

**MINISTRY OF HEALTH & FAMILY WELFARE  
GOVERNMENT OF INDIA, NEW DELHI**

**Tender No. MoHFW /ME/RIAHS-BBSR/HLL/ID/2013**

**Request for Proposal (RFP)**  
*for*

**Construction of Regional Institute of Allied Health Sciences (RIAHS)  
at BHUBNESHWAR, ODISHA**

**VOLUME - III**

**TECHNICAL SPECIFICATIONS**



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**MINISTRY OF HEALTH & FAMILY WELFARE  
GOVERNMENT OF INDIA, NEW DELHI**

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**TECHNICAL SPECIFICATIONS**

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**Construction of Regional Institute of Allied Health Sciences (RIAHS)**  
**At**  
**BHUBNESHWAR, ODISHA**

**TECHNICAL SPECIFICATIONS**

**CHAPTER A**

**BRIEF OF REQUIREMENT OF THE WORK:**

**1. General Scope of Work :**

The scope of construction of Regional Institute of Allied Health Sciences (RIAHS) at BHUBNESHWAR, ODISHA involves construction of buildings including internal & external services like Plumbing, Electricals, HVAC and Lifts etc for following:

- a. Administration and Academic Block
- b. Hostel Blocks
- c. Residential Blocks & Guest House
- d. Auditorium
- e. Services Blocks
- f. Infrastructure Developmental including External Development Works.

The work includes a number of specialized Civil/ Electrical/ HVAC/ Mechanical/ Electronic services etc. to be executed as integral parts of the project by engaging specialized agencies as provided in the Notice inviting Bids.

**2. The following are the salient features of the Works:**

- a. Foundations & other works like underground water tank.
- b. Super structure
- c. Internal and External water supply, sewerage, Storm water
- d. Infrastructure Development i.e. Roads, Parking etc.
- e. Electrical Installation ( Internal & External)
- f. Comprehensive Fire Fighting/Protection /Alarm System
- g. HT & LT Installation, Substation, DG Sets
- h. Comprehensive HVAC
- i. Lifts
- j. PA, CCTV & Security Systems, EPABX/ Communication Systems, NET/LAN Systems, BMS, UPS
- k. Solar energy Systems

**3. Appointment of agencies for execution of works mentioned in Para 2:**

Contractor shall submit credentials of the agencies proposed to be engaged by him/ them for execution of sub heads excluding a to d above of works mentioned in Para 2 above to the Client / HLL. Particular agency shall be approved by Client/ HLL and only such agencies shall be allowed to execute the work on behalf of the contractor.

Latest CPWD Specifications for Civil, Electrical and all other works with up to date correction slips for all sub heads of work as applicable, and, Technical Specifications included in the tender documents, wherever applicable.

4. The work shall in general conform to the Latest CPWD Specifications for Civil, Electrical and all other works with up to date correction slips for all sub heads of work as applicable, and, Technical Specifications included in the tender documents, wherever applicable. Wherever any aspect of design / construction / material standards is not covered under the above mentioned specification, relevant standards shall be referred to in the order of precedence which shall be as follows. In the case of discrepancy between the Schedule of Quantities, the Specifications and /or the Drawings, the following order of preference shall be observed –

- a. Description of Schedule of Quantities
- b. Particular specification and Specific Condition, if any.
- c. Drawings
- d. CPWD Specifications
- e. Indian Standard Specifications of BIS/ NBC/ IRC/ BS/ ASTM/ DIN

## **CHAPTER B**

### **TECHNICAL SPECIFICATIONS AND CONDITIONS- CIVIL WORKS**

#### **1. EARTH WORK:** As per relevant CPWD specifications.

Irrespective of the stipulations in the relevant CPWD Specifications, any surplus excavated earth which is beyond the requirement it shall be disposed of by the contractor at his own cost to the place as permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the Department for disposal of this surplus excavated earth. Also the Contractor shall, at his own expense and without extra charges, make provision for all shoring, pumping, dredging or bailing out water, encountered from any sources such as rains, floods, springs, subsoil water table being high or due to any other cause whatsoever. The foundation trenches shall be kept free from water while all the works below ground level are in progress without any extra payment. Filling in plinth shall be consolidated with water and compacted with pneumatic rammers, to achieve 90% relative density on testing. One test is to be carried out for 1000 sq.ms. of compacted area.

#### **2. PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:**

##### **a. STONE AGGREGATE**

- i. Stone aggregate used in the work shall be of hard broken stone to be obtained from approved source (Quarries to be approved by the Engineer in charge) and shall conform to relevant provision in the Latest CPWD Specifications for works.

##### **b. SAND**

- i. Sand to be used for the work shall be of as specified in CPWD specifications 2009. Sand shall be obtained from the source to be got approved by the Engineer in charge and washed if required, with appropriate equipment to bring down the chemical, inorganic and organic impurities within the permissible limits as per the direction of the Engineer in charge. The same shall consist of hard siliceous materials.

**Note:** Where only one variety of sand is available the sand will be sieved for use in finishing work as directed by the Engineer – in – charge in order to obtain smooth surface and nothing extra will be paid on this account.

- ii. Nothing extra shall be paid for screening or washing the sand as prescribed above.

##### **c. FLYASH**

Flyash conforming to grade 1 of IS 3812 (Part 1) may be used as part replacement of OPC provided uniform blending with cement is ensured in accordance with clauses 5.2 and 5.2.1 of I.S.456-2000 in the items of BMC and RMC. However this shall not override the provisions of the respective items.

##### **d. CENTERING SHUTTERING AND SCAFFOLDING**

- i. All Scaffolding centering for RCC shall be with properly designed system and brought to site well in advance so that the progress of the work is not hampered for non-availability of the same.
- ii. All shuttering for RCC work except soffits of slab shall be in water proof shuttering Ply. Shuttering for slab and soffits shall be in water proof shuttering ply or in good quality mild steel plates free of dents, bends or warping and rusting as approved by the Engineer in charge.

- iii. Contractor should deploy complete one set of shuttering materials for minimum one complete floor and the shuttering material for beam bottom shall be minimum for two complete floors.

**e. REINFORCEMENT**

- i. TMT reinforcement steel shall be used shall be as per design and conforming to IS: 1786 pertaining to Fe 500D OR Fe 500D grade of steel.
- ii. TMT steel bars manufactured by main producers, as per list of makes, shall be allowed in the work. Contractor shall produce manufacturer Test Report for each dia and each lot Tests. Nothing extra will be paid for "straightening of bars" received from market in coils or with bends. All incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.
- iii. The actual average sectional weight for dia up to 10 mm shall be arrived at from one meter long samples (minimum 3 from each dia) taken from each lot of steel. The discretion of the Engineer – in – charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute the single lot for this purpose.
- iv. The weight of each lot of a particular diameter of 10mm and below shall be reckoned as the weight as per actual, multiplied by a factor equal to the standard sectional weight of the particular diameter divided by the average sectional weight of the particular dia in a particular lot worked out as per above para. Adjustment for the steel shall be effected on the basis of the weight as modified above for quantity payable.
- v. Measurement of all diameters of steel be on linear basis and will be converted into weight on the basis of standard sectional weight coefficients given in relevant CPWD specifications mentioned in schedule 'F' of General Conditions of Contract.
- vi. Measurement of reinforcement shall be as per procedure described in the relevant CPWD specifications mentioned in schedule 'F' of General Conditions of Contract.

**f. Concrete Mix Design**

The mix design shall be for moderate exposure and GOOD degree of quality control, unless otherwise specified.

**g. Concrete Batching Plant**

- i. The Concrete Batching Plant of suitable capacity to be installed within a period of 30 days from award of work. The contractor shall install batching plants (within 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfill the following requirements.
  - It shall be fully computerized.
  - Facility to pump concrete upto the highest point of the building.
  - It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.
  - It should have sufficient capacity to meet the requirement as per schedule.

In case of failure of Batching Plant, RMC may be allowed with a written permission of the Engineer in Charge.

- ii. Approved admixtures conforming to IS.9103 shall be permitted to be used. The chloride content in the admixture shall satisfy the requirement of BS 5075. The total

amount of chloride content in the admixture mixed Concrete shall satisfy the requirement of IS 456-2000.

- iii. The concrete mix design with and without admixture will be carried out by the contractor through the Laboratories / Test house as approved by Engineer-in-charge.
- iv. The various ingredients for mix design \laboratory tests shall be sent to the lab test house through the Engineer and the sample of such ingredients sent shall be preserved at site by the department till completion of work or change in Design Mix whichever is earlier. The sample shall be taken from the approved materials which are proposed to be used in the work.
- v. The batching and mixing plant shall be fully automatic.
- vi. The contractor has to arrange to erect batching plant for the design mix concrete on his own.
- vii. The concrete shall be transported to the site in specially made Transit Mixers & shall have suitable retarders so that it should not set before placing in position. It should have sufficient flow so that at height the concrete shall be placed by pumping only.
- viii. Each Transit Mixer reaching site shall invariably have manufacturer's certificate containing details like truck number Grade of mix, time of leaving the plant, time of reaching a site etc. A copy of the same shall be handed over to E- in – C or his authorized representative.
- ix. However samples for testing etc. shall be taken as per the mandatory tests prescribed in latest CPWD specifications.
- x. All cubes shall be tested for 7 days and 28 days tests in conformity with the relevant CPWD specifications.
- xi. In respect of projected balconies, projected slabs at roof level and projected verandah, the payment for the RCC work shall be made under the items of RCC slabs. Nothing extra shall be paid for the side shuttering at the edges of these projected balconies and projected verandah. All the exposed edge shall however be finished as per specifications and nothing extra shall be paid for this.
- xii. In the items of RCC walls, railings and roofs etc. nothing extra shall be paid for making designs as per patterns given by Architects or for thickness of sections.
- xiii. The water will be tested with regard to its suitability for use in CC/RCC work and nothing extra will be paid for on this account.
- xiv. To receive anchor bolt / foundation for machines to be installed at later date, pocket of size minimum 110x100x300 mm shall be kept while concreting of RCC/ CC members and shall be filled with CC 1:1:2 with plasticizer and as per the direction of Engineer in charge

#### **h. Ready Mix Concrete**

- i. The contractor shall engage Ready Mix Concrete (RMC) producing plants (Distance of plant from site to be approved by Engineer in Charge) to supply RMC for the work. The RMC plant proposed to be engaged by the contractor shall fulfill the following requirements.
  - It shall be fully computerised.
  - It should have supplied RMC for Govt. projects of similar magnitude.
  - It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

- ii. The contractor shall, within 10 days of award of the work submit list of at least three reputed RMC plant companies along with details of such plants Including details of transit mixer, pumps etc. to be deployed indicating name of owner/company, its location, capacity, technical establishment, past experience for approval by Engineer-in-charge.
- iii. The Engineer reserves the right to exercise over the:-
  - Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials recordings of test results and declaring the material fit or unfit for use in production of mix.
  - Calibration check of the RMC.
  - Weight and quality check on the ingredient, water and admixture added for batch mixing.
  - Time of mixing of concrete.
  - Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action.

For exercising such control, the Engineer shall periodically depute his authorized representative at the RMC plant. It shall be the responsibility of the contractor to ensure that the necessary equipment manpower & facilities are made available to Engineer and/or his authorized representative at RMC plant
- iv. Ingredients, admixtures & water declared unfit for use in production of mix shall not be used. A batch mix found unfit for use shall not be loaded into the truck for transportation.
- v. All required relevant records of RMC shall be made available to the Engineer or his authorized representative. Engineer shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production and transportation of concrete mix which shall be binding on the contractor & the RMC plant.
- vi. It shall be the responsibility of the Contractor to ensure that the RMC producer provides all necessary testing equipment and takes all necessary measures to ensure Quality control of ready -mixed concrete. In general the required measures shall be:-
  - **CONTROL OF PURCHASED MATERIAL QUALITY**

RMC producer shall ensure that the materials purchased and used in the production of concrete conform to the stipulation of the relevant agreed standards with the material Supplier and the requirement of the product mix design and quality control producer's. This shall be accomplished by visual checks, sampling and testing, certification from materials suppliers and information /data from material supplier. Necessary equipment for the testing of all material shall be provided and maintained in calibration condition at the plant by the RMC producer.
  - **CONTROL OF MATERIAL STORAGE**

Adequate and effective storage arrangement shall be provided by RMC producer at RMC plant for prevention of contamination, reliable transfer and feed system, drainage of aggregates, prevention of freeing or excessive solar heating of Aggregate etc,
  - **RECORD OF MIX DESIGN AND MIX DESIGN MODIFICATION**



RMC producer shall ensure that record of mix design and mix design modification is available in his computer at RMC plant for inspection of Engineer or his representative at any time.

- **COMPUTER PRINT OUTS OF EACH TRUCK LOAD**

Each truckload / transit mixer dispatched to site shall carry computer printout of the ingredients of the concrete it is carrying. The printout shall be produced to Engineer or his representative at site before RMC issued in work.

- **TRANSFER AND WEIGHING EQUIPMENT RMC**

Producer shall ensure that a documented calibration is in place. Proper calibration records shall be made available indicating date of next calibration due, corrective action taken etc. RMC producer shall ensure additional calibration checks whenever required by the Engineer in writing to contractor. RMC producer shall also maintain a daily production record including details of mixes supplied. Record shall be maintained of what materials were used for that day's production including water and admixtures.

- **MAINTENANCE OF PLANT, TRUCK Mixers AND PUMPS**

Plant, Truck Mixers and Pumps should be well maintained so that it does not hamper any operation of production, transportation and placement.

- **PRODUCTION OF CONCRETE**

The following precautions shall be taken during the production of RMC at the plant

- Weighing (correct reading of batch data and accurate weighing):- For each load, written, printed or graphical records shall be made of the weights of the materials batched, the estimated slump, the total amount of water added to load the delivery tickets number for that load and the time of loading the concrete into the truck.
- Visual observation of concrete during production and delivery or during sampling and testing of fresh concrete assessment of uniformity, cohesion, workability adjustment to water content. The workability of the concrete shall be controlled on a continuous basis during production. The batch mix found unfit shall not be loaded into the truck for transportation. Necessary corrective action shall be taken in the production of mix as required for further batches.
- Use of adequate equipment at the plant to measure surface moisture content of aggregates, particularly fine aggregates or the workability of the concrete, cube tests etc. shall also be ensured.
- Making corresponding adjustment at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.
- Sampling of concrete, testing monitoring of results.
- Diagnosis and correction of faults identified from observations /complaints.

The RMC plant produced concrete shall be accepted by Engineer at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.

- vii. The rate for the Item of design mix cement concrete shall be inclusive of all the ingredients including admixtures, if required, labour, machinery T&P etc. (except

shuttering which will be measured & paid for separately) required for a design mix concrete of required strength and workability. The rate quoted by the agency shall be net & nothing extra shall be payable on account of change in quantities of concrete, ingredients like cement and aggregates and admixtures etc. as per the approved mix design.

- viii. Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the pre-agreed schedule approved by Engineer.
- ix. Frequency of sampling and standards of acceptance shall be as per CPWD specifications.
  - No addition of water or other ingredients shall be permitted in the RMC at site or during transit.
  - The RMC shall be placed by pump of suitable capacity and the contractor shall arrange sufficient length of pipe at site to place the RMC in the minimum required time. The contractor shall co-ordinate with RMC supplier and pumps hirer to have effective concrete placement.
  - Pre-paid delivery tickets shall be produced with each truck load of RMC.
  - The representative of RMC supplier shall attend the site meeting as and when decided by the Engineer
- x. The contractor shall assess the quantity of RMC requirement at site well in advance and order accordingly to the RMC supplier. In case excess RMC is received at site, the department shall not be under any obligation to get extra quantities utilized and no payment for such RMC shall be made.
- xi. The contractor shall have to employ labour in shifts to ensure continuous casting of raft and other RCC members. No extra payment on this account shall be made.

### **3. WATER PROOFING TREATMENT BY CHEMICAL INJECTION SYSTEM (PRE-CONSTRUCTION)- (if required):**

#### **a. HORIZONTAL SURFACE (RAFT SLAB)**

- i. Before the raft reinforcement is placed in position:
  - Laying PCC as per drawings and specifications.(payable under the corresponding item)
  - Cement slurry (cement and approved water proofing compound) is spread on the PCC for proper bonding with subsequent water proofing treatment.
  - Water Proofing Course of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound is laid over the slurry. Stone aggregates 12mm down is embedded at random.
  - After 24 hours, spreading cement slurry (cement and approved water proofing compound) on the 1st layer of mortar.
  - Providing and laying 2nd layer of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound. Stone aggregate 12mm down size is embedded at random.
- ii. After reinforcement of raft is placed in position:
  - Providing and fixing 25mm dia GI threaded grouting nozzles of adequate length at the specified locations @ 1.50 metre c/c or as shown in the drawing all over the slab.

The grouting nozzles are tied with reinforcement in such a manner as not to choke its end during concrete operations. The top of these nozzles protrudes above the raft concrete.

- After minimum 7 days of concreting, cement grout of cement and approved water proofing compound (non shrinkage grouting compound) in proportion as specified is injected, through these nozzles at the pressure of 2.5 to 3.0 Kg/Sq.cm.
- After grouting, top of the nozzles is cut and the space is filled with cement mortar 1:2 (1 cement: 2 coarse sand) mixed with approved water proofing compound.

**b. Retaining Wall**

- i. The external surface is prepared and approved cement slurry is applied.
- ii. Providing and laying 25mm thick cement mortar in 1:4 (1 cement : 4 coarse sand) mixed with approved water proofing compound in two layers with chicken wire mesh 26 or 24 gauge 25mm size in between the two layers.
- iii. The G.I. pipes are placed at 1.5m c/c in both directions, and, 0.75 m C/C along construction joints and securely fastened to the reinforcement prior to shuttering and concreting or alternately by drilling holes (25mm to 32mm dia) in the concrete upto a depth as shown in the drawing all over the wall surface @ 1.50mt. C/C and as shown in the drawing. Treatment along all construction joints by providing nozzles, as above, shall also be executed.
- iv. Fixing 25mm dia G.I. threaded nozzles in these holes with cement mortar 1:4 (1 cement: 4 coarse sand) mixed with water proofing compound.
- v. Injecting cement grout of cement and polymer based water proofing compound (non shrinkage grouting compound) in proportion as specified in these nozzles at a pressure of 2.5 to 3.0 Kg/Sq.cm.
- vi. After the grout the nozzles are cut and filled with cement mortar 1:2 mixed with polymer based water proofing compound in proportion as specified and finished smooth.

**Note:** The proportion of approved water proofing compound to be used in respect of ordinary cement shall be as per manufacturer's specifications.

**c. Guarantee for water proofing:**

Work to be get executed through a approved specialized agency & covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance guarantee for requisite indicated value of work shall be furnished by the contractor before completion.

**d. Measurements:**

The length and breadth shall be measured correct to cm. The flooring area shall be measured in sq.ms. actually executed in raft slab. Inside wall surfaces of the basement upto ground level from top of raft slab shall be measured in sq.m. Columns cross sections area not to be deducted from the plan area.

**e. Rate:**

Rates shall be inclusive of all operations including labour, material, T&P, scaffolding etc. complete. Nothing extra shall be payable on any account.

#### 4. BRICK WORK:

- a. Bricks used in the work shall be obtained from kilns to be got approved from the Engineer in charge and shall be best quality well burnt ground moulded bricks as available in the vicinity. They shall have a compressive strength of not less than 75 Kgs/sq.cm and an absorption percentage of not more than 15 (Fifteen) % of its dry weight when immersed in water for 24 hours. In all other respects they shall conform to the provision in Latest CPWD Specifications for works.
- b. Both the face of wall of thickness more than 23cm shall be kept in the proper plane. Walls of half brick thickness or less shall be measured separately and paid in sqm.
- c. Bricks wall beyond half brick thickness shall be measured in multiple of half brick (i.e.115mm) which shall be deemed to be inclusive of mortar joints. In all other respects they shall conform to the provision in relevant specifications of the work.
- d. For mortar, use of PP Cement shall be preferred.

#### 5. REBAR WORK:

##### a. Installation of Post-Installed Reinforcement

##### i. Surface to be Cleaned & roughened

The surface where re-bar work is to be done shall be thoroughly roughened and cleaned to provide sufficient cohesion in the construction joint. Rough means a surface with at least 3 mm roughness, achieved by raking, exposing the aggregate or other methods giving an equivalent behaviour.

##### ii. Drilling

Injection anchor systems shall be used to fix reinforcement bars into concrete. Fast cure products shall be used with rebar diameters up to 25mm and moderate hole depths of upto about 1.5m, depending on the ambient temperature. Slow cure systems can be used with larger bar diameters and deep holes. As rebar embedment lengths shall be as per manufacturer's specifications. It shall be ensured that the drilling hole shall not penetrate the concrete surface or result in insufficient cover. The hole should be vertical or as dictated. The deviations to the extent of 0.08 times the hole length (4.6°) for compressed air drilling, 0.06 times the hole length (3.4°) with hammer drilling and 0.02 times the hole length (1.1°) if a drilling aid is used, may be ignored, as per approval of the Engineer-in-charge.

##### iii. Hole Cleaning

The holes should be blown out using compressed, oil free air. Extension tubes and air nozzles directing the air to the hole walls should be used, if holes are deeper than 250mm. Deeper holes than 250mm should as well be brushed by machine brushing using steel brushes and brush extensions.

##### iv. Injection And Bar Installation

It is important that air bubbles are avoided during the injection of the adhesive: when the bar is installed later, the air will be compressed and may eject part of the adhesive from the hole when the pressure exceeds the resistance of the liquid adhesive, thus endangering the installer. Moreover, the presence of air may prevent proper curing of the adhesive. In order to reach the bottom of the drilled holes, mixer extensions shall be used. The holes should be filled with the adhesive, as per BOQ, to about 2/3. Marking the

extension tubes at 1/3 of the hole length from the tip will help to dispense the correct amount of adhesive. Piston plugs ensure filling of the holes without air bubbles. After injecting the adhesive, the rebars should be inserted into the hole with a slight rotating movement. When rebars are installed overhead, dripping cups can be used to prevent excess adhesive from falling downward in an uncontrolled manner.

v. Execution

The execution of the work shall be as per the manufacturer's guide/ specifications. However, the same shall be as the instructions of the Engineer in Charge.

b. **Mode Of Measurement**

The work shall be measured in numbers and paid for as per BOQ.

**6. CEMENT PLASTER:** - The use of PPC Cement shall be preferred.

**7. WOOD WORK:**

- a. Timber required for manufacture of chowkhats and shutters for doors, windows, ventilators, partitions etc shall be Forest Stewardship council (FSC) certified wood and it shall be seasoned and preservative treated.
- b. The moisture contents of the wood used in the work shall not be more than that stipulated in the relevant clause of Latest CPWD Specifications for works. The rate quoted for various items shall be inclusive of kiln seasoning and preservative treatment of wood. In all other respects the wood used in the work shall conform to the provision in latest CPWD specification for works.
- c. The sample of species to be used shall be deposited by the contractor with the Engineer-in – charge before commencement of the work. The contractor shall produce cash voucher and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them failing which it would not be so accepted as kiln seasoned.
- d. Glass :
  - i. Transparent sheet glass (Float glass) conforming to IS 1761 – 1970 shall be used.
  - ii. Minimum thickness shall be governed as under, unless otherwise specified in the item.

AREA of Glazing	Max. Unsupported length	Thickness
For glazing area up to 0.5 sqm	120 cm	4 mm
For glazing area more than 0.5 sqm	120 cm	5.5 mm

- iii. Glazing for toilet and in fixed ventilators shall be of frosted type.

e. Shutters:

- i. Factory made shutters, as specified shall be obtained from factories to be approved by the Engineer – in - charge and shall conform to IS 2202 (Part –I) 1977. The contractor shall inform well in advance to the Engineer – in – charge the name address of the factory from where the contractor intends to get the shutters manufactured.
- ii. The contractor will place order for manufacture of shutters only after written approval of Engineer – in – charge in this regard is obtained. The contractor is bound to abide by the

decision of the Engineer – in-charge. In case the factory already proposed by the contractor is not found competent to manufacture quality shutters, the Engineer – in – charge will recommend the name of another factory from the approved list.

- iii. The contractor will also arrange stage wise inspection of the shutters at factory with the Engineer in charge or his subordinate authorized representatives. Contractor will have no claim, if the shutters brought at site are rejected by the Engineer in charge in part or in full lot due to bad workmanship / quality or damages caused during their shifting from factory to site. Such shutters will not be measured and paid and the contractor shall remove the same from the site of work within 7 days after the written instruction in this regards are issued by the Engineer in charge or his authorized representatives.

## **8. STEEL GRILL WORK:**

- a. All steel grills shall be according to the Architect's detailed drawings and obtained from approved suppliers. These shall conform to Latest CPWD Specifications for works.
- b. In case of grills an approved quality priming coat of zinc chromate shall be applied over and above a shop coat of primer. Nothing extra shall be payable for providing shop coat primer, but the zinc chromate primer will be paid for separately.

## **9. ALUMINIUM WORKS**

- a. The scope of the work is the fabrication, supply and erection at site of all types of Aluminium glazed doors, windows and ventilators in accordance with the drawings and specifications.
- b. The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.
- c. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

### **d. Materials:-**

- i. The members will be made out of aluminum alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.
- ii. The Sections will be as per approved makes, extruded sections. As indicated in the drawings the tenderer should specifically mention which sections he is using.
- iii. The weight of sections and the corresponding catalogue numbers are mentioned. The IS specifications are to be strictly adhered.
- iv. The extruder using recycled materials may be preferred.
- v. The alloy of extruded aluminum should be BS or IS old HE9, Alcon 50 SWP. to this effect test certificate has to be provided for the extruder.

### **e. Finishing:**

- i. The extruded aluminum section has to be mechanically finished to remove all scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths prior to anodizing.

