5): (CLEAR WATER SUMP)**

12. Ground Water Level at 4.0 mt below Ground Level.
13. The dynamic crone indicate  $N_c = 10$  blows/30cm, increasing with depth to 30 blows at 6.0 mt below Ground Level. The strata beyond 6.0 mt could be SM non plastic.
14. Bore Hole 3 shows soil profile as under:
  - (a) 0.0 tom 3.0 mt: CI-CH  $N_s = 10$ ,  $w = 26$ , desiccated.
  - (b) 30. to 7.0 mt: Silt with variable fine sand.  $N_s = 15$  to  $22$  blows/30cm,  $w = 26\%$ ,  $\gamma_d = 1.5 \text{ g/cc}$ ,  $C_u = 0.15 \text{ kg/cm}^2$ ,  $\phi_u = 25^\circ$
  - (c) 7.0 to 8.5 mt: Stiff CI soil  $w = 20\%$ ,  $N_s = 17$ .
  - (d) 8.5 to 10.5 mt: SM group of sand  $N_s = 20 \pm 3$ .
15. The foundation for sump wall strip or footings can be placed at 3.3 mt below Ground Level.
16. The design bearing capacity will be governed by SBP for settlement of 40 mm. For  $avN_s = 16$  blows for  $Po^1 = \text{eff.Pr} = 70 \text{ kPa}$ ,  $R_d = 70\% \pm 10$ ,  $q_{p40} = 400 \text{ kPa}$ ,  $\phi > 33^\circ$ , the design bearing capacity will be net  $26 \text{ T/mt}^2$  considering Water Table effect.
17. The side walls, beam columns or ring will be subject to earth pressure of cohesive soils up to 3.0 mt & silt. The gap of excavation is to be filled by sand rammed insitu.

*Resai*

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### I. S. CLASSIFICATION

- GW: Well graded gravels, gravel-sand mixture or no fines.  
GP: Poorly graded gravels or gravel sand mixture, little or no fines.  
GM: Silty gravels, poorly graded gravel-sand-silt mixtures.  
GC: Clayey gravels, poorly graded gravel-sand-clay mixtures.  
SW: Well-graded sands, gravelly sands; little or no fines.  
SP: Poorly graded sands or gravelly sands, little or no fines.  
SM: Silty sands, poorly graded sand-silt mixtures.  
SC: Clayey sands, poorly graded sand-clay mixtures.  
ML: Inorganic silt and very fine sands rock flour; silty or clayey fine sands or clayey silts with non-to low plasticity.  
CL: Inorganic clays, gravelly clays, sandy clays, silty clays, lean clays of low plasticity.  
OL: organic silts and organic silty clay of low plasticity.  
MI: Inorganic silts, silty or clayey fine sands or clayey silts of medium plasticity.  
CI: Inorganic clays, gravelly clays, sandy clays, silty clays, lean clays of medium plasticity.  
OI: Organic silts and organic silty clays of medium plasticity.  
MH: Inorganic silt of highly compressibility, micaceous or diatomaceous fine sandy or silty soils, elastic silts.  
CH: Inorganic clays of high plasticity, fat clays.  
OH: Organic Clays of medium to high plasticity.  
Pt: Peat and other highly organic soil with very high compressibility.

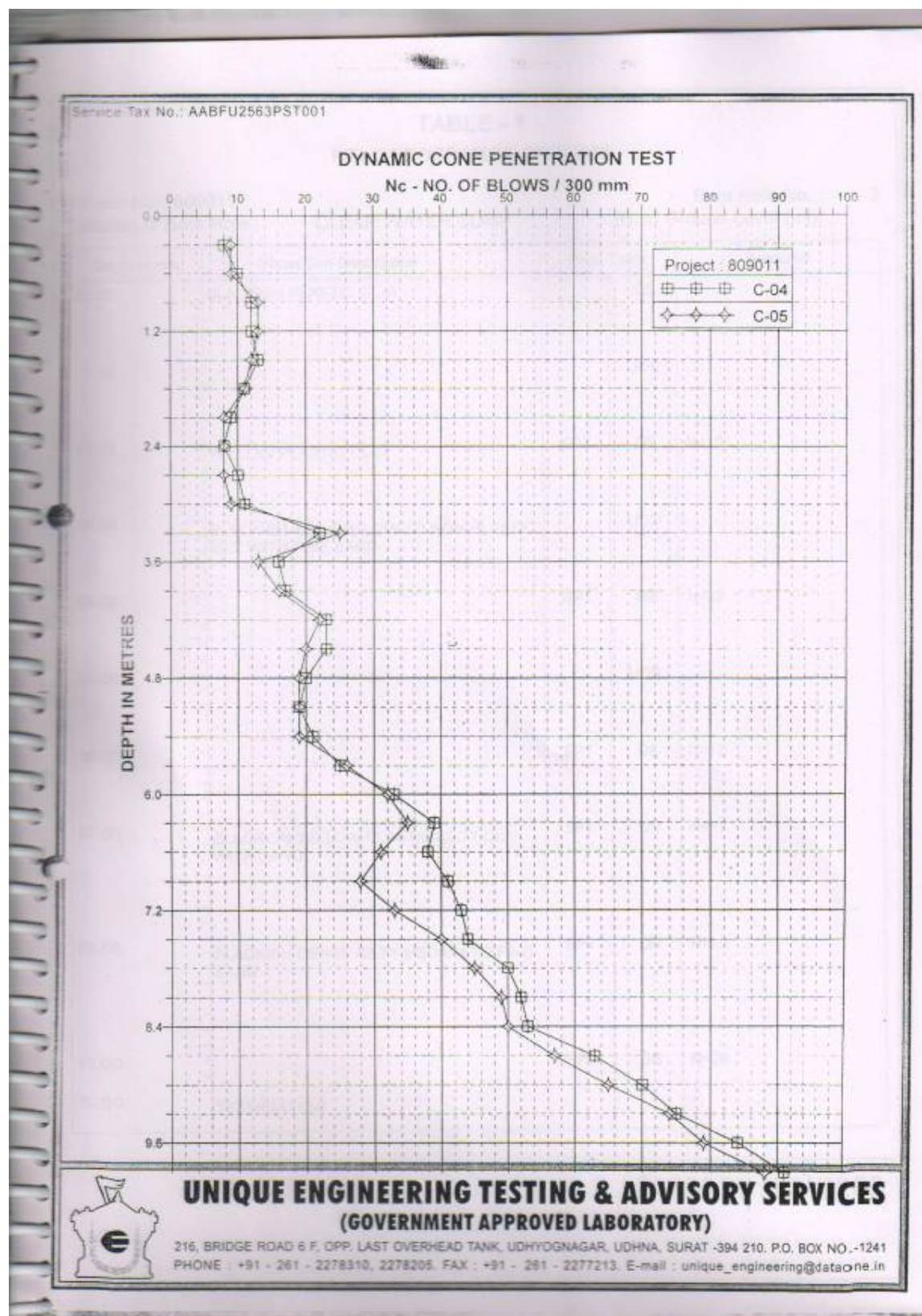


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|  |  |                          |  |
|--|--|--------------------------|--|
| Service Tax No.: AABFU2563PST001         |  | <b>TABLE - 1</b>         |  |
| <b>FIELD PROGRAMME OF TESTS</b>          |  |                          |  |
| Project No. : 809011                     |  | Bore Hole No. : 3        |  |
| Location of Bore Hole : CLEAR WATER SUMP |  | RL of Ground Level (mt): |  |

| Depth in mts | Visual Soil Description                                | Field Tests | Remarks |
|--------------|--|-------------|---------|
| 00.00        | BLACKISH PLASTIC CLAY                                  | DS          |         |
| 01.00        |  | UDS         |         |
| 02.00        | YELLOW PLASTIC CLAY                                    | SPT DS      | N=10    |
| 03.00        | BLACKISH YELLOW LOW TO NON-PLASTIC SILT WITH FINE SAND | UDS         |         |
| 04.00        |  | SPT DS      | N=22    |
| 05.00        |  | UDS         |         |
| 06.00        |  | SPT DS      | N=13    |
| 07.00        | BLACKISH YELLOW PLASTIC SILTY CLAY WITH SAND           | SPT DS      | N=17    |
| 08.50        | BLACKISH DENSE SILTY MEDIUM TO FINE SAND               | SPT DS      | N=23    |
| 10.00        |  | SPT DS      | N=26    |
| 10.50        | TERMINATION  |             |         |