- ii. The polyester powder coating, if required as per item of work, shall be of desired shade with minimum average thickness to 50 microns or other shades as required and to this effect the tenderer shall have to produce test certificate from authorized institutions Bureau of Indian Standard.
- iii. The polyester powder coated material should be properly wrapped in gummed tape before fabrication to avoid scratches during fabricated and erection shall be kept protected till handing over.

**f. Fabrication:**

- i. Before commencing the fabrication the contractor shall submit to the Engineer – in - charge for their approval detailed shop drawings, based on the Architects drawings and corresponding specification showing junctions, fittings, accessories such as hinges flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing arrangements . Type and method of scaffolding he intends to use, Fabrication is to be taken up only after approval by the Engineer – in - charge and in accordance with the approved drawings. Sections for fabrication of door/ window/ventilators etc shall be as per architectural drawings or as approved by the the Engineer – in - charge.
  - ii. A sample of finished door / windows/ ventilator railing etc.shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication,
  - iii. The doors, window, ventilators and partitions shall as per thickness given in the BOQ item / specifications, Polyester Powder coating shall be as specified in the item specifications.
  - iv. All materials shall conform to relevant IS. Codes and in the absence of IS code, they should correspond to the best engineering practice; decision of the the Engineer – in - charge shall be final and binding on the contractor.
  - v. Fabrication shall be done true to the drawing/ sample approved and in correspondence to the finished openings at the site. All joints shall be mitered at the corners, true right angles, and joints to be finished neatly to hairlines, with concealed fasteners, wherever possible joints shall be made in concealed locations.
  - vi. All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.
  - vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.
  - viii. Wood work faces /parts coming in contact with masonry shall before shifting to the site be given a heavy coat of alkali resistance bitumen paint. Steel items coming in contact with other incompatible materials shall be given a thick coat of zinc chromate primer.
- g. **Glazing:** Glazing shall be done with flawless sheet glass of best approved quality without waviness, distortion, coloration / discoloration, of specified thickness in sizes as shown in the drawings, fixed as required with special glazing clips, putty, neoprene/PVC gaskets. All glass shall be cleaned thoroughly before they are fixed in position. Unless otherwise specified the minimum thickness shall be 5.5 mm thick.

**10. FIRE CHECK DOORS:-**

**a. General:-**

- i. The door shall be procured from approved manufacturer of CPWD / CBRI. The fire and smoke / hot gases check door shall be conforming to IS-3614 (Part-II)). The manufacturer

- shall have a prototype door tested and certified by CBRI Roorkee, of 120 min. fire rating confirming to BS : 476 part 22 & IS : 3614 Part II .
- ii. The fire and smoke / hot gases check door shall not collapse during the rated period of the fire under the specified fire conditions.
  - iii. The fire and smoke / hot gases check door shall not allow the passage of hot gases or the flames through the rebate of the gap between the door frame and shutter or through the holes, developed in the shutter during fire.
  - iv. **Material:** -Door frames and shutter shall be made from materials specified in the bill of quantities. In this work, wooden door frames and shutters are specified.
  - v. **Shop drawing:-** The contractor shall submit including required designing shop drawing for doorframes, shutters complete with
    - Plan, elevation with relative position of adjacent works
    - Glazing details with type size and fixing
    - Fitting and fixtures with type size, brand and fixing details.
    - Finishing details.
  - vi. **Sample Approval:-** A sample of fire check door including fittings and fixtures, shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication
- b. Door Frames:** - Door frame shall be manufactured from 2nd class teakwood (Ivory Coast) door frame of section as per BOQ. It shall have heat activated intumescent fire seal strip of section 10mm x 4mm 2 No. of approved make. The frame shall be coated with one coat anti-termite fire retardant primer of approved brand.
- c. Door Shutter:-**
- i. The Door shutter shall be of thickness 50 mm minimum but not more than 55mm or as per BOQ, suitable for mounting on the door frame. It shall comprise of two non-combustible boards 12mm to 18 mm thick sandwiching 20 mm to 25 mm fire resistant insulation filler veneered with 3mm thick commercial ply on both faces and pasting of minimum 1 mm thick laminate over wooden fire of approved brand a 100% without Asbestos, Bructile and merschaum, having density not more than 1150 kg/m<sup>3</sup> and thermal conductivity 0.14 W/m K with heat activated intumescent fire seal strip of size 20mm x 4mm of approved mounted in the grooves of teakwood lipping on all sides except bottom.
  - ii. The intumescent sealant shall be used to fill the gaps between board and internal wooden lipping.
  - iii. **Vision Panel:-** Vision Panel shall be rated vision panels with 6mm thick clear glass (2 hours fire rating) made from Spin turned Rings (380mm dia circular vision panel) or press formed (300mm Square vision panel). Glass shall be fixed with glazing gasket of self-sticking ceramic glass fibre having a classification temperature of 1260°C.
  - iv. **Finish:** - The door frame and door shutter shall be finished with thermo setting acrylic paint for scratch resistance and durability. The paint shall be of approved brand and quality.
  - v. **Ironmongry Hinges:** - Stainless steel ball bearing butt hinges, 3mm thick shall be fixed flushed to the frame and shutter.
- d. Lock:** - Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.
- e. Flush Bolts (For Double Door):-** 300mm concealed extended lever action flush bolts satin finish, fixed to top and bottom of the inactive blade shall be provided.



- f. **Automatic Door Closer:** - Dual adjustable speed automatic door closer with rack and pinion method shall be provided.
- g. **Smoke Seals:** - Heavy duty smoke seals for smoke check doors shall be provided.
- h. **Acoustic Seals:** - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.
- i. **Opening Width:** - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.
- j. **Measurement:** - Frames and shutters shall be measured in square meter out to out.
- k. **Testing:** - The Engineer – in - charge holds the right to get the door tested for fire rating at the cost of the contractor/vendor. In case the Engineer-in-charge desires to get the doors tested, then one door shall be selected at random out of the entire lot and shall be tested for two hour fire rating. The testing shall be got done from either CBRI, Roorkee or from any other laboratory approved by the Engineer-in-charge. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet the requirement, the entire lot shall be rejected.
- l. **Rates:** - The rates shall be inclusive of all material, T&P, Labour, etc. complete including the cost of fittings, testing etc. as described above.

## 11. GLASS ENTRANCES AND GLAZING WITH PATCH FITTING:

- a. GENERAL:
  - i. The contractor shall be responsible for design, fabrication, supply, installation, test and guarantee of all items including taking all measures that may be required to complete the work as per Architectural concept drawings and specifications details.
  - ii. The specialist agency engaged to carry out the external glazing installation and supply shall have at least 5 years of relevant experience and have completed external glazing systems of similar nature and equivalent scale of works as shown in the tender documents.
  - iii. The specialist contractor shall submit an outline of recent comparable works (illustrated by appropriate drawings, sketches, photographs, brochures) by the firm / its technical partner to illustrate the competence, experience and suitability of the firm.
- b. The scope of work shall include:
  - i. Design, preparation of shop drawings, calculations, engineering data and test reports.
  - ii. Fabrication and installation of Glass Entrances and Glazing with Patch Fittings system.
  - iii. All anchors, fixings, attachments, reinforcements, steel reinforcing for mullions and transoms required for a complete installation, except those specifically indicated as being provided by other trades.
  - iv. Exposed Architectural mullions and other support members.
  - v. Finishes, protection coatings and treatments.
  - vi. Sealing with approved sealants within and around the perimeter.
  - vii. All thermal insulation, firesafing etc. including supports and/or backing.
  - viii. All caulking, sealing, electrometric and metal flashing, and gaskets including sealing at junctions with roof, ground-floor waterproofing and building expansion joints between structures.
  - ix. Electrical bonding and earthing of all metal cladding elements.
  - x. Provisions to receive electrical outlets and cutouts for conduits and other electrical work.
  - xi. Glass and glazing.
  - xii. Transportation, storage, handling, protection and cleaning.

c. SUBMITTALS:

- i. Product Data: Include construction details, material descriptions, dimensions of individual components, profiles and finishes.
- ii. Shop Drawings

d. Fabrication and installation details, including followings

- i. Plans, elevations and sections.
- ii. Details of fittings and glazing.
- iii. Hardware quantities, locations and installation requirements.
- iv. Sample for verification, for each type of exposed finish required for
- v. Metal finish: 150mm long section of patch fittings, rails and other items.
- vi. Glass: 150mm square, showing exposed edge finish.

e. MATERIALS

i. Glass

- Glass shall be as specified in drawing or BOQ or as per design requirement. It shall be Indian / imported hard coated reflective bronze and heat strengthened glass. It shall be of approved make.
- In toughening of Glass, rolling direction shall be parallel to the width of the glass panel such that waviness if any is parallel to the horizontal and no waviness parallel to the vertical and to ensure that such waviness is of negligible order.

ii. Components

- Patch fittings: Stainless steel clad aluminium
- Floating Transom Bar: Steel clad in metal matching fittings and in sizes recommended by manufacturer for application indicated. Include stainless steel support rods, lateral adjustment and ceiling channel. Support fins to be metal, finished to match transom bar.
- Rails: Stainless steel clad aluminium.
- Accessory Fittings : Matching with patch fittings and rails metal and finish for overhead door stop, Centre hosing lock, glass support fin brackets and other as shown in drawing.
- Anchors and fastenings: Concealed
- Weather stripping: Sweep type

iii. Hardware

- Hardware should be heavy duty in matching finish
- Concealed Floor Closer and Top Pivots
- Centre hung; BHMA A156.4, Grade 1; including cases, bottom arm, top walking beam pivots, plates, and accessories required for complete installation.
- Swing : Double acting; Positive dead stop, concealed with hold open angle
- Delayed action closing

- Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.
- Push-pull set : Stainless steel finish
- Lock set of approved make.

f. FABRICATION

- i. Provide holes and cutouts in glass to receive hardware, fittings, rails and accessories before tempering glass. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll wave distortion is parallel with bottom edge of door or tile.
- ii. Factory assembled components and factory installed hardware to greatest extent possible.

g. EXECUTION

- i. Examine areas and condition for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- ii. Install all glass system and associated components according to manufacturer's written instructions.
- iii. Set units in level and plumb.
- iv. Maintain uniform clearances between adjacent components.
- v. Lubricate hardware and other moving parts according to manufacturer's written instructions.
- vi. Set, seal and grout floor closer cases as required suiting hardware and substrate indicated.

h. CLEANING

- i. The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes.
- ii. The Contractor shall clean both internal and external surfaces to remove corrosive substances, dust or cement / mortar dropping during the installation as may be directed and instructed by the Engineer – in - charge.
- iii. The internal surfaces of glass and aluminum frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting.
- iv. The Contractor shall provide written verification that cleaning agents are compatible with aluminum, stainless steel, glass coatings, granite, glazing materials and sealants. In no case shall alkaline or abrasive agent be used to clean the surface. Care shall be taken during cleaning to avoid scratching of the surface by grit particles.
- v. Prior to snagging inspections the Contractor shall, remove the internal protection sheets and carry out a thorough cleaning of all glass and aluminum.
- vi. The Contractor shall also make good any physical damage to the structure including scratches, dents, abrasions, pitting, etc. to the satisfaction of the Engineer – in - charge.
- vii. Manufacturer's delivery or job markings on glass and adhesive for manufacturer's labels shall be either a neutral or slightly acidic material. In no case shall such material be alkaline; any staining of glass by alkaline material will be cause for rejection of the glass.

- viii. After the installation of each pane of glass all markings and labels shall be carefully and completely removed from the panes. Thereafter no markings or labels of any sort shall be placed on the glass.
- ix. Glazed openings shall be identified by suitable warning tapes or flags attached with a non-staining adhesive or other suitable means to the framing of the opening. Tapes or flags shall not be in contact with glass.
- x. As soon as it is practically possible after the issuance of the occupation Permit for the Building, the Contractor is to carry out a complete cleaning of the external face.
- i. PERFORMANCE GUARANTEE: The contractor shall offer a minimum of 10 year Performance Warranty for the entire installation carried out.
- j. MEASUREMENTS: - Measurements shall be in Sq m of actual area covered.
- k. RATE: - Rate shall include all required labour, material, designing, drawing conveyance, testing at approved laboratory breakage, wastage, supervision, protection till hand over and free maintenance during defect liability period etc. complete.

## 12. FLOORING:

- a. The flooring in the building shall be as per the approved floor finish drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.
- b. Wherever Vitrified Tile flooring is done, it shall be with multy grade/range 1<sup>st</sup> Quality tiles.
- c. Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.
- d. Rate for the items of flooring is inclusive of provision of sunken flooring and finishing edges of the same in bath kitchen, toilets, cutting holes for traps/ pipes etc., and nothing extra shall be paid on this account unless otherwise specified.

## 13. LAMINATED FLOORING

### a. SCOPE

The scope of the work includes suppling and fixing Laminated Flooring with 4.3mm thick x 30m x 2.00m wide carpet sheeting including butting the factory edges for seaming.

### b. SUBMITTALS

- i. Product Data: Manufacturer's data sheets on each product to be used, including:
  - Preparation instructions and recommendations.
  - Storage and handling requirements and recommendations.
  - Installation methods.
- ii. Shop Drawings: Installation details including location and layout of each type of flooring and accessory. Include layout data for each location with consideration for expansion control.
- iii. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- iv. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, which represent actual product, color, and patterns.

- v. **Manufacturer's Certificates:** Certify products meet or exceed specified requirements.
- vi. **Closeout Submittals:** Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance.
- c. **QUALITY ASSURANCE**
  - i. **Manufacturer Qualifications:** Company specializing in manufacturing products specified in this section with minimum ten years documented experience.
  - ii. **Installer Qualifications:** Installer experienced in installation or application of systems similar in complexity to those required for this project, including specific requirements indicated.
  - iii. **Mock-Up:**
    - Provide a mock-up for evaluation of surface preparation techniques, application workmanship and requirements for expansion control.
    - Finish 10 feet by 10 feet (3 mm by 3 mm) area, including typical field and edge conditions.
    - Locate in area designated by Architect.
    - Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
    - Refinish mock-up area as required to produce acceptable work.
    - Maintain mock-up as a standard of quality for the work of this Section.
- d. **DELIVERY, STORAGE, AND HANDLING**
  - Store products in manufacturer's unopened packaging until ready for installation.
  - Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
  - Store materials in a flat in a dry, warm, ventilated and weather tight location.
  - Protect flooring products from damage.
- e. **SEQUENCING**
  - Ensure that floor layouts and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
  - Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.
- f. **EXAMINATION**
  - Do not begin installation until substrates have been properly prepared.
  - Verify that surfaces to receive laminate flooring are smooth, flat and sound.
  - Verify wood subfloor is properly secured, smooth and flat. Moisture readings of wood subfloors must not exceed 14 percent throughout the entire installation. The use of a Tramex moisture meter or other acceptable method is recommended for verifying moisture readings.
  - Verify required floor mounted utilities are in proper location.

- Verify laminate flooring has been acclimated to ambient temperatures, and acclimation and ambient temperatures are in accordance with manufacturer's instructions.
- If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

**g. PREPARATION**

- i. Clean surfaces thoroughly prior to installation.
- ii. Concrete slabs: Grind high spots and fill low spots to provide a maximum 3/16 inch (5 mm) deviation in any direction when checked with a 10 foot (3 m) straight edge.
- iii. Wood Subfloors: Fill voids to provide a maximum 3/16 inch (5 mm) deviation in any direction when checked with a 10 foot (3 m) straight edge.
- iv. Vinyl Substrate: Verify vinyl is tightly fastened to subfloor. Vinyl shall be smooth, flat and clean. Fill voids to provide a maximum 1/8 inch (3 mm) deviation in any direction when checked with a 10 foot (3 m) straight edge.
- v. Remove wood floors on concrete subfloor prior to installation.
- vi. Remove carpeting on subfloor prior to installation.
- vii. If a leveling compound is used to level subfloor, material must be fully cured and dry as specified for the applicable substrate prior to starting installation. The use of a TrameX moisture meter or other acceptable method is recommended for verifying moisture readings.
- viii. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- ix. Allow unopened cartons of planks to remain in the room where they are to be installed at least 48 hours (96 hours in drier or very humid climates) prior to installation.

**h. LAMINATE INSTALLATION**

- i. Install in accordance with manufacturer's instructions.
- ii. Install flooring planks parallel to the long direction of the room. Verify strip flooring direction with Architect before starting installation.
- iii. Install flooring symmetrically about room center line unless otherwise indicated. Lay planks from left to right.
- iv. Stagger end joint locations a minimum of 12 inches (250-300 mm).
- v. Fit flooring neatly to vertical interruptions. Follow shape of interrupting item when joint will remain exposed and maintain 1/4 inch (6 mm) expansion space.
- vi. Install divider strips where flooring terminates at centerline of doors and adjacent to other materials or unfinished floor areas.
- viii. Expansion Space: Provide expansion space at walls and other vertical interruptions and terminations of flooring of not less than 1/4 inch (6 mm), unless otherwise indicated on Drawings. In larger areas a 1/2 inch (12 mm) expansion space is required.
- ix. Door Frames:
  - Undercut wood door frames and allow for 1/4 inch minimum (6 mm) expansion clearance.
  - Do not undercut metal door frames, cut floor panels to fit around frames. Provide 1/4 inch (6 mm) expansion space and fill with color-matched perimeter sealant.

- x. Provide transitions at interior metal door applications.
- xi. Pipe Holes, Fixture Bolts, Fixture Anchors, Pillars, Fixed Objects:
  - Drill a hole in the flooring 1/2 inch (13 mm) larger than the pipe/anchor diameter to allow for movement.
  - For pipes/anchors located on the long side of a plank or very close to the edge of the plank, saw in toward the hole at 45 degree angle.
- xii. Molding and Trim:
  - Install moldings and trim in accordance with manufacturer's instructions.
  - Adhere molding with construction mastic and/or mechanical when joining another flooring material.
  - Adhere transition and end cap to subfloor with construction mastic and/or mechanical fasteners.
- xiii. Expansion Molding: Bond trims to subfloor. Connect lengths of Expansion together. Do not install over padding.

**i. PROTECTION**

- i. Protect installed products until completion of project.
- ii. For glued installations prohibit traffic on floor finish for 24 hours after installation.
- iii. Touch-up, repair or replace damaged products before Substantial Completion.

**j. MODE OF MEASUREMENT**

The work shall be measured and paid for in square meters.

**14. Carpet flooring / skirting**

**a. SCOPE**

The scope of the work includes supplying and fixing 4.3mm thick x 30m x 2.00m wide carpet sheeting including butting the factory edges for seaming.

Acrylic adhesive shall be provided on the exposed substrate with a trowel having triangular notches 1.78mm x 1.78mm x 1.6mm at 3.0mm centres at the rate of between 5.5 to 6.5m<sup>2</sup> per litre depending on sub-floor porosity, on a previously prepared sub-floor. The sheeting shall be butt jointed at edges for seamless finish.

**b. GENERAL**

The material shall be placed as per jobsite conditions for a minimum of 48 hrs. prior to installation.

**c. PRELAYING**

Prior to cutting, the material shall be organized by roll number to ensure that all rolls and cuts will be installed in consecutive order. It shall be ensured that all rolls are from the same batch. The sheets shall not be reversed for seaming. Installation shall be with arrows all pointing in the same direction. Wherever possible, the arrows shall be made to run toward the main light source. Sheets shall be installed running lengthwise. The flooring shall be fixed with adhesive having low solvent, solvent free and very low emission properties.

**d. INSTALLATION**

Approved Carpet sheeting should be installed in accordance with manufacturer's recommendations and as approved by the Engineer-in-charge. Sub-floors shall be smooth, hard, clean and dry before laying commences. Uneven solid or suspended timber sub-floors may need preparation to meet the required standard. The carpet shall be stored with sheet standing on end and shall acclimate material for 24 hours in a uniform room temperature between 18°C and 27°C prior to installation. All sub-floors shall be tested for moisture content prior to installation. The adhesive to be used shall be in accordance with the manufacturer's guide. DO NOT REVERSE sheets for seaming. Install with arrows all pointing in the same direction. Whenever possible, run the arrows toward the main light source. The sheet should be installed length wise in corridors.

Note:

- (1) Do not use a stretcher or knee kicker. Trim the excess material at doorways and walls using a carpet knife or edge trimmer with a hooked blade, and use a spatula to press the carpet firmly into the adhesive after trimming.
- (2) The finishing accessories such as skirting, profile and stair nosings shall be part of flooring system only.
- (3) Mixing of sheeting and tiles in the same area is not recommended.

**e. MAINTENANCE**

Directly after installation, the floor shall be vacuum cleaned using a vacuum cleaner with a power brush. Stains or spills shall be removed using clean warm water. Always work from the outside inwards. Remove excess water. Allow the floor to dry. Occasional maintenance may require that you first soak stains by spraying a solution of mild detergent. Scrub with plenty of warm water, using a machine for carpet wet cleaning with brush action. Allow the floor to dry. There shall be a 5 year limited warranty against defective material provided that it is installed and maintained in accordance with manufacturer's recommendations.

**f. MODE OF MEASUREMENT**

The carpet system shall also include finishing accessories such as skirting, profile and stair nosings (where specified) and the entire work shall be payable in square meters.

**15. FALSE CEILING:**

- a. False ceiling items in general are carried out as per the description of the item in the Bill of quantities and also as per the manufacturer's specifications / as directed by the Engineer – in – Charge.
- b. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.
- c. The false ceiling tiles from manufacturers using recycled materials shall be preferred.



**16. UNDER DECK INSULATION:**

- a. **Material:-**The under deck insulation shall be with Glass Wool Insulation Board. The Glass Wool Board shall conform to following specifications.

<b>GLASS INSULATION WOOL BOARD (GREEN BUILDING)</b>			
	<b>Test Parameters</b>	<b>Standard Value</b>	<b>Tolerance</b>
<b>1</b>	<b>Physical Test</b>		
a	Visual Appearance		
b	Shots Content	Free from Shot Content (Tested as per IS : 8183)	
c	Dimensions		
	i. Length	1200 mm	<b>+20 mm/ -10 mm</b>
	ii. Width	600 mm	<b>+10 mm/ -10 mm</b>
	iii. Thickness	100mm	<b>+5 mm/ -5 mm</b>
d	Bulk Density	48 Kg/M <sup>3</sup>	±15%
e	Hydrophobic / Non Hyderophobic Behavior (Tested as per Is – 8183 / 3144)		
	i. Moisture Content	2.0% Max	
	ii. Moisture Absorption	2.0% Max	
f	Incombustibility	Incombustible When Tested As Per Is 818 / 3144	
g	Recovery after Compression	90% Min. (Tested As Per Is -8183)	
<b>2</b>	<b>For Long Life Functionality / Dimension Retention / Rigidity</b>		
a	Loss on Ignition (Binder Content)	Av. 7% Minimum when evaporated at 550 ± 50 till yellow & black colourless fiber achieved	
b	Jolting Test	Height settlement not more than 3.0% in test as per IS: 8183/3144	
c	Vibration Test	Height settlement not more than 1.0% in test as per IS: 8183/3144	
d	Recycled Content	25% External Cullet 10% Internal Cullet 7% Trimmed Waste	
<b>3</b>	<b>Chemical Test :- Resistance To Corrosion Attack</b>		
a	Chloride Content %	0.01% max. (tested as per IS: 8183)	
b	Alkalinity	Ph- 7.0 – 10.0 (tested as per IS: 8183)	
c	Odour Emission Test	No apparent difference in odour(tested as per IS: 8183- 1993)	
<b>4</b>	<b>Type Test</b>		
a	Thermal Conductivity	0.3 w/m k (At 25 dg. C mean temp.)	

**b. Installation Guidelines:-**

- The insulation board to be fixed to hold against the RCC true ceiling.
- For fixing drill RCC slab through the insulation at 1200 mm x 600 mm centres.
- Apply the Hilti make IDP- 6/8 polyamide fasteners (110 mm in length) or equivalent with the help of hammer to the drilled points.
- All the edges of the boards placed side by side to be sealed with 50 mm wide self adhesive white HDP tape.
- The above insulation system can be concealed under false ceiling system if required

**17. ALUMINIUM COMPOSITE PANELS (ACP) CLADDING (if required):**

- a. Scope of Work includes providing and fixing Aluminium Composite panel cladding including framing as per the elevation, section and the plan drawings provided, fabricated out of heavy duty Aluminium extruded profiles conforming to alloy 643900 WP with chemical composition and mechanical properties as per IS-733 and as per specifications. The scope of work shall be read in conjunction with the specification of curtain walling / structural Glazing System.
- b. The contractor shall design, supply, fabricate, deliver and install and guarantee all construction necessary to provide a complete aluminium composite panel cladding, complete with all necessary anchors, hardware and fittings to provide a total installation, fully in conformity with the requirements and intent of the drawing and specification as per item description.
- c. The contractor shall design the cladding as per the prevalent site conditions and building elevations profiles. The design parameters shall be in conformity the structural glazing system. No extra claims shall be entertained at any stage for aluminum profile/ wall thickness and size dimensions. The Contractor shall quote rates accordingly.
- d. The anchoring / bracing of the wall cladding to the RCC beams/ columns shall be done with non-corrosive galvanized brackets of approved design, (Galvanizing to be done conforming to IS 4759-1996 up to 610 gms. Per Sq. M. (80- 90 micron thickness).
- e. The framework shall be aligned for the entire height of each Mullion and of the entire width of each Transom by laser beam equipment to ensure 100 percent 'X' axis and 'Y' axis alignment.
- f. The system should also provide for pressure equalization. The details for pressure equalization to be submitted by the contractor and got approved by the Engineer-in-charge.
- g. EPDM Gaskets of suitable profiles (to accommodate shall be provided including the labour element for fixing in appropriate locations is to be included in the rate).
- h. The Periphery of the framework shall be sealed both from inside and outside with silicon weather sealant to make the cladding watertight.
- i. Cost of Aluminium composite panel consisting of a core of polyethylene sandwiched between two aluminium skins of 0.5mm thickness with a mild edge. 4 mm total thickness with surface finish of PVDF coating as approved by the Engineer-in-charge, as shown in the elevation, plan and cross section drawings along with labour element for cutting stacking, carrying to heights and fixing to appropriate locations is included in the rates.
- j. All the vertical and horizontal section grooves are to be sealed non staining silicon sealant of make as specified in the list of approved make to make the entire system synchronous with the basic structural glazing/curtain wall structure and also make the system air tight and watertight. The fixing details should be got approved by the Engineer-in-charge. The peel off foil should be removed at the time of handing over as may be required by the Engineer-in-charge.
- k. Any joint provided between cladding elements to cater for individual panel installation and shall be sealed off with extruded EPDM gasket or silicon sealant.