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**TABLE - 2**  
**LABORATORY PROGRAMME**

Project No. : 809011 Bore Hole No. : 3

| Depth & Type of Sample | N. M. C. | Density | Specific Gravity | Particle Size Analysis | Atterberg Limits | Shrinkage Limit / Free Swell | Shear Test (UCC/Trx/Box/Vane) | Other Tests |
|------------------------|----------|---------|------------------|------------------------|------------------|------------------------------|-------------------------------|-------------|
| 0.00/D                 |          |         |                  | Part                   | Yes              | FRS                          |                               |             |
| 1.00/U                 | Yes      | Yes     | Yes              | Part                   | Yes              | FRS                          | UCC                           |             |
| 2.00/S                 | Yes      |         |                  | Part                   | Yes              | FRS                          |                               |             |
| 3.00/U                 | Yes      | Yes     | Yes              | Part                   | Yes              | FRS                          | TRX                           |             |
| 4.00/S                 | Yes      |         |                  | Part                   | Yes              |                              |                               |             |
| 5.00/U                 | Yes      | Yes     | Yes              | Part                   | Yes              |                              | TRX                           |             |
| 6.00/S                 | Yes      |         |                  | Part                   | Yes              |                              |                               |             |
| 7.00/S                 | Yes      |         |                  | Part                   | Yes              |                              |                               |             |
| 8.50/S                 | Yes      |         |                  | Part                   | Yes              |                              |                               |             |
| 10.00/S                | Yes      |         |                  | Part                   | Yes              |                              |                               |             |



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**TABLE - 3**

**RESULTS OF STANDARD PENETRATION TEST**

Project No.: 809011 Bore Hole No.: 3

| Depth<br>in mts | No. of Blows for Penetration |              |              | Ns (Blows<br>/300 mm) | Nc(Corrected<br>value of Ns) | N. M. C.<br>(in %) |
|-----------------|------------------------------|--------------|--------------|-----------------------|------------------------------|--------------------|
|                 | 0 - 150 mm                   | 150 - 300 mm | 300 - 450 mm |                       |                              |                    |
| 2.00            | 03                           | 05           | 05           | 10                    | 10                           | 26.88              |
| 4.00            | 08                           | 10           | 12           | 22                    | 19                           | 23.00              |
| 6.00            | 08                           | 06           | 07           | 13                    | 13                           | 21.51              |
| 7.00            | 07                           | 09           | 08           | 17                    | 17                           | 20.36              |
| 8.50            | 09                           | 11           | 12           | 23                    | 18                           | 13.16              |
| 10.00           | 10                           | 12           | 14           | 26                    | 19                           | 17.17              |



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**TABLE - 5**  
**PARTICLE SIZE ANALYSIS**

Project No. : 809011 Bore Hole No. : 3

| Soil Strata   | Depth & Sample Type | Gravel in %<br>(>4.75 mm) | Sand in %     |                    |                   | Silt in %<br>+<br>Clay in % |
|---------------|---------------------|---------------------------|---------------|--------------------|-------------------|-----------------------------|
|               |                     |                           | (4.75 - 2 mm) | (2mm - 425 $\mu$ ) | (425 - 75 $\mu$ ) |                             |
| 0.00 to 2.00  | 0.00/D              | 0                         | 0             | 2                  | 2                 | 96                          |
| 0.00 to 2.00  | 1.00/U              | 0                         | 0             | 0                  | 1                 | 99                          |
| 2.00 to 3.00  | 2.00/S              | 0                         | 0             | 0                  | 2                 | 98                          |
| 3.00 to 7.00  | 3.00/U              | 0                         | 0             | 0                  | 4                 | 96                          |
| 3.00 to 7.00  | 4.00/S              | 0                         | 0             | 0                  | 29                | 71                          |
| 3.00 to 7.00  | 5.00/U              | 0                         | 0             | 0                  | 5                 | 95                          |
| 3.00 to 7.00  | 6.00/S              | 0                         | 0             | 0                  | 31                | 69                          |
| 7.00 to 8.50  | 7.00/S              | 0                         | 1             | 5                  | 12                | 82                          |
| 8.50 to 10.50 | 8.50/S              | 0                         | 9             | 39                 | 18                | 34                          |
| 8.50 to 10.50 | 10.00/S             | 7                         | 8             | 35                 | 19                | 31                          |