**l. Product**

- i. ACP shall be as approved with high fibre filled sandwiched panel 4mm install on Aluminium framing and Galvanised brackets. Aluminium cladding panel to be PVDF

fluorocarbon coated factory applied colours. Reverse side to be in mill finish. All the joints shall be sealed with silicon sealant of approved make. The colour of sealant to be decided by Engineer-in-Charge.

- ii. A sample of panels and installation methods to be submitted to the Engineer-in-Charge for approval.

**m. Manufacture**

The panels shall be visually flat. Any stiffener applied to compensate for wind load shall not read through.

**n. Installation**

The panels shall be fixed in accordance with manufacture's recommendations.

**o. Technical Properties of Aluminium Composite Panels**

A	Composition	4.0 mm thick aluminium composite panel comprising of high mineral filled core sandwiched between two skins of aluminium alloy, Skin material 0.5mm thick aluminium sheet (3005 H6) core material natural polyethylene.
B	Dimensions	Panel thickness : 4mm
C	Tolerance	Width $\pm$ 2.0mm Length $\pm$ 4.0mm Thickness + 0.02mm
D	Principal Properties	Panel weight: 5.5 kg/sq.m Thermal expansion: 1mm/M/60 deg.C. Moment of Inertia: 0.347 cm <sup>4</sup> /m
E	Acoustic Properties	Average airborne sound transmission loss R/N 25db (DIN 4109)
F	Mechanical Properties	Tensile strength $\geq$ 130 N / mm <sup>2</sup> 0.2 % proof stress 90 N / mm <sup>2</sup> Elongation 5 % Modules of elasticity 70,000 N/mm <sup>2</sup>
G	Thermal Transmittance	R = 0.014 m <sup>2</sup> °C/W
	Finish	PVDF stove lacquered (Fluoro carbon) on one side and reverse side in mill finish.
	Colour	Colour to be selected by Engineer-in-Charge using standard PVDF colour chart from manufacturer.
	Panel size: Width	1000/1250/1500mm
	Length between	1500 and 5000mm
	Aluminium Extrusions	Extrusions shall be of aluminium alloy 6063 T5, conforming to BS-1470 – 1475: 1972 in mill finish.

- p. **Protection:** The finished surface shall be protected with 80 microns self adhesive Peel Off film with two layers of white and black tested to withstand at least 6 months exposure to local weather condition, without losing the original peel off characteristic or causing stains or other damages. Protection should not be removed until after installation.
- q. **Warranties;** The Contractor shall provide a data to confirm compliance with specific requirements for resistance and fire properties. The guarantee should be for a 20 salt spray resistance and fire properties. The guarantee should be for a 20 year period against peeling chalking (No. 8 rating), fading, blistering, flaking, chipping and cracking.

- r. **Measurement:** The measurement shall be for exposed actual surface area with grooves cladded on plain/ curved surface excluding the concealed trims.
- s. **Technical Data:** - The technical data provided hereunder is for guidelines. The data, specific for the site location, shall be got approved by the contractor from the Client/ Engineer-in-Charge for the design of the ACP and structural Glazing System.

i. **Design Wind Loading**

- 850 N/m<sup>2</sup> positive and negative to Podium.
- 1150 N/m<sup>2</sup> positive and negative to Tower.
- 1500 N/m<sup>2</sup> positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

ii. **Deflection**

Deflection of any aluminium frame shall not exceed 1/175 of the clear span.

iii. **Expansion and Contraction**

The cladding shall be so fabricated and erected as to provide for all expansion and contraction of the components. Any temperature change due to climatic conditions shall not cause harmful buckling, opening of joints, undue stress on fastening and anchors, noise of any kind or other defects.

iv. **Flatness**

The cladding surface taken individually shall not have any irregularities such as oil canning, waves, buckles and other imperfections when viewed at any position but not less than at an angle of 15 degrees to the true plane of the panel with natural lighting of incident of not less than the same angle.

v. **Water Tightness**

The panel cladding shall be so constructed to be water tight with provision for rear ventilation.

vi. **Acoustic Treatment**

The cladding panel system shall be designed so as to dampen noise caused by splashing water.

- **Fixings**

- Fasteners including concealed screws, nuts, bolts and other items required for connecting aluminium to aluminium shall be of non-magnetic stainless steel.
- Rivets used for fastening panel to aluminium sub-frame shall be of alloy aluminium large flange head type with stainless steel mandrel.
- All fixing anchors, brackets and similar attachments used in the erection shall be of aluminium or non-magnetic stainless steel.

- **Weather seal**

- All exposed joints between panels which are required to be water tight, shall be sealed with extruded EPDM gasket of hardness approx. 75 SHORE.
- All secondary weather seal shall be of self-adhesive tape as approved by the Engineer-in-charge.

**18. STRUCTURAL GLAZING SYSTEM (if required):****a. SCOPE OF WORK**

- i. The contractor shall design, engineer, test, fabricate, deliver, install, and guarantee all construction necessary to provide a complete structural glazing system to the proposed building, all in conformity with the Drawings as shown. Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the Drawings and/or without limiting the generalities of the foregoing, the structural glazing Systems shall include, without being limited to, the followings:
  - Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings metal closure, windows etc.
  - All anchors, attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
  - All thermal insulation associated with the system. All fire protection associated with the system.
  - All copings, end closure and metal cladding to complete the system.
  - All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.
  - Isolation of dissimilar metals and moving parts.
  - Anticorrosive treatment on all metals used in the system. Polyester powder coating aluminium sections.
- ii. The contractor shall also be responsible for providing the followings:
  - Engineering Proposals, Shop Drawings, Engineering data and Structural Calculations in connection with the design of the structural glazing System.
  - Scheduling and Monitoring of the Work.
  - Mock-ups, samples and test units.
  - Performance testing of the structural glazing framing and glazing assembly.
  - Co-ordination with work of other trades.
  - Protection.
  - All final exterior and interior cleaning and finishing of the structural glazing System
  - As-built record drawings and photographs.
  - Guarantees and Warranties.
  - All hoisting, staging and temporary services.
  - Conceptualising and design of a suitable maintenance system for structural glazing.
- iii. The water tightness and structural stability of the whole structural glazing System are the prime responsibility of the Contractor. Any defect or leakage found within the Guarantee Period shall be sealed and made good all at the expense of the Contractor.
- iv. The structural glazing system shall be designed to provide for expansion and

contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects. Specific details should be designed to accommodate thermal and building movements.

**b. BUILDING REGULATIONS**

Structural glazing shall comply with all Government Codes and Regulations including IS codes, if any.

All structural glazing; individual aluminium and glass components and all completed work shall be designed and erected to comply with the following:

- i. Design load and deflection.
- ii. Structural glazing construction in its entirety shall be fabricated and erected to withstand without damage or permanent deformation inward (positive) and outwards (negative) pressure, all acting normal to the construction plane with a maximum deflection of not exceeding 1/175 of the clear span between structural support or 20mm maximum whichever is less.
- iii. Structural performance of all parts of structural glazing system shall conform to relevant IS codes, wind load as per IS-875 and seismic loads as per IS-1893. Deflection shall cause no permanent set in excess of 1/1000 of span nor evidence of structure failure.
- iv. **Design Wind Loading**
  - 850 N/m<sup>2</sup> positive and negative to Podium.
  - 1150 N/m<sup>2</sup> positive and negative to Tower.
  - 1500 N/m<sup>2</sup> positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

**c. MEASUREMENTS**

Measurements of the structural glazing shall be in the metric system in sq.m correct to two places of decimal. The area considered for measurement shall be net area as fixed on the exterior face of the structural glazing including open able windows as part of structural glazing. The contractor shall be responsible for verifying all the dimensions and actual conditions on site.

**d. RATE**

The rates shall include the cost of all the operations described above including the cost of all materials, labour, design, fabrication, erection, finishing, scaffolding and testing of water tightness etc.

**e. TENDER DRAWINGS AND SPECIFICATIONS**

The tender drawings indicate profile and configuration required together with relationship to structural frame and interior building elements.

The Specification and tender drawings is of the performance type and includes only the minimum requirements of the /structural glazing Wall System without limiting the Contractor to the method of achieving desired performance.

**f. POST TENDER REQUIREMENTS**

- i. Design Proposals

The contractor shall propose the final design in such a way that all basic functional and architectural requirements are fulfilled and get the same approved by Deptt. However, basic design requirements as described in the specification and other Architectural requirements such as the size of window, net glass area, ventilator, configuration of windows and spandrels shall be retained.

The design proposals shall be in the form of drawings, drawn to full scale as far as practical and specification shown in or describing all items of work including:

- Request details as indicated on the tender drawings.
- Metal quality, finishes and thickness.
- Glass quality, coating and thickness and proposed manufacturer's brand names.
- Sections of the mullion and transom together with structural calculations.
- Arrangement and jointing of components.
- Field connections especially mullion to mullion and transom to mullion.
- Fixing and anchorage system of typical wall unit together with structural calculations.
- Drainage system and provision in respect of water leakage in the curtain wall/structural glazing system.
- Provisions for thermal movements.
- Sealant and sealing method.
- Glazing method.
- Wind load and seismic load and any other specific load considered in the design.
- Lightning protection link-up system of the curtain wall/structural glazing for connection and incorporation into the lightning conductor system of the building. Design concept shall be stated in the proposal.

The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case this tolerance exceed those specified in the Specification.

Any parts of the curtain wall/structural glazing, when completed, shall be within the following tolerances:

Deviation from plumb, level or dimensioned angle shall not exceed 3mm per 3.5m of length of any member, or 6mm in any total run in any line.

Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle, shall not exceed 9mm total at any location.

Change in deviation shall not exceed 3mm for any 3.5m run in any direction.

#### ii. Samples

The contractor shall also submit samples of mullion and transom sections in lengths of 300mm with the same finish and workmanship along with the proposals and 300mmx300mm samples of glass (samples to include exposed screws and other exposed securing devices, if any).

#### iii. Preliminary Programme

The tenderer shall also submit a preliminary programme of the contract works showing the various stages of design sampling, testing, fabrication, delivery and installation of

the works.

- iv. Upon approval of the shop drawings, at least 4 copies shall be submitted by the Contractor.
- v. The Contractor/Sub-contractor shall submit a maintenance manual for the curtain wall/structural glazing system inclusive of all metal parts, glass and finish etc.
- vi. During detailed design and execution any details may increase as per actual requirement at site, these variations shall be executed without any extra cost implications to the client.

**g. Execution Performance Testing**

The performance tests are to be conducted on the structural glazing system, if the area of the structural glazing system exceeds 2500 Sq.ms from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories), Department of Science and Technology, India. The decision of the Client/ Engineer-in-charge about the necessity of testing of shall be final and binding.

**i. General Requirements**

Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the façade.

After approval of structural calculations and shop drawings for the structural glazing, one (1) Test Unit for performance testing of the structural glazing shall be constructed by the contractor at a laboratory approved by the Department (Refer BOQ).

Erect mock-up under manufacturer's/installer's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

Test procedures test schedules and test locations shall be submitted to Client for approval before testing.

Prior to fabrication of Test Units, the contractor shall submit shop drawings and calculations of the Test Unit for the Architect's approval.

Production for final job site erection shall not start until approval has been obtained as a result of the mock-up test.

**ii. Test of Wind Pressure**

The equivalent load of wind pressure or wind suction shall be given to the Test Unit as increasing or decreasing the inside pressure in the 'Pressure Chamber' at which the Test Unit is fixed.

The static wind pressure shall be applied up to 1.5 Kpa at maximum wind pressure. The variation of dynamic pressure shall be of any approximate sine-curve-line.

Deflection on each observational points of the Test Unit shall be observed and recorded under the Static pressure as described above.

Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

The deflection on the main structural parts in these conditions shall not exceed:

- 1/175 of the span between supports or 20mm, whichever is the lesser for vertical elements.



- 1/250 of the span between supports for horizontal elements.

The extent of recovery of deformation 15 minutes after the removal of the test load is to be least 95%.

iii. Test of Lateral Deflection Per Floor Height

Lateral deflection per floor height shall be occurred on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

The deflection of every + 2.5mm shall be increased upto + 13mm on the Test Unit (Static Deflection Test).

The dynamic deflection shall be applied upto + 13mm.

The variation of dynamic deflection shall be of an approximate sine-curve-line, one period of 3 seconds.

The dimension of the deflection on each observational points of the Test Unit shall be measured under the condition as described above, the damage shall be observed.

Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall/structural glazing except sealant at maximum deflection.

iv. Test of Water-tightness

Water shall be sprinkled to the Test Unit under the wind pressure. Pressure shall not be applied to the Test Unit.

The volume of the sprinkling water in one minute shall be 5 litres/m<sup>2</sup> min. (0.1 gal/sq.ft.).

All water leakage and drainage system at the joint and openable sash of the curtain wall/structural glazing system shall be observed from the outside of the chamber.

Hold the test 2 times, in sequence as described below, conforming to the above mentioned conditions.

Install the test unit.

Hold 1st water-tightness test.

Hold test of wind pressure as described above. Hold 2nd water-tightness test.

Lateral deflection test.

Water leakage at all parts of the Test Unit shall not be observed inside during the 1st water- tightness test.

v. Test Report

The Contractor is required to submit five (5) copies of test reports to the Client.

vi. Cost of Performance Test

The Contractor shall allow in his tender for the cost of the performance testing and of fabrication, erection, corrections to and demolition of the Test Units including any special provision required in the testing laboratory for the tests mentioned above.

The Contractor shall allow for amendments and adjustments to the mock-up as required by the Employer.

If the Test Unit fails to pass the initial testing, the Contractor shall make the necessary corrections to the Test Unit and shall have to get the Test Unit retested by the Testing Laboratory till it passes the tests.

Cost of corrections to the Test Unit and cost of re-testing shall be borne by the Contractor at no additional cost to the Employer.

vii. Shop Drawings and Calculations for the Performance Testing

Prior to fabrication of Test Unit, the Contractor shall submit shop drawings and calculations of the Test Unit for Client/employer's approval.

viii. Record Drawings

The testing laboratory shall keep copy of approved Test Unit shop drawings and calculations at testing laboratory during testing of Test Unit.

The testing laboratory shall accurately and neatly record on the above mentioned shop drawings all changes, revisions, modification etc. made to Test Unit, which shall become the record drawings.

At completion of testing and after approval of test reports the testing laboratory shall submit the marked-up record drawings to the Client.

ix. Contractor's Representatives

Full time attendance by Approved Representatives of the Contractor & subcontractor associated with the erection of curtain wall/structural glazing shall be provided for the erection of the Test Unit and for all testing of the Test Unit.

**h. PERFORMANCE GUARANTEE**

The tenderer shall provide a performance guarantee of requisite value to be indicated in the General Conditions of Contract for a period of five years, to provide for expenses, to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period to start from the date of completion of the project.

**19. GLASS ENTRANCES AND GLAZING WITH SPIDER FITTING:**

**a. SCOPE OF WORK:**

- i. The contractor shall be responsible for design, fabrication, supply, installation, test and guarantee of all items including taking all measures that may be required to complete the work as per Architectural concept drawings and specifications details.
- ii. The specialist agency engaged to carry out the external glazing installation and supply shall have at least 5 years of relevant experience and have completed external glazing systems of similar nature and equivalent scale of works as shown in the tender documents.
- iii. The specialist contractor shall submit an outline of recent comparable works (illustrated by appropriate drawings, sketches, photographs, brochures) by the firm / its technical partner to illustrate the competence, experience and suitability of the firm.

**b. GENERAL:**

Following shall be the work to be provided by the contractor

- i. Design, preparation of shop drawings, calculations, engineering data and test reports.

- ii. Fabrication and installation of Glass Entrances and Glazing with Spider Fittings system.
- iii. All anchors, fixings, attachments, reinforcements, steel reinforcing for mullions and transoms required for a complete installation, except those specifically indicated as being provided by other trades.
- iv. Exposed Architectural mullions and other support members.
- v. Finishes, protection coatings and treatments.
- vi. Sealing with approved sealants within and around the perimeter.
- vii. All thermal insulation, fire-safing etc. including supports and/or backing.
- viii. All caulking, sealing, electrometric and metal flashing, and gaskets including sealing at junctions with roof, ground-floor waterproofing and building expansion joints between structures.
- ix. Electrical bonding and earthing of all metal cladding elements.
- x. Provisions to receive electrical outlets and cut-outs for conduits and other electrical work.
- xi. Glass and glazing.
- xii. Transportation, storage, handling, protection and cleaning.

**c. SUBMITTALS:**

- i. Product Data: Include construction details, material descriptions, and dimensions of individual components, profiles and finishes.
- ii. Shop Drawings, fabrication and installation details, including followings
- iii. Plans, elevations and sections.
- iv. Details of fittings and glazing.
- v. Hardware quantities, locations and installation requirements.
- vi. Sample for verification, for each type of exposed finish required for:
  - Metal finish: 150mm long section of patch fittings, rails and other items.
  - Glass: 150mm square, showing exposed edge finish.

**d. MATERIAL**

- i. Glass
  - Glass shall be as specified in drawing or BOQ or as per design requirement. It shall be Indian / imported hard coated reflective bronze and heat strengthened glass. It shall be of approved make.
  - In toughening of Glass rolling direction shall be parallel to the width of the glass panel such that waviness if any is parallel to the horizontal and no waviness parallel to the vertical and to ensure that such waviness are of negligible order.
- ii. Components
  - Spider fittings: Stainless steel clad aluminium
  - Floating Transom Bar: Steel clad in metal matching fittings and in sizes recommended by manufacturer for application indicated. Include stainless steel support rods, lateral adjustment and ceiling channel. Support fins to be metal, finished to match transom bar.

- Channels: Stainless steel clad aluminium.
- Accessory Fittings: Matching with patch fittings and rails metal and finish for overhead door stop, Centre hosing lock, glass support fin brackets and other as shown in drawing.
- Anchors and fastenings: Concealed
- Weather stripping: Sweep type

iii. Hardware

- Hardware should be heavy duty in matching finish
- Concealed Floor Closer and Top Pivots
- Swing: Double acting; Positive dead stop, concealed with hold open angle
- Delayed action closing
- Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.
- Push-pull set: Stainless steel finish
- Lock set of approved make.

**e. FABRICATION**

- i. Provide holes and cut-outs in glass to receive hardware, fittings, rails and accessories before tempering glass. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll wave distortion is parallel with bottom edge of door or tile.
- ii. Factory assembled components and factory installed hardware to greatest extent possible.

**f. EXECUTION**

- i. Examine areas and condition for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- ii. Install all glass system and associated components according to manufacturer's written instructions.
- iii. Set units in level and plumb.
- iv. Maintain uniform clearances between adjacent components.
- v. Lubricate hardware and other moving parts according to manufacturer's written instructions.
- vi. Set, seal and grout floor closer cases as required suiting hardware and substrate indicated.

**g. CLEARING**

- i. The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes. Both internal and external surfaces should be cleaned to remove corrosive substances, dust or cement / mortar dropping during the installation as may be directed and instructed by the Engineer in Charge. The internal surfaces of glass and aluminum frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting. The Contractor shall provide written verification that cleaning agents are compatible with aluminium, stainless steel, glass coatings, granite, glazing materials and sealants. In no case shall alkaline or abrasive

agent be used to clean the surface. Care shall be taken during cleaning to avoid scratching of the surface by grit particles.

- ii. Prior to snagging inspections the Contractor shall, remove the internal protection sheets and carry out a thorough cleaning of all glass and aluminium. The Contractor shall also make good any physical damage to the structure including scratches, dents, abrasions, pitting, etc. to the satisfaction of the Engineer in Charge. Manufacturer's delivery or job markings on glass and adhesive for manufacturer's labels shall be either a neutral or slightly acidic material. In no case shall such material be alkaline; any staining of glass by alkaline material will be cause for rejection of the glass. After the installation of each pane of glass all markings and labels shall be carefully and completely removed from the panes. Thereafter no markings or labels of any sort shall be placed on the glass.
- iii. Glazed openings shall be identified by suitable warning tapes or flags attached with a non-staining adhesive or other suitable means to the framing of the opening. Tapes or flags shall not be in contact with glass. As soon as it is practically possible after the issuance of the occupation Permit for the Building, the Contractor is to carry out a complete cleaning of the external face.

#### **h. PERFORMANCE GUARANTEE**

The contractor shall offer a minimum of 10 year Performance Warranty for the entire installation carried out.

#### **i. RATE**

Rate shall include all required labour, material, designing, drawing conveyance, testing at approved laboratory breakage, wastage, supervision, protection till hand over and free maintenance during defect liability period etc. complete.

#### **j. MODE OF MEASUREMENTS**

Measurements shall be in Sq m of actual area covered and paid for accordingly.

### **20. STAINLESS STEEL RAILINGS**

- a. The scope of the work includes preparation of the shop drawings (based on the architectural drawings), fabrication, supply, installation and protection of the stainless steel railing till completion and handing over of the work.
- b. The stainless steel work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of the fabricator for the approval of the Engineer-in-Charge.
- c. The Contractor shall submit shop drawings, for approval of the Engineer-in-Charge, for fabricating stainless steel railing with detailing of M.S. stiffener frame work backing along with the fixing details of the M.S. frame work to the R.C.C columns. The details of the joints in the stainless steel railing including location, etc. shall also be shown in the shop drawings.
- d. The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the railing work, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-in-Charge / Consultant. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge / Consultant. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.
- e. The stainless steel shall be of grade 304 with brushed steel satin finish and procured from the approved manufacturer. It shall be without any dents, waviness, scratches, stains etc.

- f. The required joints in the railing provided as per the architectural drawings, shall be welded in a workmanlike manner including grinding, polishing, buffing etc. all complete and compacted. The temporary clamps provided and fixed to hold the stainless steel railing, in position shall be removed after the concrete has set properly. The junction of the flooring and the cladding shall be neatly filled with weather silicone sealant of approved colour and shade. Nothing extra shall be payable on this account.
- g. One test (three specimens) for each lot shall be conducted for the stainless steel pipe in the approved laboratory. Therefore, the material shall preferably be procured in one lot from one manufacturer.
- h. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.
- i. The item includes the cost of all inputs of labour, materials (including stainless steel pipes, welding, brazing, concrete, protective film, weather silicone sealant etc including cost of providing and fixing M.S. frames), T & P other incidental charges, wastages etc. The items also included providing and fixing stainless steel anchor fasteners for fixing railing.
- j. The railing shall be fixed in position using stainless steel pipes, stainless steel posts of required diameters and thickness as shown on drawing and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc.
- k. The item includes the cost of all inputs of labour, materials, T&P, other incidental charges, wastage etc. The entire work shall be carried out to the satisfaction of Engineer-In-Charge.

## **21. GLASS:**

- a. All glass and glazing material shall be verified and coordinate with the applicable Performance requirement.
- b. All glass shall be cut to require size and ready for glazing. All glass shall be accurate sizes with clear undamaged edges and surfaces which are not disfigured. Any panel which does not fit any section of the curtain wall and shop front will be rejected and a replacement made at the Contractor's expense.
- c. Glass shall conform to the quality, thickness and dimensional requirement specified in US Federal specifications DD – G0415C.
- d. Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm with in 260mm of leading or trailing edge, or 0.076mm in centre. Direction of ripple shall be consistent and is acceptable to Architect. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be unidirectional and surface compression shall be in the range of 320-450 Kg/cm<sup>2</sup>. All glass shall be delivered to site with the manufacturer's label of identification attached.
- e. The glass glazed panel / structural glazing frames for the structural glazing system shall be designed to withstand lateral imposed loads and comply with requirement of local building codes.
- f. Glass shall be free from defect or impurities detrimental to its performance. Defects such as bubbles, waves, spots scratches, spalls, discoloration, visibly imperfect coating, chipping, and

bubbles delaminating of opacifier film shall be limited in accordance with the Manufacturer's / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass should be consistent in colour.

- g. Double glazed units shall be procured only from approved manufacturer. Quality control tests shall be performed for mixing, curing, adhesion and dew point. The unit shall be guaranteed against condensation and dirt between the panes, failure of seal and damage to internal coating.
- h. All glass breakage caused by the Contractor or his sub-contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay to the project completion.

**22. WATER PROOFING TREATMENT:** All the items for water proofing treatment with cement based water proofing treatment for roof slab and sunken portion in schedule of quantities shall be guaranteed for TEN YEARS the case of cement based treatment by the contractor as per Performa prescribed. The water proofing treatment work should be got done through specialized agency approved by EIC.

## **23. INTEGRAL CEMENT BASED WATER PROOFING TREATMENT FOR ROOF /SUNKEN FLOORS OF W.C'S ETC.**

- a. The proprietary water proofing compound shall conform to I.S.2645 – 1975 in cement based water proofing treatment, stone aggregate shall be used instead of brick aggregate without any extra cost wherever required by the Engineer in – charge.
- b. The finished surface after water proofing treatment shall have required slope.
- c. While treatment of sunken floors is done it shall be ensured that the 'S' or 'P' traps as the case may be have been fixed / eased and rounded off properly the work shall be carried out as per relevant CPWD specifications.
- d. **GURANTEE:** The above water proofing, treatment shall be guaranteed for TEN YEARS against any leakage etc. the contractor shall have to execute a bond, 10 % of cost of items executed for water proofing shall be retained for 10 years as security ( Refer GCC provisions)

## **24. ANTI-TERMITE TREATMENT**

### **a. SCOPE**

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

### **b. EXECUTION**

#### **i. General**

- All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.
- All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.
- Soil treatment shall not be done when it is raining or when the soil is wet with rain or

subsoil water. Once formed, the treated soil barrier shall not be disturbed.