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**TABLE - 6**  
**ATTERBERG LIMITS**

Project No. 809011 Bore Hole No. 3

| Soil Strata   | Depth & Sample Type | Liquid Limit | Plastic Limit | Plasticity Index | Shrinkage Limit | Freeswell Index | I.S. Classification |
|---------------|---------------------|--------------|---------------|------------------|-----------------|-----------------|---------------------|
| 0.00 to 2.00  | 0.00/D              | 49           | 27            | 22               |                 | 18              | CI                  |
| 0.00 to 2.00  | 1.00/U              | 45           | 26            | 19               |                 | 19              | CI                  |
| 2.00 to 3.00  | 2.00/S              | 52           | 28            | 24               |                 | 32              | CH                  |
| 3.00 to 7.00  | 3.00/U              | 31           | -             | -                |                 | 01              | ML                  |
| 3.00 to 7.00  | 4.00/S              | 27           | -             | -                |                 |                 | ML                  |
| 3.00 to 7.00  | 5.00/U              | 32           | 23            | 09               |                 |                 | ML                  |
| 3.00 to 7.00  | 6.00/S              | 29           | -             | -                |                 |                 | ML                  |
| 7.00 to 8.50  | 7.00/S              | 36           | 22            | 14               |                 |                 | CI                  |
| 8.50 to 10.50 | 8.50/S              | 27           | -             | -                |                 |                 | SM                  |
| 8.50 to 10.50 | 10.00/S             | 27           | -             | -                |                 |                 | SM                  |



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**TABLE - 7A**  
**UNCONFINED COMPRESSION TEST TABLE**

Project No. : 809011 Bore Hole No. : 3

| Depth of Sample (mts.) | Type of Sample (UD/Rm) | Qu (Kg/cm <sup>2</sup> ) | Cu (Kg/cm <sup>2</sup> ) |
|------------------------|------------------------|--------------------------|--------------------------|
| 1.00                   | UD(Undisturbed)        | 5.39                     |                          |