## ii. Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 – 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

## iii. Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (up to a height of about 300 for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M<sup>2</sup> of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M<sup>2</sup> of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

## iv. Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M<sup>2</sup> of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

## v. Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

## vi. Treatments of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

## vii. Treatment at Junction of the Wall and the Floor

- Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.
- A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

## b. ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a



separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

**c. RATES**

Rates shall be of complete work per unit area as stated in the Schedule.

**d. METHOD OF MEASUREMENT**

- i. Complete work of anti-termite treatment shall be measured for plinth area treated.
- ii. This includes treatment, to foundations, walls, trenches, basements, plinth, Buried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work and no extra payment shall be made.

**e. I.S. CODE**

Relevant code applicable for this Specification IS: 6313 (Part-II) 1981: Code of Practice of Anti-Termite Measures in Buildings Pre-constructional chemical treatment measures.

## **25. PRECAST PAVER BLOCKS**

**a. SCOPE OF WORK**

The scope of work includes manufacturing, supplying and laying of precast paver blocks of strength and quality as specified at various Retail outlets. The work includes:

- i. Verification of the existing site condition and advising our project-in-charge to lay suitable base course, if required. Contractors are required to satisfy themselves with quality of sub-grade, sub-base course before the paver blocks are laid and suggest strengthening if required.
- ii. Clearing the site by removing all obstacles such as stones, debris etc. for laying of paver blocks.
- iii. Manufacturing of paver blocks in your plant as per requirements in technical specification enclosed.
- iv. Supplying of paver blocks at site, including handling at both ends.
- v. Laying of paver blocks at site on 50mm thick sand bedding as per requirement in technical specification, within shortest possible time. In case, site is existing operating Retail Outlets, care should be taken to ensure that the Retail Outlet operation is not closed / hampered. The job of paver blocks laying may be carried out during night hours, if required and as instructed by EIC.
- vi. Testing of paver blocks through reputed Govt. / Non Govt. Test house (Duly recognized) and submission of test results as per requirements in technical specifications. Engineer-in-Charge reserves the right to carryout tests at random. Cost of such tests shall be borne by Engineer-in-Charge if the sample passes and by contractor if it fails.

**b. GUARANTEE:-**

The contractor shall guarantee that all material and components designed, fabricated, supplied and laid by him shall be free from any type of defect due to faulty material, and / or workmanship for a period of One year from the date of completion of work at individual sites. In case of any defect e.g. settlement, depression, abrasion, chipping, cracks etc, the party shall re-lay the pavers in that particular area within 15 days of intimation as directed without claiming any cost what so ever. Otherwise, the Engineer-in-charge reserves the right to get the rectification done by engaging another agency at contractor's risk and cost.

### c. TECHNICAL SPECIFICATIONS

#### i. Paver Block manufacturing facilities

- The Engineer-in-charge, at its discretion shall nominate its representative for inspection of the factory. The Contractor shall inform the address, telephone numbers and other details of the workshop and the contact person to enable Engineer-in-Charge depute its representative. Contractor shall arrange entry to the manufacturing facilities to the Engineer-in-Charge or his representative during all working days and time.
- The Paver Block shall be made in factory with following minimum facilities:

#### ii. *Design Mix Concrete:*

- All pavers designated by strength shall be treated as design mix concrete. The aggregate and cement shall be measured by weight in an approved weigh batching equipment. Mixing water shall be measured in graduated litre cans. One or more complete bags of cement shall be used for each batch of concrete.
- The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and characteristic strength. The mix design shall be finalized before manufacturing of the paver considering a set of suppliers for cement, sand and aggregates. In case of any change of suppliers of cement, sand or aggregates, party should have design mix ready for alternate suppliers.
- The minimum cement content for compacted concrete of pavers shall not be less than 380 Kg / cum.
- The maximum water cement ratio for pavers concrete shall not be more than 0.40
- The design mix proportions for each set of raw material suppliers shall be finalized and approved by the authorized lab for the required compressive strength and the lab report with proportions should be available with the vendor at all times for scrutiny and verification purpose.

#### iii. *Paver Block Making Machine:*

The machine should be capable of producing high quality Paver Blocks by obtaining high level of compaction by application of hydraulic compaction and also by high intensity vibration to the moulds. The machine should have automatic control panel and shall apply a minimum pressure of 3000 psi and then there shall be automatic cut off of hydraulic circuit without any manual interference. In no case, pavers mould by manual force or by machine without auto cut off shall be accepted. All pavers shall have uniformity in strength.

#### iv. *Weigh Batching & Mixing Equipment:*

- The proportioning of ingredients of concrete per batch of concrete shall be performed by an approved weigh batching machine. Water shall be fed into the mixer from a tank provided with means for adjusting the flow of water so as to supply the quantity determined for concrete as per mix design .Due allowance shall be made for the weight of water carried by aggregates so that actual amount added at the mixer can be reduced as necessary. For this purpose the moisture content of coarse and fine aggregates shall be ascertained as and when required and at other times when alteration of the moisture content may be expected due to new deliverance of aggregates, inclement weather or other reasons.
- Volumetric batching of concrete may be allowed after the design mix is approved by

lab after testing, by converting the proportion of concrete from weight to volumetric measurement subject to facilities being made available by the contractor for verifying and monitoring this.

- All necessary equipment such as measuring boxes, devices for determination of moisture and bulking in sand, slump cone, etc. shall be provided by the contractor. Concrete shall be machine mixed until there is a uniform distribution of materials and uniform colour and consistency is achieved and under no circumstances for less than two minutes.
- The concrete Mix Design should be followed for each batch of materials.

v. *Curing :*

The factory should have well designed curing area to ensure adequate (minimum 14 days) curing of paver blocks.

vi. *Laboratory*

- The factory should have the following:
  - Compression testing machine of capacity minimum 200 MT
  - Other tools and equipment for testing raw materials and paver blocks.
  - Systematic record of test results of various paver blocks manufactured in the factory.
  - Concrete Mix Design for desired grade of concrete used for making of paver blocks.

**d. RAW MATERIALS**

i. Cement

The cement used in the manufacture of high quality precast concrete paving blocks shall be conforming to IS 12269 (53 grade ordinary Portland cement) or IS 8112 (43 grade ordinary Portland cement) or IS 1489 (Part 1) (Portland-pozzolana cement – fly ash based). The minimum cement content in concrete used for making paver blocks should be 380 kg/Cum.

ii. Aggregates

The fine and coarse aggregates shall consist of naturally occurring crushed or uncrushed materials, which apart from the grading requirements comply with IS 383-1970. The fine aggregates used shall contain a minimum of 25% natural silicon sand. Lime stone aggregates shall not be used. Aggregates shall contain no more than 3% by weight of clay & shall be free from deleterious salts and contaminants. Zone iv sand shall not be acceptable. Course aggregate shall be 10 mm and below.

iii. Water

The water shall be clean and free from any deleterious matter. It shall meet the requirements stipulated in IS: 456-2000.

iv. Other materials

Any other materials / ingredients used in the concrete shall conform to I.S.Specifications.

v. Pigment:

- The pigment shall be used only on wearing and top surface and throughout the paver

block. The pigment used shall not be more than 10% of weight of cement used in the wearing course layer. However, use of pigment shall in no way alter the required strength of the paver block.

- Pigment used for colouring paver blocks shall have durable colour. It shall not contain matters detrimental to concrete. The pigment shall not contain Zinc compound. Lead pigment shall not be used.

#### e. PAVERS BLOCK CHARACTERISTICS

The inter locking concrete paver tiles should conform to IS-15658: 2006. They shall be tested as per the code and have to qualify limits specified by us down below.

- i. The paver tiles should be made of M-40 design mix concrete in approved size and shape. For acceptance the average of compressive strengths of 8 pavers shall be minimum 47.2 N/mm<sup>2</sup> (MPa). Any paver in the tested lot shall not have compressive strength less than 40.1 MPa. If needed, pavers shall be designed and manufactured on higher side to concrete grade M-40 to meet this requirement without extra cost to ENGINEER-IN-CHARGE. Testing shall be done as per relevant clauses of IS-15658:2006.
- ii. The concrete pavers should have perpendicularities after release from the mould and the same should be retained until the laying.
- iii. The surface should be of anti-skid and anti-glare type.
- iv. The paver should have uniform chamfers to facilitate easy drainage of surface run off.
- v. The concrete mix design should be followed of each batch of materials separately and weigh batching plant is to be used to achieve uniformity in strength and quality.
- vi. The pavers shall be manufactured in single layer or more to ensure smooth surface on top and to remove all voids.
- vii. The pavers shall be of cement Grey colour without any pigment or coloured with pigment or with chemically treated top surface as specified.
- viii. The pavers are to be skirted all round with kerbing or otherwise as per direction of EIC, using solid concrete blocks made of grade 1:1.5:3 concrete, of size 100mm X 200mm X 400mm. The kerbing should be embedded for 100mm depth. The concrete used for kerbing shall be cured properly for 7 days minimum. The payment for laying kerb blocks will be made separately on running meter basis. ENGINEER-IN-CHARGE may decide for alternate skirting system to suite site requirements.
- ix. All paver blocks shall be sound and free of cracks or other visual defects, which will interfere with the proper paving of the unit or impair the strength or performance of the pavement constructed with the paver blocks.
- x. The compressive strength requirement of concrete paver block shall be minimum 47.2 MPa (N/sqmm) for 28 days (Testing as per IS-15658) after applying the correction factor as per IS-15658:2006. (Please refer clause 3.1 also).

#### f. PAVER BLOCK DIMENSIONS

Thickness	80mm/60mm
Shape	Regular (Uniform shape with no Hollow or Cracks)
Chamfer	5 mm to 7 mm along top edges

Thickness of Wearing Layer	Minimum 6 mm (The thickness of the wearing surface shall be measured at several points along the periphery of paver blocks. The arithmetic mean of the lowest two values shall be the minimum thickness of the wearing layer)
Plan Area $A_{sp}$ (Ref. Cl.B-3.3 Annex B, IS-15658:2006)	Maximum 0.03 m <sup>2</sup>
Colour	Natural cement Grey colour without use of any pigment OR colour as specified
Dimensional Tolerance	Tolerances as per IS-15658:2006
<b>Note:</b> All other visual/physical & dimensional acceptance on parameters like aspect ratio, squareness etc to be as per IS-15658:2006	

#### g. TESTING OF PAVER BLOCKS

SR. NO.	TEST	SPECIFICATION Average Values
<b>1.1. FOR PAVER BLOCKS</b>		
1.	28 day Compressive Strength	Minimum 47.2 MPa (N/Sqmm) (for 80mm)
2.	Abrasion Resistance	Maximum 2 mm [i.e. 10 units of 1000 mm <sup>3</sup> per 5000 mm <sup>2</sup> reported as per E-5 of Annex E of IS-15658:2000]
3.	Water Absorption	Avg. of 3 units - Maximum 6% by mass (restricted to 7% in individual test units)
<b>1.2. FOR GRASS PAVERS</b>		
1.	28 day Compressive Strength	Minimum 37.1 MPa (N/Sqmm) (restricted to 31.5 MPa in individual test units)
2.	Abrasion Resistance	Maximum 3 mm [i.e. 15 units of 1000 mm <sup>3</sup> per 5000 mm <sup>2</sup> reported as per E-5 of Annex E of IS-15658:2000]
3.	Water Absorption	Avg. of 3 units - Maximum 6% by mass (restricted to 7% in individual test units)

#### h. LAYING OF PAVER BLOCKS

##### i. Priming

- The contractor is required to verify the existing WBM driveway surface and ascertain the CBR value. Accordingly the total subgrade thickness required for achieving the desired CBR value shall be advised to Engineer-in-Charge within seven days of receipt of call-up. ENGINEER-IN-CHARGE shall, through regular vendors arrange to carry out such WBM, wherever required. Before taking over the site, the Paver block laying party is required to verify the stabilization of the surface with CBR values. In case, contractor does not advise the CBR value within seven days, ENGINEER-IN-CHARGE shall carry out WBM as per own design, and contractor shall have no claim later particularly to the quality of WBM or sub-grade.

- It will be the responsibility of the Paver block party to ensure that the Manholes / Pipeline / Cable trenches / circular drainage system etc. is raised to driveway level using the requisite materials as per instruction of EIC. The areas of potholes / deep depressions at the isolated locations shall be filled up and properly compacted before laying the paver blocks. No extra payment will be made for this purpose. The area of raised manholes shall be included in the measurement of overall area of paver blocks for the purpose of payment.

ii. Bedding sand course

- The bedding sand shall consist of naturally occurring, clean, well graded sand passing through 4.75mm sieve and suitable to concrete manufacture. The bedding should be from either a single source or blended to achieve the following grading.

IS SIEVE SIZE	% PASSING
9.52mm	100
4.75mm	95-100
2.36mm	80-100
1.18mm	50-100
600 microns	25-60
300 microns	10-60
150 microns	5-15
75 microns	0-10

- Contractor shall be responsible to ensure that single-sized, gap-graded sands or sands containing an excessive amount of fines or plastic fines are not used. The sand particles should preferably be sharp, not rounded. The sand used for bedding shall be free of any deleterious soluble salts or other contaminants likely to cause efflorescence.
- The sand shall be of uniform moisture content, which shall be within 4% - 8%, at the time of spreading and shall be protected against rain when stockpiled prior to spreading. Saturated sand shall not be used.
- The bedding sand shall be spread loose in a uniform layer as per drawing. The compacted uniform thickness shall be 50mm and within 5mm. Thickness variation shall not be used to correct irregularities in the base course surface.
- The spread sand shall be carefully maintained in a loose dry condition and protected against pre-compaction both prior to and following spreading. Any pre-compacted sand left overnight shall be loosened before further laying of paver blocks takes place.
- Sand shall be slightly spread in a loose condition to the predetermined depth only slightly ahead of the laying of the paver block.
- Any depressions in the spread sand exceeding 5mm shall be loosened, raked and re spread before laying of paver block.

iii. Laying of interlocking Paver Block:

- Paver block shall be laid in pattern as specified under cl. 7 throughout the pavement. Once the laying pattern has been established, it shall continue without interruption over the entire pavement surface. Cutting of blocks, the use of infill concrete or discontinuities in laying pattern is not to be permitted in other than approved locations.
- Paving units shall be placed on the un-compacted sand bed to the nominated laying

pattern; care shall be taken to maintain the specified bond throughout the job. The first row shall be located next to an edge restraint. Specially manufactured edge paving units are permitted or edge units may be cut using a power saw, a mechanical or hydraulic guillotine, bolster or other approved cutting machine. No haphazardly broken pavers shall be used.

- Paver block shall be placed with the help of spacers to achieve gaps nominally 2 to 3mm wide between adjacent paving joints. No joint shall be less than 2mm nor more than 4mm. However it is mandatory to use 3.0mm wide spacer while laying paver tiles so as to ensure uniform 3.0mm gap between adjacent pavers. Frequent use of string lines shall be used to check alignment. In this regard, the “laying face” shall be checked at least every two metre as the face proceeds. Should the face become out of alignment, it shall be corrected prior to initial compaction and before further laying job is proceeded with.
- In each row, all full units shall be laid first. Closure units shall be cut and fitted subsequently. Such closure units shall consist of not less than 25% of a full unit.
- To fill spaces between 25mm and 50mm wide, concrete having minimum 1:1:2 cement : sand : coarse aggregate mix and a strength of 40 N/Sqmm shall be used. Within such mix the nominal aggregate size shall not exceed one third the smallest dimension of the infill space. For smaller spaces dry packed mortar shall be used.
- Except where it is necessary to correct any minor variation occurring in the laying bond, the paver block shall not be hammered into position. Where adjustment of position is necessary care shall be taken to avoid premature compaction of the sand bedding.

iv. Initial Compaction

- After laying the paver block, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than two (2) passes of a suitable plate compactor.
- The compactor shall be a high-frequency, low amplitude mechanical flat plate vibrator having plate area sufficient to cover a minimum of twelve paving units.
- Prior to compaction all debris shall be removed from the surface.
- Compaction shall proceed as closely as possible following laying and prior to any traffic. Compaction shall not, however, be attempted within one meter of the laying face. Compaction shall continue until lipping has been eliminated between adjoining units. Joints shall then be filled and re-compacted as described in Clause 6.5
- All work further than one meter from the laying face shall be left fully compacted at the completion of each day's laying.
- Any blocks that are structurally damaged prior to or during compaction shall be immediately removed and replaced.
- Sufficient plate compactors shall be available at the paving site for both bedding compaction and joint filling.

v. Joint Filling and Final Compaction

- As soon as practical after compaction and in any case prior to the termination of work on that day and prior to the acceptance of any traffic, sand for joint filling shall be spread over the pavement.

- Joint sand shall pass a 2.36mm (No. 8) sieve and shall be free of soluble salts or contaminants likely to cause efflorescence. The same shall comply with the following grading limits:

IS SIEVE SIZE	% PASSING
2.36mm	100
1.18mm	90-100
600 microns	60-90
300 microns	30-60
150 microns	15-30
75 microns	10-20

- The Contractor shall supply a sample of the jointing sand to be used in the contract prior to delivering any such material to site for incorporation into the works. Certificates of test results issued by a recognised testing laboratory confirming that the sand sample conforms to the requirements of this specification shall be submitted prior to supply of total volume required.
- The jointing sand shall be broomed to fill the joints. Excess sand shall then be removed from the pavement surface and the jointing sand shall be compacted with not less than one (1) pass of the plate vibrator and joints refilled with sand to full depth. This procedure shall be repeated until all joints are completely filled with sand. No traffic shall be permitted to use the pavement until all joints have been completely filled with sand and compacted.
- Both the sand and paver block shall be dry when sand is spread and broomed into the joints to prevent premature setting of the sand.
- The difference in level (lipping) between adjacent units shall not exceed 3mm with not more than 1% in any 3m X 3m area exceeding 2mm. Pavement portions which are deformed beyond above limits after final compaction, shall be taken out and relaid to the satisfaction of the Engineer in charge.

vi. Edge Restraint Using Kerb Block

- Edge restraints shall be done using the kerb blocks or otherwise as directed by the Engineer-in-charge. The kerb blocks should be fixed properly to withstand overriding by the anticipated traffic, thermal expansion and to prevent loss of the laying course material from beneath the surface course. The edge restraint should present a vertical face down to the level of the underside of the laying course.
- The surface course should not be vibrated until the edge restraint, together with any bedding or concrete haunching, has gained sufficient strength. It is essential that edge restraints are adequately secured.

vii. Uniform Interlocking Spaces

The pavers should have uniform interlocking space of 2mm to 3mm to ensure compacted sand filling after vibration on the paver surface.

viii. Laying Pattern:

The laying pattern shall be as per drawings or as per directions of the Engineer-in-charge



## 26. GRASS GRID PAVERS

### a. Soil subgrade

The soil subgrade should be uniformly compacted to at least 95% of its optimum density prior to placing the gravel, sand and the grids.

### b. Aggregate Base

Aggregate used for road bases is acceptable for use with concrete grids. The fines (aggregates smaller than the No. 50 sieve) can be omitted if additional water permeability is desired. If fines are omitted, then filter cloth will be required between the sand and aggregate to prevent migration of sand into the base. The compacted aggregate base should extend beyond the edge of the grids a minimum of 150 mm, where possible. The thickness of the base depends on the load and the strength of the soil sub base. For residential uses on adequately drained soil, the base can be omitted and the grids placed directly on the sand layer. For heavy vehicular loads such as those from fire trucks, or repeated loads from cars, a minimum of 200 mm of compacted aggregate road base is recommended. Filter cloth is recommended for use with soils having low California Bearing Ratio (CBR) (i.e., less than 4%), those with high clay and silt contents, soils in high water table areas, and soils in low lying areas subject to flooding. The filter cloth is placed over the compacted subgrade and should be fine enough to prevent migration of soil into the aggregate base. Woven fabrics are preferred over nonwoven materials when the cloth is placed directly under the sand layer in installations subject to traffic. Concrete grids allow water into the gravel base. However, excess amounts of water can weaken the base and subject it to the degradation of freeze-thaw cycles. Removal of excess water from bases over poorly drained soils should be provided by the use of drain pipes. Water can be drained to a storm sewer or stream. If drainage from soils of low permeability is impractical, bases subject to regular vehicular traffic can be stabilized with 4 to 6 percent (by weight) of cement.

### c. Bedding Sand

Grading requirements for the sand should conform to specifications as detailed for Precast Paver Blocks above. The sand layer should be between 25 and 38 mm thick or as per BOQ. The sand should be screeded, to proper elevations and have a uniform moisture content (not saturated) prior to placing the grids. To maintain a level bedding surface, the screeded sand should not be disturbed.

### d. Placement of Grids

The grids should be placed with a minimum joint spacing of 2 mm. If the grids touch, they may chip and spall upon repetitive loading.

### e. Vibration of Grids

Into the Sand a high frequency (3,500-5,000 cycles per second), low amplitude plate vibrator should be used to seat the units into the bedding sand. At the end of each day, the grids placed that day should be vibrated. If bedding sand is left exposed, it should be covered with plastic to protect it from rain, since rainfall settles the exposed sand and prevents the grids from pressing into the sand when vibrated.

### f. Topsoil Placement Grass

Seed and fertilizer can be mixed with the topsoil or broadcast directly on the surface and swept into the openings and joints. The grids should be vibrated again after the voids are full. The final level of the topsoil should be 12 to 25 mm below the top surface of the concrete grids. This provides some protection from tires to the grass as it grows.

g. Edge Restraints

Edge restraints may be provided, if required, so that the pavers' donot get loose and damage the continuity of the pavement.

h. Grass Selection

The durability of turf grass depends on a variety of factors including the species, proper installation of the top soil, sod or seed, the frequency of traffic, and the climate. The selection of grass should be such that they have a have a high tolerance to wear, a high potential for recuperation from damage, and a low tendency toward thatch build up. The grass should not be subjected to vehicular traffic until it is well established.

i. Integration with Solid Pavers

Spaces in parking lots can be marked with solid concrete pavers. Pedestrian paths should be paved with solid paver's to make walking more comfortable. Figure 6 shows solid pavers used to mark parking spaces and for walkways.

j. Maintenance

The grass should be cut, watered and fertilized as with any other area of grass. The care of the grass should not be neglected, as it is difficult to re-establish grass in compacted or polluted soil without removing and replacing the soil ineach opening. Rotary brushes for snow removal are not recommended.

k. Specifications

The Concrete Grid Paving Units should be capable to withstand vehicular traffic, parking area requirements. The Standard size may be 610 x 610 mm or as per manufacturer's specification, with a minimum nominal thickness of 80 mm or as per BOQ. ).

l. Physical Requirements

At the time of delivery to the work site, the units shall conform to the physical requirements as mentioned for Precast Paver Blocks above for minimum compressive strength, maximum water absorption, minimum net area, and minimum web width.

m. Permissible Variations in Dimensions

Length or width of units shall be within +3 mm from approved samples. Similarly, heights of units shall be within +3 mm from the specified standard dimensions.

n. Visual Inspection

All units are required to be free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction.

## 27. RESTROOM CUBICLE SYSTEM/ TOILET PARTITIONS

a. **SCOPE**

The scope of work shall include providing and fixing of cubicle partitions as per manufacturer's guide under the supervision of the Engineer in Charge.

b. **GENERAL: -**

Restroom Cubicle System shall be highly resistant against water, chemical and impact.

c. **MATERIALS**

- i. All accessories shall be made of powder-coated aluminium grade 6063-T5. The doors, pilasters and intermediate partitions shall be 12 mm thick High Pressure Laminates (HPL) compact board (or phenolic board) with chamfered edges.
  - ii. The HPL compact boards shall be manufactured from sheets of special kraft and decor papers, impregnated with thermosetting synthetic resins which are fused together under heat and high pressure. HPL compact boards shall be laminated on both sides with suede finish. Top surface on both sides shall be Melamine-coated which is scratch and impact resistant.
- d. **DOORS**  
 All doors shall be of single colour, 12 mm thick HPL compact board with chamfered edge. Each will be supported by 3 Nylon Hinges (4 for accessible restroom) affixed to the pilaster, completed with Nylon Coat Hook and Nylon Door Knob. Door stopper channel shall be provided at its vertical end and incorporated with Rubber Lining to dampen noise.
- e. **PILASTERS**  
 All pilasters shall be of same colour as doors, 12 mm thick HPL compact board with chamfered edge, completed with Nylon thumbturn for locking doors. Colours different from doors, if required, shall be provided as per direction of the Engineer-in-charge. The pilaster shall be affixed to the Top Rail and secured from the top of the Top Rail. The floor clearance shall be 150 mm. All pilasters shall be supported by adjustable foot and non-corrosive steel inserts or as per approved by the Engineer-in-charge. The base of the adjustable foot shall be anchored to the floor with a clearance height of 150 mm.
- f. **TOP RAIL**  
 Heavy-duty Aluminium H-section Top Rail Channel, 70 mm x 125 mm x 5 mm (cross-section dimension, W x H x T), shall be anchored to the wall with Mild Steel Wall Bracket. Pilaster shall be section-fixed onto the bottom slot of the Top Rail for maximum strength, stability and alignment of the system.
- g. **INTERMEDIATE PARTITIONS**  
 All intermediate partitions shall be one continuous panel without any joints and of same colour as door, 12 mm thick HPL compact board with Aluminium U channel, affixed at its ends (to the wall and pilaster) with edges chamfered. For ultimate stability of the system, the length of intermediate partitions shall not exceed 1800 mm. the Intermediate panel shall be anchored to the wall with powder coated or anodized aluminium U channel
- h. **ACCESSORIES**  
 Each restroom cubicle shall be equipped with the following accessories (As per BOQ):
  - i. Heat & Bacteria Resistant Polyamide / Nylon Door Knob
  - ii. Heat & Bacteria Resistant Polyamide/ Nylon Privacy Thumb turn Thumbturn with Occupancy Indicator
  - iii. Heat & Bacteria Resistant Polyamide / Nylon Coat Hook
  - iv. Heat & Bacteria Resistant Polyamide/ Nylon Cover Gravity Hinges with 3 choices of standard, gravity-to-open or gravity-to-close
  - v. Aluminium Door Stopper Channel
  - vi. Rubber Door Stopper Lining
- i. **COMPARTMENT DIMENSIONS:-**

The compartment dimensions shall be as per site dimensions/ detailed drawings. The contractor shall submit shop drawings for the approval of Engineer-in-charge prior to its execution at site.

**j. FINISHES**

HPL compact boards are available in a variety of brilliant colours and woodgrains. HPL is available in suede finish only.

**k. INSTALLATION**

Installation shall be executed under the supervision of manufacturer's site supervisor(s) and shall be carried out in accordance with the manufacturer's installation instructions. In this regard, directions of the Engineer-in-charge shall be final.

**l. METHOD OF MEASUREMENT**

Complete work of partitions shall be measured for floor area treated. This includes all partitions, doors and related fittings and accessories.

**28. TAPECRETE WATER PROOFING(if required):**

Following shall the process of installation of Tapecrete waterproofing:

**a. SURFACE PREPARATION**

- i. Prior to application of TAPECRETE - P151 work, all surfaces shall be prepared properly to avoid failure. The surface shall be cleaned to remove all dust, foreign matters, loose materials or any deposits of contaminants which could affect the bond between the surface and the TAPECRETE P-151 coating.
- ii. New surfaces of the structural concrete shall be reasonably smooth to avoid sharp projections so as not to impede the application of TAPECRETE coating.
- iii. All concrete surfaces shall be thoroughly pre-wetted for at least one hour prior to the application of TAPECRETE coating by sprinkling of water on flat surface and by vigorously spraying water on vertical/inclined surfaces.
- iv. When placing TAPECRETE coating, all water shall be removed so that surface is only damp or surface dry. In no case there shall be standing water or a shiny wet surface.
- v. Depressions are filled and levelled using PMC fillers. For the PMC filler the mixing ratio is 1 kg cement: 1.5 kg silica sand and 0.52 kg TAPECRETE P-151.

**b. APPLICATION**

- i. Application of one coat of TAPECRETE -P-151 Polymer Modified Cementations (PMC) slurry coating over the prepared concrete surface. The slurry shall be spread out over an area which can be covered with fibre glass fabric before the slurry dries out.
- ii. Unroll the fibre glass fabric on to the wet slurry layer and impregnate with PMC slurry by pressing the fabric down so as to even out all wrinkles.
- iii. Application of one coat TAPCRETE P-151 slurry coating over the glass fabric so as to fill and over the fabric.
- iv. Application of one coat TAPECRETE-P151 - PMC brush topping over the TAPECRETE -P151 slurry coating applied surface after the slurry coat has dried on the next day.
- v. Providing protective overlay of 25mm minimum thick screed concrete / plaster to slope of (1 in 100) admixed with CICO No. 1 Integral Cement Waterproofing compound after curing of PMC brush top coating.

**NOTE:** TAPECRETE-P-151 Polymer is mixed with neat cement in the ratio of 100 kg cement: 52 kg. of TAPECRETE-P151. The mix has to be stirred thoroughly until no air bubbles remain in the mix and lump found in the mix, should be removed.

### c. CURING

- i. During the first 12 hours of curing, it shall be protected from abrasion, rain and other adverse conditions.
- ii. No traffic shall be allowed on a standard TAPECRETE-P151 treated surface within 48 hours after installation.
- iii. After application of final coat of TAPECRETE-P151 composition, initial air drying shall be done for 2-6 hours. During this period no water is to be used for curing.
- iv. Moist curing shall be done for the next 24 hours by way of spraying water on the TAPECRETE system.
- v. Following moist curing, the TAPECRETE-P151 coating shall be allowed to air dry for 3 days before submersion in water.

	TAPECRETE-P151	SLURRY	TAPECRETE	BRUSH TOPPING
	Single coat	Double coat	1.5mm thick/m2	meter3
<b>Constituents</b>	Qty. in kg	Qty. in kg	Qty. in kg	Qty. in kg
<b>Cement</b>	0.488	0.730	1.289	858
<b>Tapecrete-P151</b>	0.253	0.379	0.670	446
<b>Fine Silica Sand</b>	—	—	1.289	858

## 29. LATERITE STONE MASONRY

### a. SCOPE

The scope of Work shall include Laterite masonry work as rubble masonry in foundation and coursed masonry as the super structure. The work procedure shall be as per shall be as per relevant CPWD specifications for similar class of stone work as decided by the Engineer-in-Charge. Following shall be additionally provided for this item of work.

- i. **Stone:** The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite, etc; 'and shall be obtained from the quarries, approved by the Engineer - in Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects as it may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stony shall not contain crypt crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. Stones with round surface shall not be used. The compressive strength of common types of stones shall be as per table I and the percentage of water absorption shall generally not exceed 12%.
- ii. **Dressing Laterite**

Stones shall be hammer dressed into rectangular blocks so that all faces are free from waviness and unevenness, and the edges are true and square. The least thickness/breadth shall be not less than height. The length shall generally be equal to twice the breadth, unless otherwise specified.

**iii. Laying**

The dressed stones shall be laid in regular courses of not less than 15 cm height. All courses in the masonry shall be of the same height unless otherwise directed. The stones shall be laid in alternate header stretcher fashion; alternative courses of header and stretchers Orin any other suitable fashion as directed. The vertical joints shall break by at least 65 mm. Nonspecific comer stones are necessary. Quoin may be provided. Where so indicated.

**iv. Joints**

All be joints shall be truly vertical; the thickness of joints shall not exceed 15 mm. Each stone shall be carefully laid in place with joints completely filled with mortar. On faces, whereon plastering or pointing is required to be done, the joints shall be struck flush as the work proceeds. In other cases, joints shall be raked square to a minimum depth of 15 mm by a racking tool during the progress of work while the mortar is still green.

### 30. ALUMINUM LOUVRES

**a. Scope of Work**

The Work of this Section includes all labour, materials, equipment and services necessary to complete the aluminum Louvres as shown on the drawings and/or specified herein, including but is not necessarily limited to the following Aluminium Louvres.

**b. Quality Assurance**

**i. Performance Requirements**

- **Structural Performance:** Provide exterior metal Louvres capable of withstanding the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter or permanent damage to fasteners and anchors.
- **Wind Load:** Uniform pressure (velocity pressure) of 2 Kpa, acting inward or outward.
- **Thermal Movements:** Provide Louvres that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects.

Temperature Change (Range): 5°C to 85°C, ambient; 45°C to 85°C, material surfaces.

- ii.** Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.

**c. Field Measurements:** Verify size, location and placement of louver units prior to fabrication.

- d. Shop Assembly:** Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in shop to greatest extent possible and disassemble as necessary

for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

**e. Submittals**

- i. Product Data: Submit manufacturer's specifications, certified test data, where applicable, and installation instructions for required products, including finishes.
- ii. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.
- iii. Samples: Submit 1 sq.ft. samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work. Where normal color and texture variations are to be expected, include 2 or more units in each sample showing limits of such variations.

**f. Product Handling**

- i. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.
- ii. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

**g. Louvre Material**

- i. Provide storm resistant extruded aluminum Louvres with Z shaped profiles for the shaft areas and box section louver profiles (ASTM B221), shown on drawings and as approved by the Engineer-in-charge.
- ii. Heads, sills, jambs and mullions to be one piece structural members of 6063-T6, alloy, thickness as per design, with integral caulking slot and retaining beads. Closed cell PVC compression gaskets to be provided between bottom of mullion or jamb and top of sill to insure lead tight connections. Concealed structural supports to be designed by the louver manufacturer to carry a wind load of not less than 2.0 Kpa. All fasteners to be stainless steel.

**h. Finishes: -**

- i. PVDF 35 microns coating with shade as per the Engineer-in-charge.
- ii. Fastenings: Fasteners for exterior application shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.
- iii. Anchors and Inserts: Use non-ferrous metal or SS 316 grade anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

**i. Fabrication, General**

- i. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between Louvres and adjoining work.
- ii. Include supports, anchorages, and accessories required for complete assembly.
- iii. Provide sill extensions made of same material as Louvres, where indicated, or required

for drainage to exterior and to prevent water penetrating to interior.

- iv. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are necessary by size of Louvres. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

**j. Inspection**

Examine the areas and conditions where aluminum Louvres is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

**k. Installation**

**i. Preparation**

Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in masonry construction. Coordinate the delivery of such items to the project site.

- ii. Locate and place louver units in plumb, level and in proper alignment with adjacent work.
- iii. Use concealed anchorages wherever possible. Provide stainless steel 316 grade washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
- iv. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.
- v. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, at Contractor's option.
- vi. Protect aluminum surfaces from corrosion by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.
- vii. Provide concealed gaskets, flashings, joint fillers and insulations, and install as the work progresses to make the installations weather tight.

**31. ANTIBACTERIAL PAINT(if required):**

- a. The Antibacterial Paint shall be able to provide anti-Microbial Protection:
- b. The scope of work includes providing & applying approved makes anti-Microbial Paint on wall surfaces as per manufacturer's specifications complete in all respect & as directed by Engineer-in-charge. Following are the desired characteristic of the paint:
  - i. Protection: The product hygiene coatings to start the biocidal action as soon as the microorganism land on the surface, and prevents the growth of mould, bacteria and yeasts for at least 5 years.
  - ii. Lily Cycle Savings: The unparalleled durability of hygiene coatings should help to extend the maintenance cycle and to minimize all related material, labour and shut down costs.



- iii. Chemical Persistence: The hygiene coatings should be highly resistant to abrasives, detergents and weak acids and alkalis used in cleaning regimes. Furthermore, they can be regularly steam cleaned without any loss of performance or adhesion to the substrate.

## 32. POLYCARBONATE SHEET ROOFING

### a. SCOPE

- i. The scope of work shall include providing and fixing of polycarbonate sheets as roofing above skylight and over carpark areas as per the architect's design intent.
- ii. The fabrication work shall be got done through experienced & reputed fabricator, to be got approved from the Engineer-in- Charge. The contractor shall submit to the Engineer-in-Charge the shop drawings giving fixing details for the polycarbonate sheets in roofing and also quality assurance and methodology statement for the item.

### b. GENERAL

The polycarbonate sheet roofing shall conform to manufacture's specifications. The contractor shall procure the sheets from the manufacturer as per the approved list. The material procured shall be free of any defects and damage to the edges, surface etc. The defective material shall be replaced by the contractor at his own cost. The contractor shall ensure that the material is procured and delivered at installation site without any damage.

### c. HANDLING

Adequate care shall be taken for protection of the material before installation as well as afterwards till handing over the building for occupation. The contractor shall ensure careful handling and storage and prevent any rough handling, to prevent any edge or surface damage. Any panel with edge damaged or damage to the finish etc. shall not be allowed to be used in the work and shall be replaced by the contractor at his own cost. The contractor shall procure the material including providing for wastages, damages etc. in one lot so as not have any color and shade variation. Atleast one sample of the polycarbonate sheets brought by the contractor to the site of work shall be tested. The test shall be got done at reputed independent laboratory as approved by the Engineer in Charge.

### d. MATERIALS

The polycarbonate sheet shall be multi-wall (twin wall) section with thickness of the sheet not less than 16mm and the thickness of the walls on the two external faces not less than 0.8mm each. The sheet shall be extruded from polycarbonate material and shall have homogeneous composition of the material. The sheet shall have co-extruded UV protective layer. The sheet shall be fixed with the face treated for UV resistance, upward/exposed to sunlight. The weight of the sheets shall not be less than 1.7 Kg per sq.m. Light transmission shall be minimum 35 \_3%. The sheets shall be obtained with closed edges. The sheet shall be bent (if required) to the require profile as per the architectural drawings but with radius not less than 175 times the thickness of the sheet. The sheet shall be fixed in a manner that the cells are parallel to the span of the shed.

The polycarbonate sheets shall be of colour and shade as approved by the Engineer-in-Charge.

The physical and the chemical characteristics of the polycarbonate sheets shall be as per the manufacturer's specifications and shall conform to the ASTM standards. The sheets shall conform to BS 476 part 7 for the fire rating. The contractor shall submit written guarantee to the Engineer-in-Charge for the polycarbonate sheets procured and provided by him against any defects like peeling, breakage, fading of color/ discoloration, cracking, leakage through the roofing loss of strength etc. for a period of ten years after the date of completion of the

work. The contractor shall obtain similar back-to-back guarantee from the manufacturer. The strength requirements are as specified below: Distribution load: 800 N per sq.m.

e. **FIXING OF SHEETS**

The polycarbonate sheets shall be used in one piece along the span of the temporary sheds. The width of the sheet across the span of the shed shall not be more than 700 mm or as per manufacturer's standards. The polycarbonate sheets shall be bent to required profile (linear or curvilinear) as per the architectural drawings and fixed in position, to the structural steel framework, using self-driving self-tapping screws with EPDM washers etc. The sheets shall be secured to the structural steel framework so as to withstand all the design dead, live, wind; other accidental loads etc. and shall be fixed in a workmanlike manner. It shall not have any sag. The polycarbonate sheets shall be jointed along the length of the shed using aluminum top & bottom pressure plates having required profiles for fixing the EPDM gaskets, screws, washers etc.

The aluminum pressure plates shall be color anodized or powder coated to the require shade. The joints in the sheet shall be provided only on the RHS steel sections of the framework and shall not be permitted elsewhere. The joint width of about 3-4 mm may be provided between the sheets at the junction for thermal expansion. The EPDM gaskets of the required profiles shall than be fixed in the grooves in the aluminum pressure plates on either side of the joint in the polycarbonate sheet. The bottom aluminum plate shall be fixed to the structural steel framework using self-driving self-tapping screws; washers etc. (one screw fixed to each sheet) and the screws fixed @300 mm center to center along the span of the shed. The EPDM gaskets of the required profile shall be fixed in the grooves in the aluminum pressure plate on either side of the joint in the polycarbonate sheet. The top aluminum pressure plate shall than be fixed securely to the bottom aluminum plate using countersunk self-driving self-tapping screws, EPDM washers etc. All the screws shall be concealed using structural silicone sealant DC 995 of Dow Corning or equivalent approved brand. Also, wherever required (especially at the joint in the EPDM gasket etc.) the junction of the polycarbonate sheet and the sides of the pressure plates on both sides shall be sealed using structural silicone sealant DC 995 of Dow Corning or equivalent brand as approved. The item includes cost of all the operations and materials including Polycarbonate sheet, EPDM gaskets, anodized aluminium capping, anodized aluminum edge capping to the sheet with U-shaped EPDM gasket, all structure silicone sealant, self-driving self-tapping screws with EPDM washers, nuts, bolts, washers etc. and the like, labour, T & P, all the incidental charges, wastages etc. involved in the work. However for the purpose of payment only the actual area of the polycarbonate sheet provided and fixed in position shall be paid for separately under relevant item. The contractor shall maintain the roofing scratch and damage free till the handling over the building for occupation, at his own cost.

f. **TOLERANCE**

- i. Weight : (+/-) 5%
- ii. Length : (+/-) 30 mm
- iii. Width : (+/-) 0.5%
- iv. Thickness : (+/-) 1mm

- g. The polycarbonate sheets shall be obtained with protective films on both sides. Care shall be taken while fixing to fix the sheets with UV protected side exposed to outside. The sheet shall be stored in a manner not to expose to direct sunlight. The sheet shall be cut to the required size or drilled using the toothed blade/machine. After fixing the protective film shall be removed and the sheets cleaned using non-alkaline based detergent and abrasive equipments or solvents are avoided. The silicones, gaskets, tapes etc. shall be compatible with the polycarbonate sheet.

- h. For joining the sheets, at least one complete channel width of each sheet shall be secured per sheet within the joining profile. Since thermal coefficient of expansion of the sheets is different from the RHS steel frames, suitable provision shall be made for accommodating differential expansions. Also any rigid jointing agent that may prevent thermal movements shall not be used. The required section aluminum profiles (upper central profile, lower central profile and top profile) for fixing the polycarbonate sheet to the structural framework as well as for joining the sheet shall be as per the manufacturer's specifications. The top capping profile shall be snap fit to the upper central profile, The EPDM gaskets and the screws shall be provided as per the manufacturer's specifications.
- i. The Gaskets shall be extruded micro wave/ steam cured EPDM/ silicone of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate/dicolour or/each on exposure to weather/rain/pollutants etc.
- j. The completed space frame structure shall under go a full and complete final inspection by manufacturer's site representative and shall be certified in writing by the manufacturer that the finished product has been erected in accordance with its approved drawing and contract documents.
- k. The contractor shall submit written guarantee to the Engineer-in-Charge for the polycarbonate sheets procured and provided by him against any defects like peeling, breakage, fading of color/ discoloration, cracking, leakage through the roofing loss of strength etc. for a period of ten years after the date of completion of the work. The contractor shall obtain similar back-to-back guarantee from the manufacturer.

**l. MODE OF MEASUREMENT**

The work shall be measured and paid in square meters. Any additional MS work provided by the contractor shall be executed on the approval of the Engineer in Charge and paid for separately.

### **33. ACOUSTICAL WALL AND CEILING PANEL**

**a. General**

The Contractor shall submit the following, before commencement of this item of work, for approval of Engineer-in-Charge

- i. Shop Drawings: Show fabrication and installation details for acoustical wall panels, including plans, elevations, sections, details and attachment to other work.
- ii. Submittals: Furnish 12"x12" samples, showing manufacture full range of colors, texture and patterns available for each type of acoustical product specified.
- iii. Product Test Report: From a qualified testing agency indicating wall panels comply with requirements.
- iv. Qualification Data: For firms specified in "Quality Assurance" Article to demonstrate their capabilities and experience.
- v. Product Certificates: Signed by manufacturer certifying that the products furnished comply with requirements.

**b. Quality Assurance**

- i. Manufacturer Qualification: Manufacture shall have a minimum of 5 years experience in production of specified products and shall furnish supporting documentation showing completed jobs of approximately the same size and scope.

- ii. Fire Test Reports: Provide acoustical wall panels with the following surface-burning characteristics as per ASTM E 84.
  - Flame Spread: 25 or less
  - Smoke Developed: 450 or less
- iii. Acoustical Test Report: Provide acoustical test report from a qualified testing agency.
- c. Delivery, Storage, and Handling

Protect Acoustical Wall Panels from excessive moisture when shipping, storing, and handling. Deliver in unopened skids and store in a dry place with adequate air circulation. Do not deliver material until all wet-work has been completed.
- d. Products

The acoustical product shall be supplied in widths and lengths as indicated. All edges will be fully wrapped with mounting as indicated.

  - i. Wall Panel-
    - All materials comply with national environmental standards, very low levels of formaldehyde, and products have natural fragrant wood.
    - Acoustical Wall Panels shall be (5/8"-1"-1 1/2"-2" or custom) - 6.0-7.0 lb. per cubic foot high-density fine fibered fibreglass. Manufactures standard panel construction, fully wrapped, hardened, panel manufactures standard full line of fabric.
    - Moisture-Resistance and mold-resistance: - Moisture Sound-absorbing panels take full use of specially processed high-density moisture-proof board to ensure moisture-proof performance of products. Grooved on front and perforated on back of the panel with concealed system (for installation). It is usually used on the wall to absorb sound and reduce noise.
  - ii. Ceiling Panels
    - Environmental friendly Fungi and stains-resistance, a new type of green building material without pollution to the surroundings, also can be recyclable, no radiation, does not contain any harmful substances.
    - Anti-Sagging 90% dry felt resin bonded fiberglass wool, longer fiber compared with mineral fiber, tight structure, solid tissue, non-absorbent, ceiling keeps stable dimension and decorative effect, no sagging, wrapping.
    - Non Dust Fall The paints are being high-pressure sprayed to the surface, high adhesion with sealed edge, no dust, effectively against airborne dust absorption, so that the board can maintain a clean indoor environment.
- e. Mounting

Back-Mounting Accessories: Manufactures standard accessories for securely mounting panels, of type and size indicated and complying with the following requirements:

  - i. Mechanically Mounted Edge-Reinforced Panels: Metal impaling clips designed to support weight of panels, mechanically attached to wall substrate according to manufactures standard pattern and adhesively bonded to back of panel, with base support brackets where recommended by manufacture for additional support of panels.
- f. Flammability Rating

All components shall have a Class A Flammability rating per ASTM E-84: Surface Burning Characteristics of Building Materials, with a Flame Spread of 25 or less and Smoke Developed of 450 or less.

g. Installation

Acoustical Wall panels shall be installed in locations indicated top edges level and in alignment with other panels. The installation of panels using type of mounting accessories indicated or, if not indicated, shall be as recommended by manufacture and as directed by the Engineer-in-Charge.

Fabric Facia can be installed using a variety of different mounting methods including: Mechanical clips (z-clips), Impaling clips, Z- bar.

h. Clearing

- ii. After completion of installation of panels, dust and other foreign material shall be removed.
- iii. Surplus material, rubbish, and debris resulting from pan installation, on completion of the work shall be removed, and shall leave areas of installation in a neat and clean condition.

### 34. SAMPLES OF MATERIALS:

- a. Sample of all materials/ fittings and fixture to be used in the work such as doors, windows, tiles, sanitary, water supply, drainage fittings and fixtures shall be submitted well in advance by the contractor for approval from the Engineer-in charge of work in writing before placing orders for the entire quantity required for completion of work. Samples approved by the EIC/Client shall be kept in **Sample Room under the charge of EIC** and shall retain till completion of work.
- b. Finished items in respect of typical portion of works of repetitive nature such as typical room, toilet, railing, door, window or any other work desired by the engineer-in- charge shall be prepared by the contractor to the satisfaction of Engineer-in – charge and got approved from him in writing before the commencement of these items for the entire work.
- c. The requirements for preparation of samples shall be observed and fulfilled by the contractor well in advance to avoid any detriment to the general progress of work. In other words, this will not be allowed to have any effects on the general progress of work or on any of the terms and conditions of the contract. No claims of any kind whatsoever including the claims of extension of time will be entertained due to the incorporation of this requirement.

**35. GRIHA requirements;** Materials shall be procured by the contractor keeping in view the recycled content to **conform** the GRIHA requirements as detailed in SCC and elsewhere.

**36. VARIATION IN CONSUMPTION OF MATERIALS:** The variation in consumption of material shall be governed as per CPWD specification and clauses of the contract to the extent applicable.

**37. MISCELLANEOUS:** - Materials manufacture by reputed firms and approved by Engineer – in charge shall only be used. Only articles classified as “First Quality” by the manufactures shall be used unless otherwise specified. Preference shall be given to those articles which bear ISI certification marks. In case articles bearing ISI certification marks are not available the quality of sample brought by the contractor shall be judged by the standards laid down in the latest CPWD

specifications. For items not covered by the latest CPWD specification, relevant ISI standards shall apply.

**38. TESTS:**

- a. Materials brought at site of work shall not be used in the work before getting satisfactory test results for Mandatory tests as per relevant provisions in Latest CPWD Specifications for works. Normally, part rate payment shall be allowed in the running account bills only if the materials are tested and test results are found to be satisfactory to by the Engineer-in-charge. These tests shall be got done from laboratories pproved by Engineer-in - charge or the laboratory set up by the contractor at site as per directions of Engineer-in - charge.
- b. The Engineer-in - charge of work shall check the test results and satisfy himself before allowing any payment in the running /final bill.

## **CHAPTER C**

### **TECHNICAL SPECIFICATIONS PLUMBING, SANITARY WORKS, WTP & RELATED MACHINARIES**

#### **SECTION 1      GENERAL REQUIREMENT**

##### **1. Scope of work**

The work shall in general conform to the Latest CPWD Specifications for works as mentioned in Schedule 'F' of the GCC. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities and/or shown on the plumbing drawings.

#### **SECTION 2      PLUMBING FIXTURES**

##### **1. Scope of work**

- a. Work under this Part shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings and specified in the Bill of Quantities.
- b. Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-
  - i. Sanitary fixtures
  - ii. Bath tubs, shower trays
  - iii. Chromium plated fittings
  - iv. Porcelain or stainless steel sinks
  - v. Accessories e.g. towel rods, toilet paper holders, soap dish etc.
  - vi. Whether specifically mentioned or not, the rates quoted for the installation of the fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers, fasteners as required.
  - vii. All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

##### **2. General**

- a. All sanitary fixtures, CP Fittings and CP/SS accessories shall be supplied at site of work as per manufacturers' standard supply.
- b. All fixtures and fittings shall be provided with all such accessories and fixing devices as are required to complete the item in working condition, even if the same is not specifically mentioned the Bill of Quantities, Specifications or shown on the drawings. The rate quoted will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces etc.
- c. Fixing screws shall be half round head stainless steel wood screws or bolts with Stainless Steel washers. Iron screws rust and will not be permitted.
- d. All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be

made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

- e. Contractor shall provide poly-sulphide sealant appropriate for its use for all fixtures fixed near wall, marble core seal and edges.

### **3. Water Closets**

#### **a. European W.C.**

- i. W.C. shall be any one of the following types:
- ii. Wall hung wash down or single or double siphon type
- iii. Each W.C. set shall be provided with an approved seat of approved finish compatible and fitting appropriately with the WC set with rubber buffers and hinges. The WC seat shall be those approved and accepted for fixing on a particular type of WC.
- iv. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- v. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

#### **b. Health faucet/spray**

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as shown on the drawings or directed by the Engineer-in-charge. The angle valve and flange shall be paid under relevant item with abulation tap.