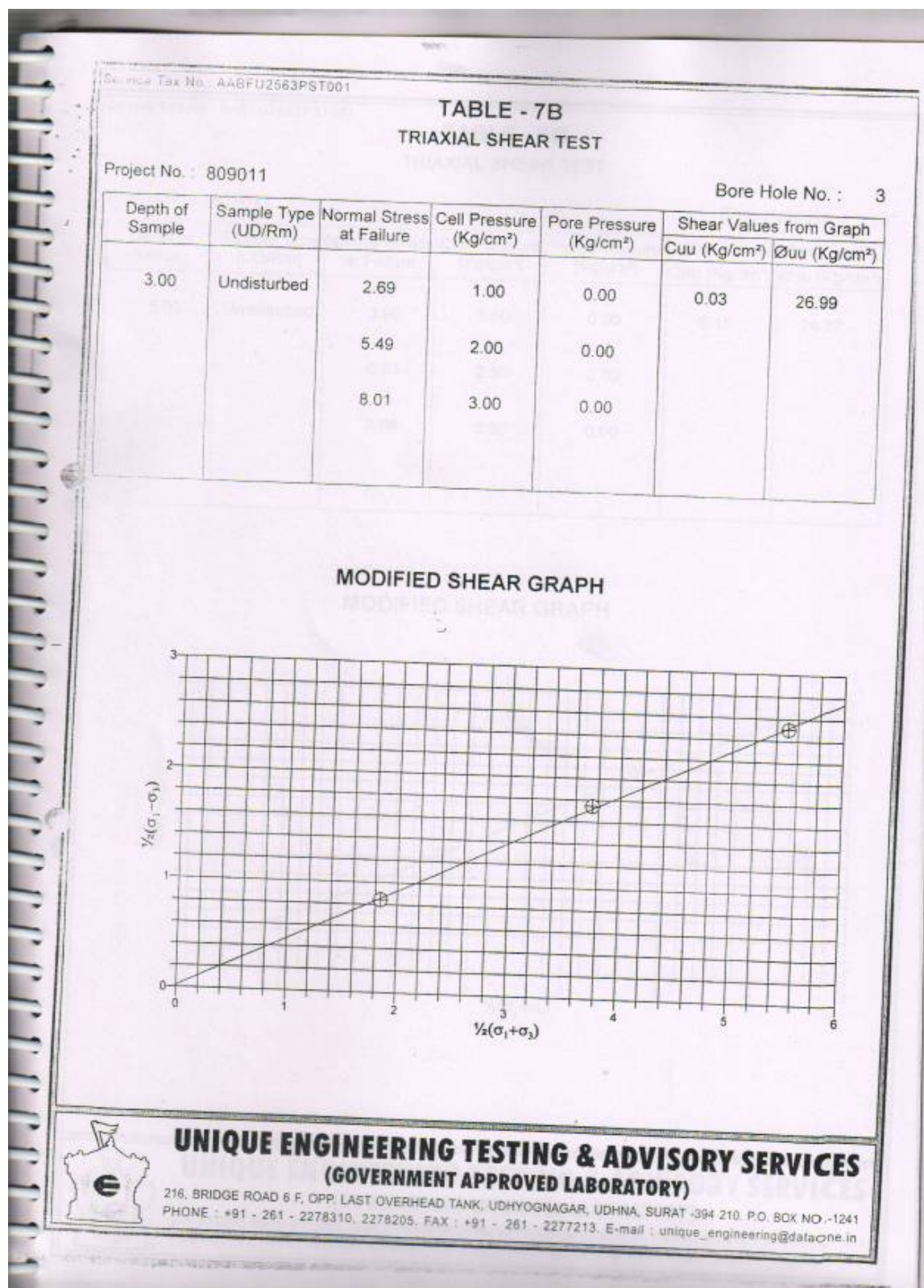
MODIFIED SHEAR GRAPH

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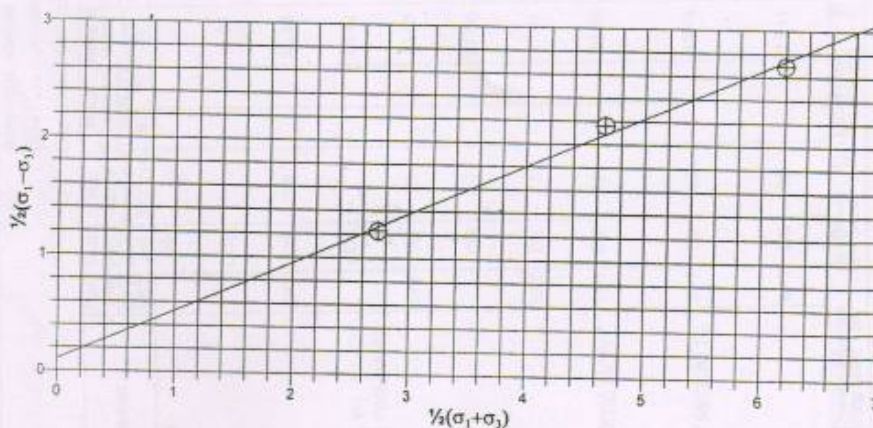
**TABLE - 7B**  
**TRIAxIAL SHEAR TEST**

Project No.: 809011

Bore Hole No.: 3

| Depth of Sample | Sample Type (UD/Rm) | Normal Stress at Failure | Cell Pressure (Kg/cm <sup>2</sup> ) | Pore Pressure (Kg/cm <sup>2</sup> ) | Shear Values from Graph   |                           |
|-----------------|---------------------|--------------------------|-------------------------------------|-------------------------------------|---------------------------|---------------------------|
|                 |                     |                          |                                     |                                     | Cuu (Kg/cm <sup>2</sup> ) | Øuu (Kg/cm <sup>2</sup> ) |
| 5.00            | Undisturbed         | 3.96                     | 1.50                                | 0.00                                | 0.15                      | 24.97                     |
|                 |                     | 6.83                     | 2.50                                | 0.00                                |                           |                           |
|                 |                     | 8.88                     | 3.50                                | 0.00                                |                           |                           |