### **4. Wash Basins**

- a. Wash basins shall wall mounted type or for under over/counter installation as specified in the BOQ.
- b. Each basin shall be supported on MS galvanized or painted C.I. brackets and the basin securely fixed to wall or under/above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- c. Each basin shall be provided with 32 mm dia. C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia. C.P. brass bottle trap with CP pipe to wall and flange as specified in the BOQ.
- d. Each basin shall be provided with a single tap a hot & cold CP mixer with or without pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and wall flange.
- e. The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide sealant
- f. Washbasins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cm or as directed by Engineer-in-charge.
- g. Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

### **5. Sinks**

- a. Sinks used shall be of any of the following types:
  - i. For kitchens, pantries, and designated utility rooms, the sinks shall be stainless steel sinks with or without drain boards.



- b. Each sink shall be supported by **MS galvanized** or painted C.I. brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- c. Stainless steel sinks shall be provided with 40 mm dia. C.P. basket waste with plug (as supplied by manufacturer), 40 mm dia. C.P. brass "P" trap with CP pipe to wall and flange.
- d. Each sink shall be provided with hot & cold CP mixer with approved type of a neck spout or individual taps as directed by the Engineer-in-Charge.

#### 6. Shower set

- a. Shower set shall comprise of hot & cold water mixer, C.P. shower arm with wall flange and shower head adjustable type.
- b. Mixer shall be exposed type, single lever, concealed stop cocks with diverter and spout as selected by the Engineer-in-charge.

#### 7. Hand Drier

- a. The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.
- b. The hand drier shall be fully hygienic, rated for continuous repeat use.
- c. The rating of hand drier shall be such that time required to dry a pair of hands upto wrists is approximately 30 seconds.
- d. The hand drier shall be wall mounting type suitable for 230 volts, single phase, 50 Hz, A.C. power supply.

#### 8. Accessories

- a. Accessories shall be of any of the following types:
  - i. Towel rails
  - ii. Towel rings
  - iii. Coat hooks
  - iv. Soap dispensers
  - v. Soap dishes
- b. Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.
- c. Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

#### 9. Measurement & Rates

- a. Sanitary fixtures shall be measured by numbers or as specified in BOQ.
- b. Rates for all items mentioned above shall be inclusive of cutting holes and chases and making good the same, stainless steel screws, nuts, bolts, fastener and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

## **SECTION 3      Soils, Waste, Vent & Rainwater Pipes & Fittings**

### **1. Scope of work**

- a. Work under this Part shall consist of furnishing all labour, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.
- b. Without restricting to the generality of the foregoing, the system shall include the following:-
  - i. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.
  - ii. C.I. soil & uPVC rainwater pipes.
  - iii. Connection of all pipes to sewer lines as shown on the drawings at ground floor levels.
  - iv. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.
  - v. Testing of all pipe lines.

### **2. General requirements**

- a. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- d. Pipes shall be securely fixed to walls and ceilings by suitable clamps intervals specified.
- e. Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

### **3. Piping System**

- a. Soil, Waste & Vent Pipes
  - i. The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in BIS: having separate pipes for waste for kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains and is approved by Engineer-in-charge.
  - ii. All waste water from AHU's plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.
  - iii. Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly where feasible and shown on the drawings.
  - iv. Floors of toilets, kitchens and other service areas located on structural slab are SUNK below the finished floor level (FFL).

b. Rainwater Pipes

- i. All terraces shall be drained by providing down-takes rainwater pipes.
- ii. Rainwater pipes are separate and independent and connected to the storm water drainage system as shown on the drawings.
- iii. Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water harvesting chambers as shown in drawings.
- iv. Any dry weather flow from waste appliances, AHU's pump rooms, shall not be connected to the sewerage system.

c. Balcony/Planter drainage

- i. All balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes as per the landscape/architectural drawings and details

d. Cast iron pipes & fittings (for Soil, waste, anti-siphon age pipes)

- i. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast to I.S. 3989.
- ii. Standard weight dimensions shall be as follows:-
  - Sand Cast Iron Pipes & Matching Fitting shall be in conformity to I.S. 1729
  - Centrifugally cast (spun) iron pipes and fittings in conformity to I.S. 3989

e. uPVC pipes & fittings (For Rain Water Pipes etc.)

- i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-1988. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating as specified in the B.O.Q.
- ii. Polythene pipes may be cold bending to a radius of not less than eight times of their external diameter. Pipes bent for smaller radius may be made by hot bending.
- iii. Fittings used for Polythene pipes shall be compression moulded fittings matching to the above specifications.

f. Jointing

- i. All Polythene pipes shall be Drip seal/Sealant and jointed as per manufacturer's specifications and relevant I.S codes.
- ii. All pipes shall be tested after installation for a pressure equal to twice the maximum working pressure in the line as per manufacturer's specifications.

g. Fittings

- i. Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching IS Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- ii. Fittings shall be of the required degree of curvature with or without access door.
- iii. Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

h. Fixing

- i. All vertical pipes shall be fixed by galvanized structural support clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
- ii. Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps (Clevis clamps) of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- iii. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-Charge/Building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

#### 4. Clamps

- a. Holder bat clamps shall be of standard design and fabricated from galvanized M.S. standard flats 40x3 mm thick and 12 mm dia. GI Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cm deep.
- b. Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with galvanized 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- c. Structural clamps shall be fabricated by electro-welding from G.I. structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide G.I. all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be hot dipped galvanized before using.
- d. Galvanized slotted angle/ channel supports on walls shall be provided wherever shown on drawings. Angles/ channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- e. Wherever G.I. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1 : 2 : 4 mix (1 cement : 2 coarse sand : 4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-charge.
- f. For sleeves, RCC cutting, hole, chasing etc. anchor fasteners and clamp spacing chart see Special Conditions.
- g. All the clamping and supporting material are included in rates nothing to be paid extra in any head.

#### 5. Traps

##### a. Floor traps

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement :2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cm of the required depth.

##### b. Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent and set in cement concrete block specified for floor traps.

c. Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting fabricated from G.I. pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe. Joint between waste and hopper inlet socket shall be Drip Seal. Inlet shall be connected to a C.I. P or S trap. Floor trap inlet hoppers and the traps shall be set in cement concrete blocks as specified in para above without extra charge.

d. Gratings for traps

Floor and urinal traps shall be provided with 100-150mm square or round C.P./Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm or as specified in the Schedule of Quantities.

e. Jointing

Soil, waste vent, anti-syphonage and rainwater pipes shall be jointed with refined drip seal conforming to I.S. 27-1977ket. Sufficient skein of jute rope shall be caulked to leave a minimum space for the Drip seal as given in Para 3.4.3 to be poured in. After the pouring the lead shall be caulked in to the joint with caulking tool and hammer.

## 6. Cleanout Plugs

a. Cleanout Plug on soil pipes

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be Drip seal caulked to the drain pipes.

b. Cleanout Plug on Drainage Pipes

- i. Cleanout plugs shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-charge. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150 mm dia. Cleanout Plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.
- ii. Cleanout Plug at Ceiling Pipes: - Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanised sheets and angles with hinged type doors with fly nuts, gasket etc., as per drawing.

## 7. Waste pipe from appliances

a. General

- i. Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of heavy galvanized steel /CPVC as given in the Schedule of Quantities or shown on the drawings.
- ii. All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized

structural clamps. Spacing for clamps for such pipes shall be as per good engineering practice approved by the Engineer-in-Charge.

b. Galvanized pipes

Waste pipes from appliances shall be galvanized steel tubes conforming to I.S.1239 (Heavy class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be wrapped with bitumen tape and then painted with two coats of black bitumen paint. Exposed pipes with one coat of Zinc chromate with etch coating primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. Colour shall be as per the approved colour code.

## 8. Cast iron pipes for drainage

- a. All drainage lines passing under building, in exposed position above ground e.g. basement ceiling etc. shall be cast iron pipes. Position of such pipes shall generally be shown on the drawings.
- b. Cast iron pipes shall be spigot & socket (S&S) centrifugally spun iron pipes conforming to I.S. 1536. (Class LA). Quality certificates shall be furnished.
- c. Fittings  
Fittings used for C.I. drainage pipe shall conform to I.S. 1538 (Heavy class). Wherever possible junction from branch pipes shall be made by a Y- tee.
- d. Joints
  - i. Joints between pipes shall be made with pre-moulded rubber joints (Tyton Joints) supplied by the manufacturer to ensure compatibility and water tightness.
  - ii. Joints between pipes and fittings shall be made by caulked spun yarn dipped in tar and molten drip seal 45 mm deep by hammering with caulking tools.

## 9. Encasing pipe in Cement Concrete

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m. Rate for concrete round pipes shall be inclusive of pillars, supports, shuttering and centring.

## 10. Painting

- a. All cast iron, soil, waste vent, anti-siphon age and rainwater pipes in exposed location in shafts and pipe spaces shall be painted with two or more coats of synthetic enamel paint to over a priming coat to give an even shade.
- b. Paint shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe colour code.
- c. G.I. waste pipes in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint over each priming coat.
- d. C.I. soil and waste pipes below ground and covered in cement concrete or lead pipes shall not be painted.

## 11. Cutting and making good

- a. Pipes shall be fixed and tested as building proceeds.
- b. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or brick work in cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

## 12. Testing

- a. Testing procedure specified below apply to all soil, waste and vent pipes above ground including C.I. LA pipes laid in basement ceiling.
- b. Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing shall be certified for its calibration by an approved laboratory.
- c. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site. All testing equipment must be calibrated and shall carry certificate from an approved laboratory.
- d. Testing soil, waste and rainwater pipes
  - i. Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.
  - ii. After installation all connections from fixtures, vertical stacks and horizontal drains including C.I. LA pipes shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.
  - iii. The entire installation shall be tested by smoke testing machine. The test can be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging all inlets by bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.
  - iv. After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. Rectify and replace where required.
- e. Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-charge and signed by both.

## 13. Measurements

- a. General
  - i. Rates for all items quoted shall be inclusive of all work and items given in the specifications and Schedule of Quantities.
  - ii. Rates are applicable for the work under floors, in shafts at ceiling level area for all heights and depths.
  - iii. Rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

- iv. Rates are inclusive of pre testing, on site testing, of the installations, materials and commissioning of the works.
- v. Pipes (Unit of measurement, linear meter to the nearest Centimetre) or as specified in CPWD specifications.
- b. All C.I. Soil, waste, vent, anti-syphonage and rain water pipes shall be measured net when fixed correct to a centimetre including all fittings along its length. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above will apply to both case i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level.
- c. Pipes shall be measured per running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality, and finish. The diameters shall be nominal diameter of internal bore. The pipes shall be described as including all cutting and waste. In case of fittings of unequal bore, the largest bore shall be measured.
- d. Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centring cutting complete as described in the relevant specifications.
- e. Slotted angles/channels shall include support bolts, nuts and clamps embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.
- f. Fittings  
Unit of measurement shall be the number of pieces. Pipe fittings are included in the rate for pipes. Urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.
- g. Painting  
Painting of pipes shall be measured per running metre and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.
- h. Excavation for soil pipes  
No payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron soil and waste pipes laid below ground, in sunken slabs.
- i. Engineer-in-charge's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.



## **SECTION 4      Water Supply Systems**

### **1.      Scope of work**

- a. Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.
- b. Without restricting to the generality of the foregoing, the water supply system shall include the following:-
  - i. Rising main from water supply pumps to all overhead tanks.
  - ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.
  - iii. Insulation to hot water pipes within toilets.
  - iv. Connections to all plumbing fixtures, and appliances.

### **2.      General requirements**

- a. All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.
- e. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the Engineer-in-Charge.
- g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

### **3.      Water Supply System**

- a. Contractor should study the site plan and water supply system diagram for overviews of the system.
- b. Source
  - i. Water supply will be acquired from Clients mains line (water report enclosed).

- ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank located in basement.
- c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

#### 4. G.I/ CPVC Pipes & Fittings

- a. All pipe inside the building and where specified, outside the building shall be galvanized conforming to I.S. 1239 / CPVC, steel tubes of class specified. When class is not specified they shall be heavy class.
- b. Fittings shall be malleable iron galvanized /CPCV of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I. /CPCV pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 1879-(Section I to X).
- c. Pipe and fittings shall be joined with screwed joints, after cutting a pipe with a hacksaw or a cutting machine care shall be taken to remove burr from the end of the pipe after reaming with a proper file.
- d. Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.( Use of red and white lead sutli will not be permitted for screwed joints)
- e. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I./CPCV pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.
- f. Clamps
  - i. G.I/CPCV pipes in the shaft and other locations shall be supported by galvanized M.S. clamps of design approved by Engineer-in-Charge. Pipes in wall chases shall be anchored by G.I hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from G.I. Structural. Pipes in typical shaft shall be supported G.I. slotted angles / channels as per standard drawings.
  - ii. Spacing of clamps, hooks etc. Shall be as per good engineering practice approved by the Engineer-in-charge
- g. Unions
 

Contractor shall provide adequate number of unions on pipes 50mm and below to enable easy dismantling later when required .Unions shall be provided near each gunmetal valve , stop clock , or check valve and go on straight runs as necessary at appropriate locations as required and /or direct by Engineer-in-Charge.
- h. Flanges
  - i. Flanged connections shall be provided on pipes 65 mm and above as required or where shown on the drawings generally as follows:
    - On straight runs not exceeding 30 m, near bends and at connections to main branch lines.
    - On all valves ends

- On equipment /pump connections as necessary and required or as directed by Engineer – in - charge.
- i. Flanged connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion neoprene gaskets Bolt hole dia. for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780. and C.I. butterfly valve to IS: 13095.
- j. Trenches
  - i. All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia. of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cm	75 cm
65 mm to 100 mm	45 cm	100 cm

**ii. Sand filling**

Where specified in the Schedule of Quantities all G.I. pipes in trenches shall be protected with fine sand 15 cm all around before filling in the trenches.

- k. Where shown on the drawings, main pipe lines may be run in masonry trenches from the pump house to the buildings in phase I & II , filled up with sand and buried in ground as per architectural / landscape details.

**l. Painting**

All pipes above ground shall be painted with one coat Zinc with each coating and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-charge.

**m. Pipe protection**

- i. Where specified in the Schedule of Quantities all pipes in chase or below floor shall be protected against corrosion by the application of two coats of bitumen paint covered with bitumen tape and a final coat of bitumen paint before covering up the pipe.
- ii. All G.I. /CPVC water supply pipes below ground shall be protected against corrosion by applying one layer of 4 mm thick multilayer anticorrosive polymeric mix tape applied over a coat of primer as per recommendations of the manufacturers. (Pypcoat)

**n. Insulation**

Hot water pipes within a toilet /kitchen from hot water header shall be insulated with fire resistance closed cell chemically cross linked polyethene is used in the forms of rolls, sheets and tubes. The thickness of insulation is 13mm on all sizes of pipes. Density of insulation is 30±2kg/cum.

**5. Valves**

**a. Ball valves**

Valves 50 mm dia. and below shall be screwed type ball valves with stainless steel balls spindle Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm<sup>2</sup> and accompanying couplings and steel handles to B.S. 5351.

**b. Butterfly Valves**

- i. Valves 65 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/or flow regulation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick .P.N 1.6
- ii. Butterfly valve shall be of best quality conforming to IS: 13095.

c. **Non Return Valve**

- i. Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only, It shall be single door swing check type of best quality conforming to IS: 5312.P.N1.6
- ii. Each butterfly and slim type swing check valves shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanized nuts, bolts and double washers of correct length.
- iii. Sluice valve shall be of approved makes conforming to I.S.:780 of class as specified.

## 6. **Storage Tanks**

### a. **Underground Tanks**

- i. Underground storage tanks for water supply shall be reinforced cement concrete built by the building contractor.
- ii. Each tank shall be provided with lockable type manhole cover as approved by the Engineer-in-charge or as approved by local municipal authority.

### b. **Overhead Tanks**

Overhead water storage tanks for water supply shall be of reinforced cement concrete or of PVC as per requirement.

### c. **Tank connection and accessories**

- i. Contractor shall provide the following to each tanks:
  - Inlet and outlet connections to pumps, equipment and main pipe lines.
  - Tank overflows with mosquito proof gratings
  - Scour drain and valve as per drawings
  - Water level gauge with approved type of brass gauges, plastic tube, a wooden board with level marking.
- ii. Electronic level controllers, cabling, sequence controllers and all related equipment shall be provided by agency executing the pumping system work. Plumbing contractor shall provide necessary G.I. sleeves and co-operate with the contractor to ensure that the work is successfully executed.

### d. **Outlets and overflow**

All nozzles for puddle flanges in RCC tank for inlet, outlet, overflow and scour etc. shall be provided by civil contractor or as given in the Schedule of Quantities. Further connections and accessories shall be provided under this contract.

## 7. **Testing**

- a. All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg /cm<sup>2</sup> whichever is more. Pressure shall be maintained for a period of at least 12 hours without any drop & withstand for 8 hrs.
- b. A test register shall be maintained and all entries shall be counter-signed by Contractor(s) in the presence of Engineer-in-charge.
- c. In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.
- d. After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

## 8. Measurements

- a. G.I./CPVC pipes
  - i. G.I./CPVC pipes above ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, and flanges. Deduction for valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.
  - ii. G.I./CPVC pipes below ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of fittings, e.g. couplings, tees, bends, elbows, unions. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chases and making good and all other items mentioned in the specifications and Schedule of Quantities.
- b. Gunmetal, cast iron, butterfly and non-return valves puddle flanges, level indicators and meters shall be measured by numbers.
- c. Brick masonry chamber for valves and meters shall be measured by number and include all items given in the Bill of quantities.
- d. Painting/pipe protection  
Painting/pipe protection for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.
- e. Engineer-in-Charge's decision with respect to the correct interpretation regarding mode of Engineer-in-Charge measurement shall be final and binding on the contractor.

## Section 5 DRAINAGE (Sewers & Storm Water Drains)

- a. **Scope of work**
  - i. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

- ii. Without restricting to the generality of the foregoing, the drainage system shall include:-
  - a) Sewer lines including excavations, pipe lines, manholes, drop connections and connections to the municipal sewer.
  - b) Storm water drainage, excavation, pipe lines, manholes, catch basins, drain channels, recharging pits and overflows to municipal drain

**b. General requirements**

- iii. All materials shall be new of the best quality conforming to specifications and subject to the approval of the
- iv. Drainage lines and open drains shall be laid to the required gradients and profiles.
- v. All drainage work shall be done in accordance with the local municipal bye-laws.
- vi. Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.
- vii. Location of all manholes, etc. shall be as per site plan drawings. No drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Engineer-in-Charge.

**c. Reinforced cement concrete pipes**

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun S & S RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

**i. Laying**

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge.

**ii. Jointing**

After setting out the pipes the socket shall be centred over the spigot and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45° to the longitudinal axis of the pipe on both sides of the collars neatly.

**iii. Testing**

All pipes shall be tested to a hydraulic test of 1.5 m head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above the smoke test shall be carried out by the Contractor, if directed by the A test register shall be maintained which shall be signed and dated by Contractor/ Engineer-in-Charge.

**iv. RCC. pipes**

R.C.C. pipes shall be measured for the finished length of the pipeline in running metres nearest to a centimetre.

- (a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole,
- (b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.

## **Section 6 - BOREWELL**

### **a. SCOPE:**

The general character and the scope of work to be carried out under this contract is illustrated in the following specifications. It gives only general guidance as regarding design, drilling and construction of Borewells. Improved methods of construction may be adopted with prior agreement between the contractor/agency and Client. The construction and testing of Borewells shall be as per I.S: code No 2800, (Part I & II). This contract is an item rate contract. All payments shall be made for the actual work executed. The required minimum yield shall be ensured by the contractor.

### **b. SELECTION OF SITE:**

The site, where the Borewell is proposed shall be examined by tenderer, and changes if required shall be discussed with consultants prior to starting the work. Any previous data available with the Contractor/Agency regarding nearby Borewells should be made use of to evolve suitable procedure for drilling, developing, testing etc.

### **c. GEOLOGICAL DATA:**

During the drilling time, contractor shall collect the samples of different strata from suitable intervals or where change in the strata is met with. It shall be carefully examined and analyzed and Data shall be preserved carefully and handed over to the Owners. The contractor/agency shall make one drilling time log during the execution of work.

### **d. DESIGN AND LOWERING OF PIPE ASSEMBLY:**

The size and length of blind pipes and slotted/strainer pipes shall be selected according to the actual requirement and according to the strata met with the expected discharge and the depth of Borewell. The size and distribution of the slots shall be as per IS: 8110 (Latest Revision).

### **e. GRAVEL PACKING:**

All Gravel shall consist of hard well rounded particles reasonably uniform in diameter and shall be of a size 1.5mm to 3mm.

### **f. DEVELOPMENT OF BOREWELL:**

The well shall be developed either by surging and agitating or by over pumping and backwashing with an air lift and high velocity jetting, etc. Any other acceptable method may also be adopted.

The development process shall be continued until the stabilization of sand and gravel pack has taken place.

### **g. HANDING OVER OF THE BOREWELL:**

The Borewell shall be handed over to the owner in a complete shape. The housing pipe shall be closed by a well cap for the period between the completion of the Borewell and the installation of the pump set. Sealing of the Borewell may be done by grouting the annular space between bore and the housing pipe, thickness of grouting depends upon the quality of water.

The following information shall be furnished by the drilling agency on completion of the Borewell.

1. Strata chart of the Borewell indicating the different types of soil met with at different depths.
2. Samples of strata collected, neatly packed and correctly marked in sample bags.
3. Chart of actual pipe assembly lowered indicating the size of pipes, depth ranges, where slotted/strainer pipes have been used, depth and diameter of housing pipe, reduced level of the top of the housing pipe and the diameter and depth of the bore hole.
4. Position of every joint in the well assembly.
5. Hours of development done by compressed air or over pumping unit etc.
6. Pumping water level at the developed discharge.
7. Two attested copies of all test certificates from the agency approved by the Engineer-in-charge.

## **SECTION – 7      Water Treatment Plant**

### **1.    Scope of work**

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required for the satisfactory supply, installation, completion and commissioning of water treatment plant system and allied works as described hereinafter, as specified in the schedule of quantities and/or shown on the plumbing drawings and described in the scope of work .

### **2.    The System**

- a. The system described below is for the contractors bidding for the works to understand the extent and scope of work and the intent in the manner in which the water supply system is planned and shall be executed. This does not form a part of the contractor's scope of work with respect to the various elements that are described in this paragraph.

#### **b. Sources of supply**

**Local** water supply for which a water main from the main road to the underground water tank will be laid by contractor.

#### **c. Underground water tanks**

- i. **Static fire water storage tanks** in compartments .Connections from the tube well water supply lines will be made into these tanks. Water will overflow into the raw water tanks
- ii. Raw Water Tank to hold the tube well as well as CWS Supply water will be made to:
  - A set of pumps will be connected to and water filter and chlorination system and the filtered water stored in the Treated Water Tanks (in three compartments. All piping and connections for this system are a part of this contract.



- Domestic Water Pumping Systems

- iii. Water supply to the various buildings will be made from a set of pumping sets to the overhead water and supplementary fire tanks located on the terrace of each building in the following order:

### 3. Rising Mains & level control system

- a. Water from the pumps described above will fill each tank by a rising main to each tower.
- b. To control the level in each tank and enable it to fill as the water demand so requires, each tank will be provided with a ball cock to shut off the water supply when the tank is full.
- c. A set of electronic level sensing probes will be installed in each tank. The probes installed in each pumping system will be wired to a central electronic panel which will activate the pump when any one of the tank probe signals low water conditions and top up all tanks. No excess flow will occur due to the ball cock in the tank.

### 4. Level Controllers

- a. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:-
  - i. Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location
- b. Overhead tank level controller cum indicators
  - i. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:
  - ii. To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.
  - iii. Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.
  - iv. Indicate the water level in each OHT in the level indicating panel installed in the pump room
  - v. Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.
- c. Control & Indicating Panel (For overhead and underground water tanks)
  - i. A centralized indicating stand-alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ( $\frac{1}{4}$ th,  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:
    - ii. Digital level indicator panel meter for each water tank.

- iii. Etched plate identification plates.
- iv. Control cabling from MCC to the panel installed in the control room as directed by the Engineer-in-Charge.
- v. Cabling from PHT sensing probes to the panel

## 5. Pressure filters for Water Supply System

- a. Specification shall apply for water filtration system
  - i. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media, G.I. face piping, accessories testing and commissioning complete, Working Pressure 2.4 kg/cm<sup>2</sup> (Test pressure 3.75 kg/cm<sup>2</sup>). Along with bfv & nrv & gauge, prv etc.
  - ii. Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.
  - iii. The diameter and height of each vessel shall be as per the design requirement and given in the BOQ and as per site conditions.
- b. Multi-Port Valves
  - i. Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.
  - ii. Provide suitable sampling cocks to draw water samples for raw water and treated water.
- c. Face Piping
  - i. Each vessel shall be provided with non-corrosive face piping from the inlet to the outlet. Face piping shall be CPVC (IS 4985) 10 kg/cm<sup>2</sup> all CPVC fittings are heavy grade to pipe and solvent weld and flanged joints
  - ii. All valves shall be butterfly valves as specified in the piping section over 65 mm dia. and for pipe dia. below 50 mm dia. shall be provided with ball valves.

## 6. Designing of Water Treatment Plant :

Designing shall essentially include but not limited to the following :

- a. Process Design
  - b. Preparation of general arrangement drawing with sufficient information for the Structural Engineering Consultant to design the structure of various components.
  - c. Selection of all mechanical and electrical equipment like pumps, motors, pipes, valves and other appurtenances, switchgear, cables etc.
  - d. Preparation of detailed engineering drawings
7. **Supply and Installation of Mechanical & Electrical Equipment** like pumps, filters, softner, pipes, valves and other appurtenances, pump control panel, cabling etc.

## IMPORTANT NOTES

- a. It is understood that this Contract includes supply, installation, testing and commissioning of all the equipment, components etc. whether explicitly mentioned above or not for the successful commissioning of the Water Treatment Plant as per the parameters mentioned herein.
  - b. The tenderer must clearly indicate the material of construction, performance parameters, sizes etc of each equipment being offered by him.
  - c. The Civil Work like construction equipment foundations etc. is not included in the Scope of this work. However, the Contractor will have to provide complete details regarding the requirements of Civil Works, so that these can be executed by a separate agency.
8. **Interconnecting Pipework:** All interconnecting pipework starting from the inlet to the Raw Water Feed Pumps up to the final outputs of treated water streams.
9. **Electrical Works :** Pump control panel, all interconnecting power and control cabling for pumps, dosing pumps from control panel to respective motors and drives, interlocking of dosers, level controllers with cabling etc.

## 10. Raw Water Characteristics

The water characteristics of the available water sources are as per the enclosed Water Test Report

**WORK REFERENCE:** Laboratory testing of Water for use as Potable Water.

**SAMPLE REFERENCE:** Well Water

**SOURCE:** 100m from Boundary wall.

<u>PHYSICAL EXAMINATION</u>			
SI No.	Type of Test	Obtained	Requirement (Desirable Limits) as per I.S. 10500
1	Colour	Not Agreeable	5 units Max.
3	Smell	Not Agreeable	-
5	Turbidity, NTU	10.0 NTU	5.0 NTU (Max.)
6	Sediment	Present	-

<u>CHEMICAL EXAMINATION</u>			
SI No.	Type of Test	Obtained	Requirement (Desirable Limits) as per I.S. 10500
1	pH Value	5.80	6.5 to 8.5
2	Carbonate Hardness	12.0 mg/ltr.	-

	Non-Carbonate Hardness	25.0 mg/ltr.	-
	Total Hardness	37.0 mg/ltr.	300 mg/ltr. (Max.)
3	Free & Saline Ammonia	0.036 mg/ltr.	-
4	Chloride (as Cl)	0.50 mg/ltr.	250 mg/ltr. (Max.)
5	Nitrate (NO <sub>3</sub> )	1.2 mg/ltr.	45 mg/ltr. (Max.)
6	Sulphate (SO <sub>4</sub> )	Nil	200 mg/ltr. (Max.)
7	Phosphates	Nil	-
8	Nitrites	0.032 mg/ltr.	-
9	Iron	0.65 mg/ltr.	0.3 mg/ltr (Max.)*
10	Albuminoid Ammonia	Nil	-
11	Residual Free Chlorine	Nil	0.2 mg/ltr. (Min)
12	Dissolved Oxygen	5.0 mg/ltr.	-

BACTERIOLOGICAL EXAMINATION			
Sl. No.	Type of Test	Obtained	Maximum allowable Limit
1	Total colonies in Agar plate in 1 ml. of the sample after 48 hours of incubation at 37° C $\pm$ 0.5° C	Countless	100
2	Most Probable Number (MPN) of Coliform group of Organisms per 100 ml.	1800+	Absent
3	Most Probable Number (MPN) of E. Coli per 100 ml	Not Detected	Zero

## 11. Treated Water Requirements

### a. From Filter/Softener Based Water Treatment Plant

Interval between Two Regenerations : **10 Hours.**  
 Total Output between Two Regenerations : **2,25,000 Litres**

Total Hardness = 30 - 80 mg/litre

pH = 7.0 – 7.5  
Other Parameter shall be as per IS: 10500

**Note:** Blending is to be achieved with the help of Rotameters

## 12. Water Filtration Plant (For Domestic Water)

- a. Design parameters for the proposed filter shall be as follows:
  - i. Filter media:- Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.
  - ii. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer's design)
  - iii. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m<sup>2</sup> of filter surface area and water supply from raw water pumps by reverse flow)
  - iv. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria

## 13. Chemical Dosing Pumps

- a. Pump applications
  - i. Chlorination of raw water from tube wells,
  - ii. Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/HDPE solution tank with level gauge and lid on top.
  - iii. Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumps so that they operate only when the pumps are operating.

## 14. Air Blower for Back Washing

- a. Low pressure air blower with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate with oil and water separator.
- b. Air blowers will be used for back washing operations. The air blower shall be designed for operation of one filter at a time. Blowers will be designed for air flow of approx 5.1 lpm/m<sup>2</sup> air capacity at 0.5 kg/cm<sup>2</sup> pressure. (This may be modified to suit manufacturer's requirement for filters offered.)
- c. The electrical switchgear shall be included in the respective MCC panel of the system

## 15. Pipes & Fittings

- a. Headers, piping and connections
  - i. All pipes within the plant room building in exposed locations and shafts including connections buried under floor and for suction and delivery headers shall be G.I. pipes heavy class and thickness specified. Pipes up to 150 mm dia. shall conform to I.S. 1239.

- ii. Pipe 200 mm dia. and above shall be G.I. ERW tubes to IS 3589. If black pipes are available they shall be galvanized before use.
- iii. Fittings for G.I. pipes shall be approved type malleable iron or wrought iron screwed galvanized fittings for screwed joints. Fittings 200 mm dia. may be shop fabricated but shall be shop galvanized after fabrication.
- iv. All M.S. structural supports and clamps shall be galvanised. All the pipe work within plant room shall be adequately supported with G.I. structural supports from floor or ceiling as required and directed by Engineer-in-Charge.

**b. Jointing**

**i. G.I. Pipes (Screwed joints)**

Pipe shall be provided with metal to metal threaded joints. Teflon tape shall be used for lubrication and rust prevention. (USE OF LEAD /ZINC BASED JOINTING COMPOUND ARE NOT PERMITTED)

**ii. Flanged joints / Dead Joints**

- Flanges shall be provided on:
  - Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.
  - Both ends of any fabricated fittings e.g. bends, tees etc. of 50 mm dia or larger diameter. (When Permitted)
  - Both end of all suction delivery and other headers.
  - For jointing valves, appurtenances, pumps, connections with pipes, to water tanks and other places necessary and required as good for engineering practice.
  - Flanges shall be as per applicable I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion rubber gasket complete.
  - The cost of flanges is included in the rates of pipes along with fittings.

**iii. Unions**

Provide approved type of dismountable unions on pipes lines 50 mm and below near valves or inspector test/drain and assemblies and as required as per site conditions.

**iv. Vibration Eliminators**

All suction and delivery lines and as shown on the drawings double flanged reinforced neoprene bellow type flexible pipe connectors shall be provided. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer's details.

**c. Valves**

**i. Sluice valves**

- Full way Sluice Valves shall be used on the suction connection to pumps and headers.
- Sluice valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.
- Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class

**ii. Butterfly Valves (PN 1.6 rating)**

- Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6
- They shall have a cast iron body.
- Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.
- The shaft to be EN-8 Carbon Steel with low friction nylon bearings.
- The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.
- Built in flanged rubber seals.
- Actuator to level operated for valves above ground and T Key operated for valves below Ground.
- Built in flanges for screwed on flanged connections. Manufacturer's details on fixing and Installation will be followed.

**iii. Non Return Valves (NRV PN 1.6 rating)**

- Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
- NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform relevant IS or match the butterfly valves.PN 1.6
- Built in flanges for screwed on flanged connections.

**iv. Ball Valves**

Ball Valves up to 40 mm dia. shall be screwed type ball valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm<sup>2</sup> and accompanying coupling and steel handles (to B.S. 5351).

**d. 'Y' Strainers (PN 1.6 rating)**

Provide cast iron 'Y' type strainers with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pumps.

**16. Measurements****a. General**

- Unit rate for individual items, e.g., pressure tanks, MCC, level controller, water tank are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to measured separately in this contract only.
- All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

**b. Level controllers & Alarms**

Level controllers for each set of pumps shall be measured by number and inclusive of probes, cabling up to surface box near the pump and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

**c. Piping Work**

- i. Suction and delivery headers for each pumping system shall be measured per set with required length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.
- ii. CPVC pipes between various filters and units shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.
- iii. Vibration eliminators, "Y" strainers, butterfly valves, slim non return valves, ball valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications except from pump room.

## **17. Specifications for Electrical Installation**

### **a. Electrical Control Panels**

#### **i. General**

- All medium voltage switchboards shall be suitable for operation at three phase/three phase 4 wire, 415 volt, 50 Hz, neutral grounded at transformer system with a short circuit level withstand of 31 MVA at 415 volts or as per schedule of quantities.
- The Switch Boards shall comply with the latest edition with up to date amendments of relevant Indian Standards and Indian Electricity Rules and Regulations.

#### **ii. Switch Board Configuration**

- The Switch Board shall be configured with Air Circuit Breakers, MCCB's, and other equipment as called for in the Schedule of Quantities.
- The MCCB's shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance.
- The Switch Boards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear.

#### **iii. Equipment Specifications**

- All equipment used to configure the Switch Board shall comply to the relevant Standards and Codes of the Bureau of Indian Standards and to the detailed technical Specifications as included in this tender document.

#### **iv. Constructional Features**

- The Switch Boards shall be metal enclosed, sheet steel cubicle pattern, extensible, dead front, floor mounting type and suitable for indoor mounting.
- The Switch Boards shall be totally enclosed, completely dust and vermin proof. Synthetic rubber gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as specified. All doors and covers shall also be fully gasket with synthetic rubber and shall be lockable.
- The Switch Board shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support



for all components. The doors and covers shall be constructed from CRCA sheet steel of thickness not less than 1.6 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.

- All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.
- Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self-threading screws shall not be used in the construction of the Switch Boards.

**v. Switchboard Dimensional Limitations**

- A base channel 100 mm x 50 mm x 6 mm thick shall be provided at the bottom.
- A minimum of 200 mm blank space between the floor of switch board and bottom most unit shall be provided.
- The overall height of the Switch Board shall be limited to 2300 mm
- The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.

**vi. Switch Board Compartmentalisation**

- The Switch Board shall be divided into distinct separate compartments comprising.
- A completely enclosed ventilated dust and vermin proof bus bar compartment for the horizontal and vertical bus bars.
- Each circuit breaker and MCCB shall be housed in separate compartments enclosed on all sides.
- Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "on" and "off" position.
- For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus bars and connections.
- A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.
- Separate cable compartments running the height of the Switch Board in the case of front access Boards shall be provided for incoming and outgoing cables.
- Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from top.
- Adequate and proper support shall be provided in cable compartments to support cables.

**vii. Switch Board Bus Bars**

- The Bus Bar and interconnections shall be of electrolytic Copper/ Aluminium and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bar. The maximum current density for copper shall be 1.6 amps per sq. mm. and for Aluminium shall be 1 amp per Sq. mm. and suitable

to withstand the stresses of a 31 MVA fault level or at 415 volts for 1 second or as per schedule of quantities.

- The bus bars and interconnections shall be insulated with insulation tape/ fiber glass.
- The bus bars shall be extensible on either side of the Switch Board.
- The bus bars shall be supported on non-breakable, non-hygroscopic insulated supports at regular intervals, to withstand the forces arising from a fault level of 31 MVA at 415 volts for 1 second.
- All bus bars shall be colour coded.
- All bus bar connections in Switch Boards shall be bolted with brass bolts and nuts. Additional cross section of bus bars shall be provided wherever holes are drilled in the bus bars.

**viii. Switch Board Interconnections**

- All connections between the bus bars/Breakers/cable terminations shall be through solid tinned copper strips of adequate size to carry full rated current and PVC/fibre glass insulated.
- For unit ratings up to 100 amps PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of all such interconnections shall be crimped and aluminium lugs shall be used.

**ix. Draw out Features**

- Air Circuit Breakers shall be provided in fully draw out cubicles. These cubicles shall be such that draw out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. The fixed and moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the draw out cubicles to ensure safety and compliance to relevant Standards. The MCCB's shall be provided in fixed type cubicles.

**x. Instrument Accommodation**

- Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switch Board.
- For MCCB's instruments and indicating lamps can be provided on the compartment doors.
- The current transformers for metering and for protection shall be mounted on the solid copper/aluminium bus bars with proper supports.

**xi. Wiring**

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm.

**xii. Cable Terminations**

- Knockout holes of appropriate size and number shall be provided in the Switch Board in conformity with the location of incoming and outgoing conduits/cables.

- The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located at the rear / top of the panel.
- The cable terminations for the MCCB's shall be brought out to the rear in the case of rear access switchboards or in the cable compartment in the case of front access Switch Boards.
- The Switch Boards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc for termination of 1100 volt grade aluminium conductor PVC/PVCA cables.

**xiii. Space Heaters**

The Switch Board shall have in each panel thermostatically controlled space heaters with a controlling 15 amp 230 volt switch socket outlet to eliminate condensation.

**xiv. Ventilation Fans**

The Switch Board shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 2500 amp and above. The fan shall be interlocked with switchgear operation.

**xv. Earthing**

A main earth bar of G.I./copper as required shall be provided throughout the full length of the Switch Board with a provision to make connections to the can be tap from main earthing.

**xvi. Sheet Steel Treatment and Painting**

- Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall then receive two coats of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.
- All sheet steel shall after metal treatment be spray or powder painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

**xvii. Name Plates And Labels**

Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

**xviii. Testing**

Copies of type test carried out at ACB/MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the routine tests as per relevant clause of SCC

**xix. Testing at Site**

- Pre-commissioning tests as required and as per manufacturers recommendations shall be carried out on each switchboard at site before energizing the switchboards including but not restricted to the following.
  - Physical checking of the switchboards including checking alignment of panels, interconnection of Bus bars, tightness of bolts/connections and evidence of damage/cracks in any components.
  - Physical checking and inspections of Inter panel wiring
  - Checking free movement of ACBs/MCCBs/SFUs
  - Checking of operation of breakers
  - Insulation tests of bus bar supports and control wiring etc. with 1.1 kV megger.
  - Primary & secondary injection tests of relays and CTs.
  - Checking of Interlocking function.

## 18. Cables

### a. Medium Voltage Cables

- i. Medium voltage cables shall be aluminium conductor PVC insulated, PVC sheathed armoured conforming to IS 1554. Cables shall be rated for a 1100 Volts. The conductor of cables from 16 Sq. mm. to 50 mm<sup>2</sup> shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 mm<sup>2</sup> and above. Conductors shall be made of electrical purity aluminium 3/4 H or H temper. Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Cores	:	Red and Black
3 Cores	:	Red, Yellow and Blue
3 1/2 /4 Cores	:	Red, Yellow, Blue and Black

- ii. Current ratings shall be based on the following conditions.
  - Maximum conductor temperature 70<sup>o</sup> C
  - Ambient air temperature 45<sup>o</sup> C
  - Ground temperature 30<sup>o</sup> C
  - Depth of laying 1000 mm
- iii. Short circuit rating of cables shall be as specified in IS 1554 Part-I.
- iv. Cables have been selected considering conditions of maximum connected loads, ambient temperature, grouping of cables and allowable voltage drop. However, the contractor shall recheck the sizes before cables are fixed and connected to service.
- v. M.V. cables shall be PVC insulated aluminium/copper conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches,

duct and on cable trays as required. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and un armoured cables.

vi. On Trays/Walls

- Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

Type of Cable	Size	Clamping by	Fixing Interval
MV	Up to and including 25 sq mm	Saddles 1 mm thick	45 cms
MV & HV	35 sq mm to 120 sq mm	Clamps 3 mm thick 25 mm wide	60 cms
MV & HV	150 sq mm and above	Clamps 3 mm thick 40 mm wide	60 cms

Note: The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the centre of the bend on both sides.

## 19. Cable trays

- Channel or of ladder design as specified in BOQ. Cable trays shall be fabricated from sheet G.I of thickness as per BOQ Cable trays, of sizes as per schedule of quantities and drawings shall be of perforated doubled bend and shall be complete with tees, elbows, risers, and all necessary hardware.
- Trays shall have suitable strength and rigidity to provide proper support for all the contained cables. Trays shall not have sharp edges, burrs or projections injurious to cable insulation. Trays shall include fittings for changes in direction and elevation. Cable trays and accessories shall be painted with two coats of red oxide zinc chromate primer after proper surface preparation and two finishing coats of synthetic enamel paint of approved make or as specified in BOQ. Cable trays shall have side rails or equivalent structural members.
- Cable trays shall be mounted on support structure as specified by means of specified size of threaded rods and suitable fasteners. Spacing of the support structure shall be such that the cable trays shall remain perfectly horizontal without buckling when fully loaded with cable runs. The support structure shall be suspended from ceiling slab or grouted to walls in an approved manner. Width of the horizontal arms of the support structure shall be same as the tray width plus length required for threading /bolting /welding to the vertical supports. The length of vertical supporting members for horizontal tray runs shall be to suit the number of tray tiers required. Cable trays shall be bolted/ welded to the support structure. Minimum clearance between the top most tray tier and the ceiling shall be 300 mm. Trays shall be erected properly to present a neat and clean appearance. Trays shall be installed as a complete system. The entire cable tray system shall be rigid. Each run of cable tray shall be completed before laying of cables. Cable trays shall be erected so as to be exposed and accessible. Cables shall be fixed to the tray by clamps fabricated from minimum 3 mm thick GI sheets. The cables shall be dressed properly so as to provide minimum one cable diameter clearance between adjacent cables and from tray ends. Cable trays shall be earthed by 2 runs of 25 mm x 3 mm GI strips throughout their lengths.

## 20. LAYING OF CABLES

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for medium voltage cables. Cables shall be laid in masonry trenches, directly on walls/cable trays,

directly buried in ground or in pipes/ducts as elaborated below. Cables of different voltages and also power and control cables shall be laid in different trenches with adequate separation. Wherever available space is restricted such that this requirement cannot be met, medium voltage cables shall be laid above HT cables. Where more than one cable is laid side by side, cable marker tags of approved type inscribed with cable identification details shall be permanently attached to cables at entry points to the building, at specified intervals for cables laid direct in grounds and in locations like manholes, pull pits etc.

## **21. Drawings**

Shop drawings for control panels and wiring of equipment showing the route of conduit cable shall be submitted by the contractor for approval of Engineer-in-charge before starting the fabrication of panel and starting the work. On completion, all details like location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the contractor.

## **22. Measurement**

Panels shall be counted as number of units. The quoted rate of panel shall also include all accessories, switch gear, fuses, contractor, indicating meters and lights as per the specification. Cable tray, Power & Control cable shall be measured in running meter.

## **23. Commissioning and Guarantees**

### **a. Scope of work**

The work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

### **b. General requirements:**

- i. Work under this Part shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this Part
- ii. Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.
- iii. On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

### **c. Pre commissioning**

- i. On completion of the installation of all pumps, piping, valves, pipe connections, electrical wiring, motor control panels and water level controlling devices the contractor shall proceed as follows:-
  - Testing of M.C.C
  - Tests to be carried out for motor control centres shall be:
    - Insulation resistance test with 500 volt megger, before and after high voltage test, on all power and control wiring.
    - High voltage test sat 2000 volts A.C. for one minute on all power and control wiring.
    - Low voltage continuity test (6 volts) on power wiring of each feeder, between bus bars and the outgoing terminals with switches and contactors in closed position.

- Low Voltage continuity test (6 volts) on all control wiring.
- Operation test for all feeders with only control supply made 'on' to ensure correctness of control wiring, operation of the various equipment used such as push buttons, protective devices, indicating lamps and relays etc. All contactors shall be checked and there shall be no chattering.
- Earth continuity test with voltage not exceeding 6 volts between various non-current carrying metallic parts of equipment, steel work etc. And the earth bus provided in the MCC.
- Operation of all instruments and meters provided on the MCC.

**d. Pipe work**

- ii. Check all clamps, supports and hangers provided for the pipes.
- iii. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant Part of the specifications. If any leakage is found, rectify the same and retest the pipes.
- iv. Check all face piping and valves
- v. check air blower connections

**e. Commissioning & testing**

- i. All pumping sets

Start the duty pump on manual controls, check its operation and then test run on auto controls. Change over the duty pump and test it in the same manner as the first pump.

- ii. Test runs the entire system to ensure satisfactory performance.

**f. Handing Over**

- i. All commissioning and testing shall be done by the contractor to the complete satisfaction of the Engineer-in-Charge and the job handed over to the Engineer-in-Charge or his authorized representative.
- ii. Contractor shall also hand over, to the Engineer-in-Charge, all maintenance & operation manuals, 4 sets of As Built drawings and all other items as per the terms of the contract with soft copy.

**g. Guarantees**

- i. The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
- ii. The form of warranty shall be as approved by the Engineer-in-charge.
- iii. The warranty shall be valid for a period of one year from the after getting virtual completion certificate.
- iv. The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
- v. The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.

- vi. The contractor shall separately submit with this offer his charges per month for operation of mechanical equipment(s) after commissioning and handing over.

## 24. I.S. Codes

Following codes and Indian standards shall be applicable as amended up to date-

### 1 Electrical equipment

- i. Marking & arrangement for switch gear bus bars, main connections and auxiliary wiring- I.S. 375
- ii. Direct acting electrical indicating instruments- I.S.1248
- iii. Metal enclosed switch gear and control gear- I.S. 3427
- iv. A.C. Contactors of voltage not exceeding 1000 volts. - I.S. 2959
- v. A.C. Motor starters of voltage not exceeding 1000 volts.- I.S. 1822
- vi. Air breaks isolation for voltages not exceeding 1000 volts.- I.S. 2607
- vii. Heavy duty air break switches and composite unit of air break switches and fuses for voltage not exceeding 1000 volts. - I.S. 4047
- viii. PVC insulated cables (for voltage Up to 1100 volts with copper/ aluminium conductors)(Section I & II) - I.S. 694
- ix. Normal duty air break switches and composite units of air break switches and fuses for voltage not exceeding 1000 volts. - I.S. 4064
- x. Code of practice for earthing - I.S. 3043
- xi. Pumps & motors
  - Centrifugal pumps - I.S. 1520
  - Electrical Motors - I.S.7538
- xii. Pipes
  - G.I. Pipes - I.S. 1239
- xiii. Valves
  - Butterfly Valves - IS 23339/13095
  - Slim Type NRV - I.S. 7312
  - Sluice valve - I.S. 780
- xiv. Vibration Eliminator
- xv. Water Shock Absorbers
- xvi. Pipe Colour Code as per I.S. 2379-1983.



## **SECTION – 8 SPECIFICATIONS OF PUMPING & MACHINERY**

### **1 GENERAL CONDITIONS**

#### **a. SITE CONDITIONS**

It is assumed that before tendering the Contractor would have visited the site and familiarized himself with all the local conditions and means of transportation and communications. No claim of whatsoever nature would be entertained at a later date on account of the Contractor's ignorance of the local conditions.

### **2 STANDARD AND CODES OF PRACTICE**

The work shall be carried out as per the enclosed Specifications of Work and Material and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with CPWD specifications, National Building Code 2005, relevant Codes of Practice and Standards as issued by Bureau of Indian Standards (B.I.S.), all with the latest amendments wherever applicable.

### **3 WORKMANSHIP**

All the work shall be carried out in a workmanship like manner and as per the best practices of the trade.

### **4 DRAWINGS AND DOCUMENTS**

#### **a. General**

- i. The Drawings are intended as a guide to the firms tendering and give approximate positions of pipes, conduits, cable runs and/or equipment only and while measuring from these drawings, the Tenderer must make due and proper allowance for all necessary

diversions from the straight line, rises or falls as may be required for the proper execution of the works.

Detail drawings in all cases shall be worked to in preference to those of a more general nature and figured dimensions where indicated shall be followed in preference to scale.

Where necessary, the exact positions of plant and/or equipment will be decided by the issue of further drawings, but no claim for extra payment due to insufficient information on this scope will be entertained.

In any case of doubt as to the interpretation of either Drawings and/or Specification, the Tenderer must refer the matter to the Owner prior to the submission of his Tender.

- ii. It is to be clearly understood that this Tender is to be absolutely inclusive for the proper completion of the whole of the works specified to the true intent and meaning of the specification and/or Drawings and the description therein contained shall be read conjointly and together and no error, inconsistency, discrepancy in the Drawings and/or Specification will relieve the Contractor of his obligations to include for an hand-over the work in the true meaning and intent of the Specification and/or Drawings, complete in every respect.

Should any portion of the works which would reasonably and obviously be inferred as necessary for the installation as a whole but not expressly specified, the Contractor shall provide and execute such work as part of the Contract and shall not be entitled to any extra payment of that account.

- iii. The Contract Drawings and such other drawings as may be furnished to the Contractor during the progress of the Works shall be considered as illustrating between the Drawings and the Specification, the Contractor shall execute the work in accordance with the decision of the Owner. If modifications are necessary, the Contractor shall submit modifications to the Owner for approval before such modifications are executed.
- iv. All Drawings and Specification are the property of the Owner.
- v. The Contractor will be required to give and obtain all necessary site and other particulars and to agree such details with the Owner. The Contractor must also obtain details of any other Contractor's work affected by his work and shall work in close co-operation with all such firms or persons concerned.
- vi. The Contractor shall be responsible for any damage caused to buildings and contents and works by reason of, arising out of, or incidental to, or in connection with the execution of any work in the Contract Documents.

The Contractor shall permit nothing to be done which may injure the stability of the Works, or existing buildings and no cutting through floors or walls will be allowed other than where required by the Drawings, without the sanction of the Owner.

- vii. The Contractor must prepare the shop drawings and shall submit to the Owner for approval, before the work is commenced. Three copies of all working details and installation drawings shall be submitted.

These drawings must be submitted by the Contractor as soon as possible after the order is placed to give ample time for all parties concerned to study and comment thereon.

- viii. The work described on any working drawings submitted shall be carefully checked by the Contractor for all clearances, field conditions, maintenance of architectural conditions and proper co-ordination with all trades on the job. To this end, the Contractor, during the construction drawing stage, shall ensure that he co-ordinates drawings of all other trades that might interfere with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between trades shall be referred to the Owner.

The equipment layout is to be detailed on the drawings, showing the exact method of installing and clearly illustrating components to be used in making all connections.

- ix. Pipework drawings must be fully detailed, showing all pipework in double line and indicating the precise size of fittings, valves and equipment, position of hanger supports with reference numbers must be indicated and a large scale detail must be given, showing the type and method of installation of each type of hanger. A schedule is to be included on each drawing, showing details of the type of hanger fixings and references number for each type.

All general layout drawings shall be drawn 1/50 scale, unless agreed otherwise with the Owner.