**MODIFIED SHEAR GRAPH**



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# SUMMARY OF GEOTECHNICAL EXPLORATIONS

| Project No. : 909011               |                      | Bore Hole Started on : 05-04-08                        |                                    | Depth of Water Table : 4.02 mts from Ground Level |  |   |                  |                                    |                               |                              |                    |                                |                             |
|------------------------------------|----------------------|--|------------------------------------|---|--|---|------------------|------------------------------------|-------------------------------|------------------------------|--------------------|--------------------------------|-----------------------------|
| Bore Hole No. : 3                  |                      | Bore Hole Completed on : 05-04-08                      |                                    | R. L. of Ground Level :                           |  |   |                  |                                    |                               |                              |                    |                                |                             |
| Method of Drilling : SHELL & AUGER |                      | Diameter of Bore Hole : 150 mm                         |                                    | Location of Bore Hole : CLEAR WATER SUMP          |  |   |                  |                                    |                               |                              |                    |                                |                             |
| Depth in metres                    | I. S. Classification | Visual Soil Description                                | Field Test /Samples<br>SPT UDS VST | Ns No. of Blows per 300 mm                        | Rock Properties<br>Moist. CR RQD Content % | Natural Density (in gms/cc)<br>Bulk Dry | Specific Gravity | Particle Size Analysis<br>Gr. Sn % | Atterberg Limits<br>LL % PL % | Shrinkage Limit %            | Free Swell Index % | Shear Properties<br>Test Type  | Additional Tests or Remarks |
| 00.00                              |                      | BLACKISH PLASTIC CLAY                                  | DS                                 |   |  |   |                  | 0 4 96                             | 49 27 22                      |                              | 18                 |                                |                             |
| 01.00                              | CI                   |  | UDS                                |   |  | 19.98                                   | 1.79 1.49 2.62   | 0 1 99                             | 45 26 19                      |                              | 19                 | UCC                            | Qu = 5.39                   |
| 02.00                              | CH                   | YELLOW PLASTIC CLAY                                    | SPT DS                             | 10  |  | 26.88                                   |                  | 0 2 98                             | 52 28 24                      |                              | 32                 |                                |                             |
| 03.00                              |                      | BLACKISH YELLOW LOW TO NON-PLASTIC SILT WITH FINE SAND | UDS                                |   |  | 26.42                                   | 1.93 1.53 2.77   | 0 4 96                             | 31 - -                        |                              | 1                  | Tuu                            | 0.03 27.0*                  |
| 04.00                              |                      |  | SPT DS                             | 22  |  | 23.00                                   |                  | 0 29 71                            | 27 - -                        |                              |                    |                                |                             |
| 05.00                              | ML                   |  | UDS                                |   |  | 27.60                                   | 1.96 1.54 2.80   | 0 5 95                             | 32 23 9                       |                              |                    | Tuu                            | 0.15 25.0*                  |
| 06.00                              |                      |  | SPT DS                             | 13  |  | 21.51                                   |                  | 0 31 69                            | 29 - -                        |                              |                    |                                |                             |
| 07.00                              | CI                   | BLACKISH YELLOW PLASTIC SILTY CLAY WITH SAND           | SPT DS                             | 17  |  | 20.36                                   |                  | 0 18 82                            | 36 22 14                      |                              |                    |                                |                             |
| 08.50                              |                      | BLACKISH DENSE SILTY MEDIUM TO FINE SAND               | SPT DS                             | 23  |  | 13.16                                   |                  | 0 66 34                            | 27 - -                        |                              |                    |                                |                             |
| 10.00                              | SM                   |  | SPT DS                             | 26  |  | 17.17                                   |                  | 7 62 31                            | 27 - -                        |                              |                    |                                |                             |
| 10.50                              |                      | TERMINATION  |                                    |   |  |   |                  |                                    |                               |                              |                    |                                |                             |
| SPT - Standard Penetration Test    |                      | DS - Disturbed Sample                                  |                                    | Gr - Gravel                                       |  | Liquid Limit                            |                  | Plasticity Index                   |                               | Cv - Coeff. of Consolidation |                    | CR - Core Recovery             |                             |
| UDS - Undisturbed Sample           |                      | VST - Vane Shear Test                                  |                                    | Sn - Sand   |  | PL - Plastic Limit                      |                  | C, I - Shear Parameters            |                               | Mv - Coeff. of Volume Change |                    | RQD - Rock Quality Designation |                             |

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