- x. The Contractor shall provide a detailed programme incorporating working drawing production, which can be read in conjunction with the building construction programme.
- xi. The Contractor shall prepare schedules and drawings showing precise details of holes in concrete, block works etc., base frames or support required and the like. The schedules shall show in detail the builder's work required to be performed by all other trades for the mechanical and electrical installations. These drawings and schedules, in an approved form, must be submitted to the Owner well in advance and his approval must be obtained before any structural work requiring holes or other modifications is constructed.
- xii. Signed and approved drawings will not be departed from unless a signed variation or omission certificate is issued in writing by the Owner. Drawings returned to the Contractor for alteration or amendment shall be re-submitted to the Owner for approval.

Amended or altered drawings shall show the nature of the amendment or alteration in a revision block on the drawing, together with the revision number or letter and the date of the revision.

- xiii. Should the Contractor prove unable to produce satisfactory "Working Drawings" or be unable to produce drawings to conform to the progress of the work, the Owner reserves the right to take whatever steps are necessary to have drawings undertaken by others and debit the Contractor's account.

Any decision taken by the Owner to have working drawings produced elsewhere will not relieve the Contractor of his contractual obligations and the Contractor must provide to the Owner all necessary details, physical dimensions, descriptive literature, etc., of all equipment to be incorporated on drawings within 10 days of a request from the Owner.

**b. Manufacturers' Data**

- i. Manufacturers' performance data, certified factory drawings of plant and machinery, giving full information as to capacity, dimensions, materials and all information pertinent to the adequacy of the proposed equipment shall be submitted for approval.

Manufacturer names, sizes, catalogue numbers and/or samples of all materials shall be submitted for approval.

Submittals and working drawings should, as far as possible be complementary so that drawings and submittals can be cross checked.

- ii. The copy of the placement of order with the manufacturer of the equipment shall be submitted to the Owner for his approval and must be accompanied by relevant drawings, technical data, catalogues and samples, where data, certified drawings or other required information is not available until after orders have been placed, the Owner will give provisional approval until all requested drawings and information have been supplied to the Owner and approved by him. It is the Contractor's responsibility to ensure that all necessary information is supplied to the Owner in accordance with the progress of the work.

**c. Operating and Maintenance Manual**

- i. The Contractor shall furnish six copies in bound form of an instruction manual containing all information applicable to this section of the Works. This manual is to be similar in design and content to those to be provided under other services.

The manual shall contain a comprehensive written description of the Works, outlining the operation of the systems and maintenance procedures.

**d. "As Installed " Drawings**

- i. The Contractor shall arrange to keep on Site a full set of drawings showing the progress of the Works, which must be kept upto date.

The Contractor shall keep a record as the work proceeds of any work installed not in accordance with the drawings. On completion of the Works the Contractor shall supply three clear coloured prints of each applicable drawing, showing the exact position of all apparatus, pipe lines, services, control valves, switchgear, etc., together with diagrams, schedules, etc. to the Owner's requirements and in addition one complete set of plastic negatives and soft copy on compact disk (CD).

The word "AS INSTALLED DRAWINGS" shall be clearly indicated on all drawings adjacent to the title block.

**e. DISCREPANCIES IN THE DRAWINGS**

Should there be any discrepancy due to in-complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be

immediately brought to the attention of the Owner and his decision would be final and binding on the Contractor.

**f. INSTRUMENTS FOR MEASUREMENT AND TESTING**

The Contractor shall provide, free of cost, all equipments, instruments, labour and all other allied assistance required by the Owner or their representatives for measurement and testing of the works.

**g. CO-ORDINATION WITH OTHER TRADES**

The Contractor shall be responsible for coordinating this work with works of other trades sufficiently ahead of time to avoid unnecessary hold ups. Hangers, sleeves, recesses etc. shall be left in time as the work proceeds.

**h. PROTECTION**

All work shall be adequately protected, to the satisfaction of the Owner so that the whole work is free from the damage throughout the period of construction upto the time of handing over.

Special care must be taken to prevent damage and scratching of all fittings and fixtures. Tool marks on exposed fixtures shall not be accepted. Protective paper on fixtures shall be removed with hot water only at the final completion of the work.

Before handing over the work, the Contractor shall clean all elements of the complete installation, remove plasters, splashes, stickers, rust stains and all other foreign matter and leave every part in acceptable condition and ready for use to the satisfaction of the Owner.

**5 HORIZONTAL CENTRIFUGAL PUMPS**

**a. DESIGN REQUIREMENTS**

- i. The pump shall be capable of developing the required total head at rated capacity for continuous operation. The pumps shall operate satisfactorily at any point on the Head-Discharge (H-Q) characteristic curve over a range of 50% to 130% capacity (for pumps other than fire pumps).
- ii. The total head capacity curve shall be continuously rising towards the shut off. The shut off head shall be at least 110% of the total head. The pump should deliver at least 125% of its rated capacity at 75% of the specified total head (for pumps other than fire pumps).
- iii. Fire pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head.
- iv. The required NPSH at duty point shall be at least 1.0M less than the available NPSH.
- v. Pumps shall run smooth without undue noise and vibration. The velocity of vibration shall be within 4.5 mm/sec. The noise level shall be limited to 85 dBA at a distance of 1.8M.
- vi. The power rating of the pump motor shall be the larger of the following :
  - The maximum power required by the pump in the entire operating range.
  - 115% of the power required at the duty point. Power requirement shall be worked out considering 1% negative tolerance on quoted figure of efficiency.

**b. FEATURES OF CONSTRUCTION**

- i. Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pump shall be interchangeable.
- ii. Impeller shall be enclosed type, securely keyed to the shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction.
- iii. Pump shall be provided with renewable type casing ring.
- iv. The first critical speed of the pump rotor shall be at least 30 percent above the operating speed.
- v. Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing boxes.
- vi. Stuffing boxes shall be of such design that they can be repacked by removing the gland and lantern ring.
- vii. Pump shall be furnished complete with flexible coupling.
- viii. Coupling guard, bolted to the base plate shall be furnished.
- ix. The base plate for pump and motor shall be common. Suitable holes shall be provided for grouting. Foundation bolts shall be complete with nuts and washers.
- x. Suction and discharge connections shall be flanged.
- xi. Pump impeller shall be dynamically and statically balanced.
- xii. All accessories required for proper and safe operation shall be furnished with the pump.
- xiii. Wherever, mechanical seal has been asked for in Bill of Quantities, it shall be factory fitted at manufacturer's works.

**c. MATERIALS OF CONSTRUCTION**

Corrosion Resistant in general

- |              |   |                         |
|--------------|---|-------------------------|
| • Casing     | : | Cast Iron               |
| • Impeller   | : | Stainless Steel /Bronze |
| • Shaft      | : | Stainless Steel         |
| • Seal       | : | Mechanical Seal         |
| • Base Plate | : | CI/MS fabricated        |

**6 INDUCTION MOTORS****a. DESIGN REQUIREMENTS**

The Motors shall generally conform to IS:325. In addition, the motors shall also meet the specific requirements as mentioned below.

**b. PERFORMANCE CHARACTERISTICS**

- i. Motors shall be capable of giving rated output, without reduction in the expected life span when operated continuously under
- ii. the following supply conditions :

**Supply Condition**

- |                                 |         |
|---------------------------------|---------|
| • Variation in Supply Voltage   | +/- 10% |
| • Variation in Supply Frequency | +/- 5%  |

- Combined Voltage and Frequency Variation +/- 10%
- iii. Motors shall be suitable for full voltage direction-line starting or star-delta starting or any other method of starting as specified in "Equipment Parameters". When slipring motors are specified, liquid rotor starter shall be as per clause 128.
- iv. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.
- v. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified.
- vi. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.
- vii. The guaranteed performance of the motor shall be met with tolerance specified in applicable standard.

#### c. INSULATION

- i. Any joints in the motor insulation such as at coil connections or between slot and end winding sections, shall have strength equivalent to that of the slot sections for the coil.
- ii. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.
- iii. The motors shall be provided with Class F insulation with temperature rise limited to that of class B insulation.

#### d. CONSTRUCTIONAL FEATURES

- i. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repairs.
- ii. Motors weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- iii. The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

#### iv. Bearing:

- Greased ball bearings or roller bearings shall be of reputed make.
- The bearings shall be so constructed that the loss of lubricating fluid is kept to a minimum and greasing shall be possible without any dismantling operation.

#### v. Terminal Box:

- Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent mentioned shall be provided at cover joints and between box and motor frame.
- The terminal box shall be suitable for bottom entry of cables.
- The terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees/180 degrees.

- The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances.
  - Suitable cable glands and cable lugs shall be supplied to match specified cables.
- vi. Two independent earthing points shall be provided on opposite sides of the motor for bolted connection. These earthing points shall be in addition to earthing stud provided in the terminal box.

## 7 FULL WAY BALL VALVE

The valves shall be of full bore type and of quality approved by the Consultant/Owner.

### a. MATERIALS OF CONSTRUCTION

- |      |           |   |                                       |
|------|-----------|---|---------------------------------------|
| i.   | Body      | - | Nickel plated brass/ nonferrous alloy |
| ii.  | Ball      | - | Forged Brass                          |
| iii. | Seat      | - | Virgin PTFE                           |
| iv.  | Stem Seal | - | Nitrile Rubber                        |

## 8 BUTTERFLY VALVES

The valve shall be of cast iron conforming to relevant IS:13095. The valve shall be of quality approved by the consultant/Engineer-in-charge.

### a. MATERIALS OF CONSTRUCTION

- |       |            |   |                        |
|-------|------------|---|------------------------|
| v.    | Body       | - | Cast Iron              |
| vi.   | Shaft      | - | Carbon steel           |
| vii.  | Body Liner | - | EPDM / nitrile rubber  |
| viii. | Disc       | - | Epoxy Coated C.I./D.I. |

## 9 NON-RETURN VALVES — DUAL PLATE (WAFFER TYPE) CHECK VALVE

The valve shall be of quality approved by the consultant/Engineer-in-charge.

### a. MATERIALS OF CONSTRUCTION

- |     |       |   |                            |
|-----|-------|---|----------------------------|
| ix. | Body  | - | Cast Iron                  |
| x.  | Shaft | - | Carbon steel               |
| xi. | Disc  | - | Stainless Steel (AISI 316) |

## 10 PIPES AND FITTINGS

### a. PIPE WORK

#### i. Materials

The pipe work shall be done in black mild steel pipes of 'Heavy' grade conforming to IS:1239 (Part I)-1990 for upto 150 mm dia pipe and IS:3589-1991 for pipes above 150 mm dia.

All fittings shall be of mild steel of suitable grade conforming to relevant Indian Standards. All fittings shall have manufacturer's trade mark stamped on it. Fittings in M.S. pipe lines shall include elbows, tees, bends, reducers, nipples, union bushes, G.I. clamps of approved design, M.S. flanges with 3 mm rubber insertion, nuts, bolts, washers etc.



Screwed fittings shall be approved type black malleable hexagonal on all ends of the fitting suitable for screwed joints.

For welded joints forged steel fittings of approved type with “V” groove shall be used.

Fabricated fittings shall not be permitted generally. However, if use of any fabricated fitting is found necessary by the Engineer-in-Charge, fabrication of such fitting shall be taken up by the Contractor on the written directives of the Engineer-in-Charge in a workshop following proper welding procedures. For fabricating a ‘Tee’ connection pipes shall be drilled and reamed and joint only welded. Gas cutting of pipes shall not be permitted. Fabricated ‘Tee’ out of M.S. plates shall not be used.

All fittings shall be tested at manufacturer's work. The Contractor may be required to produce certificate to this effect from the manufacturers.

## **ii. Jointing**

The pipes and fittings upto 50 mm diameter shall be threaded joints using Teflon Tape on the threads. Joints for pipe and fittings above 50 mm diameter shall be welded joints. Care shall be taken to remove any burr from the end of the pipe after cutting..

### **• Welded Joints**

#### **General**

The welding of pipes in the field should comply with IS:816, 1969. Electrodes used for welding should comply with IS:814, 1991.

Joints between M.S. pipes and fittings shall be made with pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner Butt welded joints shall not be acceptable. Care shall be taken to remove any burr from the end of the pipe after cutting.

All welders must be fully qualified and proof of an operator's qualification shall be either the Contractor's record of suitable tests passed within the previous six months or tests made before the commencement of the work.

The Contractor must submit to the Owner the names of the welders who will be employed on the work, together with documentary evidence of their competency.

Any welder considered by the Owner as not having the skill necessary for the work will at once be barred from further welding on the site or in the Contractor's workshop.

The Owner may instruct the Contractor to cut out typical welded joints for inspection and the Contractor shall include for the removal of such pieces and re-making joints to the satisfaction of the Owner. The Contractor shall include in his Tender for the cost of removing all such pieces for inspection and re-making joints.

Care must be exercised by the Contractor to ensure that the welding flux does not project into the bore of the tube. All welds shall be good, clean metal, free from slag inclusions and porosity, of even thickness and regular contour, well fused with the parent metal and finished smooth.

Where site welding is carried out in proximity to inflammable materials, the Contractor must take special precautions to protect the materials from risks of fire.

### **Testing of Welded Joints**

The welded joints shall be tested in accordance with procedure laid down in IS:3600 (Part I) : 1985. One test specimen taken from at least one field joint out of any 10 shall be subjected to test.

If the results of the tensile test do not conform to the requirements specified, retests of two additional specimen from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or two, extensive gouging (scooping out) and repairing shall be carried out as directed by the authority.

If internal pressures exceed 1.5 MPa (15 kgf/cm<sup>2</sup>), special attention should be given to the assembly of the pipe and the first run of weld.

Non-destructive testing of the completed weld may be carried out on pipe-lines by radiographic (see IS:4853 : 1982) or ultrasonic method (see IS:4260, 1986) as agreed upon between the Owner and the Contractor.

- **Screwed Joints**

Joint for black steel pipes and fittings shall be metal to metal threaded joints using Teflon tape on the threads.

- **Flanged Joint**

M. S. Flanges shall be as per IS: 6392 and shall be faced. Rubber or asbestos gasket shall be inserted between the joints.

Flange shall be provided on :

- Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.
- Both ends of any fabricated fittings e.g. bends, tees etc. of 65mm or larger diameter.
- For jointing all type of valve, appurtenances, pumps, connection with other type of pipes, to water tanks and other places necessary and required as per good for engineering practice.

- **Unions**

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

- **Laying and Fixing**

- Above Ground :  
Exposed pipes on walls and ceilings shall be fixed with standard pattern G.I. holder bat clamps on angle iron frames embedded in walls or suspended from

ceiling. The clamps shall be spaced at regular intervals in straight lengths as per the following table:-

Dia of Pipe (mm)		Horizontal Length (M)	Vertical Length (M)
25	2.4	3.0	
32	2.7	3.0	
40	3.0	3.6	
50	3.0	3.6	
65	3.6	4.5	
80	3.6	4.5	
100	4.0	4.5	
150	4.5	5.4	

Additional supports are to be provided at every change of directions and branch-offs

#### **Anchor Blocks**

Suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer and high pressure should be provided at all bends, tees and such other locations as directed by the Owner. Exact location, design, size and mix of the concrete block shall be approved by the Architect / Consultant prior to the execution of the work.

### **11 SUMP PUMPS**

- a. The pumps shall run smooth without undue noise and vibration.
- b. The power rating of the pump motor shall not be less than the maximum power required from zero discharge to zero head.
- c. Pump shall be vertical, centrifugal, single stage, nonclog type.
- d. It shall be suitable for handling turbid water containing stringy materials.
- e. The pump shaft journal bearings shall preferably be grease lubricated. No external water will be made available for the lubrication of the bearings.
- f. Delivery piping with gun metal stainless steel non-return valve shall be supplied.
- g. Delivery pipe shall be as per IS:1239, heavy class.
- h. The maximum suspension length of pumps shall be 1.5 metre.
- i. Pump shall be operated automatically by providing magnetic float operated level controllers.

#### **j. MATERIALS OF CONSTRUCTION**

Materials of construction in general shall be as follows unless specified otherwise in Bill of Quantities:

- |      |             |   |              |
|------|-------------|---|--------------|
| i.   | Casing      | : | Cast Iron    |
| ii.  | Impeller    | : | Cast Iron    |
| iii. | Shaft       | : | Carbon Steel |
| iv.  | Cover Plate | : | Steel        |

### **12 SUPPORT OF PIPEWORK AND VALVES**

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipework and its associated equipment. Valves and other devices mounted in the pipe work shall be supported independent of the pipes to which they connect.

### **13 PUMP CONTROL PANELS**

#### **a. GENERAL**

Pump control Panels are to be suitable for 3 phase 4 wire 415 Volts 50 Hz system with a fault level of 31MVA at 415 volts.

Panels are to be metal clad, cubicle type totally enclosed, floor mounted and air insulated. The total height of the switchboard is to be not more than 2100 mm. Panels are to be extensible on both sides and shall conform to IP - 43 as per IS :2147

## b. STANDARDS

The equipment shall be designed to conform to the requirements of :

- i) IS : 8623 - Factory built assemblies of switchgear and controlgear.
- ii) IS : 13497 - General requirements for switchgear and controlgear for voltages not exceeding 1000 Volts.
- iii) IS : 2147 - Degrees of protection provided by enclosures for low voltage switchgear and controlgear.
- iv) IS : 375 - Marking and arrangement of busbars.

Individual equipment housed in the power control centre shall conform to the following IS specifications.

- |       |                                 |   |    |   |                 |
|-------|---------------------------------|---|----|---|-----------------|
| i)    | Fuse Switch & Switch Fuse Units | - | IS | : | 13947           |
| ii)   | Air Circuit Breakers            | - | IS | : | 13947           |
| iii)  | Moulded Case Circuit Breaker    | - | IS | : | 13947           |
| iv)   | H.R.C. Fuselinks                | - | IS | : | 9224            |
| v)    | Current Transformers            | - | IS | : | 2705            |
| vi)   | Voltage Transformers            | - | IS | : | 3156            |
| vii)  | Relays                          | - | IS | : | 3231            |
| viii) | Indicating Instruments          | - | IS | : | 1248            |
| ix)   | Integrating Instruments         | - | IS | : | 722             |
| x)    | Control Switches & Push Buttons | - | IS | : | 6875            |
| xi)   | Auxiliary Contactors            | - | IS | : | 2959, IS : 6875 |

## c. CONSTRUCTION DETAILS

Cubicle shall be mounted on a base folded channel. All doors, sidewalls and interior separations shall be of CRCA MS sheet of 1.5/2MM thickness. CRCA sheets of 2mm thickness for load bearing members and 1.5mm for non-load bearing members. Insulation barriers and protective screens shall be provided wherever required.

Apparatus forming part of the power control centres shall have the following minimum clearances:

- |      |                            |   |        |
|------|----------------------------|---|--------|
| i)   | Between phases             | - | 25 mm. |
| ii)  | Between phases and neutral | - | 25 mm. |
| iii) | Between phases and earth   | - | 25 mm. |
| iv)  | Between neutral and earth  | - | 19 mm. |

Creepage distances shall comply with those specified in relevant standards.

**d. MOULDED CASE CIRCUIT BREAKERS**

MCCB shall conform to IS - 13947 and be rated for the currents as shown on the single line diagram. They shall have a short circuit rating as specified elsewhere.

All MCCB shall be provided with an adjustable thermal overload trip device together with an adjustable magnetic short circuit release. The MCCB shall have a trip free toggle mechanism, and dolly shall come to midway position and the trip operates.

The operating mechanism shall be quick make and quick break and trip free and contacts shall be single break type with arcing contacts located within arc chutes.

The MCCB shall be suitable for both vertical and horizontal mounting.

**e. CURRENT TRANSFORMERS**

Current transformers shall be of the ring type suitably fixed between insulating pieces and clamped. They shall conform to the requirement of IS : 2705 and shall have current ratio and outputs and accessories as specified.

**f. INSTRUMENTS**

Indicating instruments shall be flush mounting type square of required size and conforming to the requirement of IS : 1248.

**g. BUS BARS**

The bus bar shall be of copper strip (unless specified otherwise in Bill of Quantities) designed for a continuous current of specified rating and fabricated from bars conforming to high purity electrical grade copper. Each bar shall be provided with flexible expansion links as approved.

The bars shall be suitably supported with fibre glass reinforced epoxy supports to withstand the short circuit forces possible.

Bimetallic washers shall be provided for joining of dissimilar metals electrically.

**h. CONTROL WIRING**

- i. All control wiring shall be carried out with 1100V grade single core PVC cable conforming to IS : 694 having stranded copper conductors of minimum 1.5 sq.mm. section potential circuits and 2.5 sq.mm. section for current transformer circuits.
- ii. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance.
- iii. Wires shall be identified by numbered ferrules at each end. The ferrules shall be of the ring type and of non-deteriorating material. They shall be firmly located on each wire so as to prevent free movement.

- iv. All control circuit fuses shall be mounted in front of the panel and shall be easily accessible.

**i. LABELS**

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

**j. TESTS**

The design of the Power Control Centres shall have been type-tested in accordance with following sections of Cl.8 : 1:1 of IS : 8623 :

- v. Verification of temperature rises limits.
- vi. Verification of dielectric properties.
- vii. Verification of short circuit strength.

Routine tests shall be conducted on each Power Control Centre in accordance with Cl. 8 : 1 : 2 of IS : 8623 and shall comprise :

- i. Inspection of the Power Control Centre is including inspection of wiring and electrical operational tests where necessary.
- ii. Dielectric tests.
- iii. Checking of Protective Measures and electrical continuity of the protective circuits.

**k. METAL TREATMENT AND FINISH**

All steelwork used in the construction of the switchboards should have undergone a rigorous metal treatment process as follows :

- i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii. Pickling in dilute sulphuric acid to remove oxide scales and rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- iii. A recognised phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v. Drying with compressed air in a dust-free atmosphere.
- vi. Powder coated to the specified shade of IS : 5. The total thickness of paint should not be less than 25 microns.

**l. L.T. SWITCHGEARS**

Commissioning checks and tests shall include all wiring checks and checking up of connections. Primary/secondary injection tests for the relay adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

- i. Operation checks and lubrication of all moving parts.
- ii. Interlock function checks, if any
- iii. Continuity checks of wiring, fuses etc. as required.
- iv. Insulation test : when measured with 500V meggar the insulation resistance shall not be less than 100 mega ohms.
- v. Trip tests and protection gear test.

## **14 CABLING**

### **a. STANDARDS & CODES**

This chapter covers the specifications for supply and laying of Medium Voltage cables.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date and as below. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

Equipments certified by Bureau of Indian Standards shall be used in this contract in line with government regulations. Test certificates in support of this certification shall be submitted, as required.

It is to be noted that updated and current standards shall be applicable irrespective of dates mentioned along with ISS's in the tender documents.

PVC insulated heavy duty cables	IS 1554 – 1988
Code of practice for installation and maintenance of power cables	IS 1255 – 1983
Conductors for insulated electrical cables	IS 8130 – 1984
Drums for electrical cable	IS 10418 – 1982
Methods of test for cables	IS 10810 – 1988
Recommended current rating	IS 3961 – 1987
Recommended short circuit rating of high voltage PVC cables	IS 5891 – 1970

### **b. DELIVERY, STORAGE AND HANDLING**

Cables shall be delivered at site in original drums with manufacturer's name clearly written on the drum

Manufacturers recommendation particularly in respect of sealing shall be strictly followed.

Cable drum shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in ground causing rot and damage to the cable drum. The cable drum shall conform to IS 10418.

During storage, periodical rolling of drums, in the direction of arrow marked on the drum, shall be done once in 3 month through 90° C

Both ends of cables shall be properly sealed to prevent moisture ingress

Drums shall be stored in well ventilated area protected from sun and rain

Drums shall always be rested on the flanges and not on flat sides.

Damaged battens of drums etc. shall be replaced.

Movement of drums shall always be in direction of the arrow marked on the drum.

For transportation over long distance, the drums shall either be mounted on drum wheels and pulled by ropes or they shall be mounted on trailers etc. drums shall be unloaded preferably by crane otherwise they shall be rolled down carefully on suitable ramps.

While transferring cable from 1 drum to another, the barrel of the new drum shall have diameter not less than the original drum.

Cables with kinks or similar visible defects like defective armouring etc shall be rejected.

Cables shall be supplied at site in cut pieces as per actual requirements.

### c. CABLES

Medium voltage cables shall be aluminium conductor PVC insulated, PVC sheathed armoured conforming to IS 1554. Cables shall be rated for a 1100 Volts.

The conductor of cables from 16 Sq. mm. to 50 Sq. mm. shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq. mm and above. Conductors shall be made of electrical purity aluminium ¾ H or H temper.

Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1	Core	:	Red/Black/Yellow/Blue
2	Core	:	Red and Black
3	Core	:	Red, Yellow and Blue
3	½ /4 Core	:	Red, Yellow, Blue and Black

### d. LAYING OF CABLES

#### i. General

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for medium voltage cables and 15 times the overall diameter for 11 kV cables. Cables shall be laid in masonry trenches, directly on walls/cable trays, directly buried in ground or in pipes/ducts as elaborated below. Cables of different voltages and also power and control cables shall be laid in different trenches with adequate separation. Wherever available space is restricted such that this requirement can not be met, medium voltage cables shall be laid above HT cables.

#### ii. In Masonry Trenches

Wherever so specified, cables shall be laid in indoor/outdoor masonry/RCC trenches with chequered plate/RCC covers to be provided by OWNER. Cables shall be laid on painted



MS supports of approved design grouted in trench walls at intervals not exceeding 600 mm. If required, cables shall be arranged in tier formation inside the trench. Cables shall be dressed properly so that the clear spacing between the cables shall not be less than the diameter of the cable. Suitable clamps, hooks and saddles shall be used for securing the cables in position. The cost of supplying and fixing cable support work shall be deemed to be included in the rates for laying of cables. Complete details of this support work shall be shown in shop drawings to be prepared by the Contractors and submitted for Owner's/ approval before execution. Works shall be carried out only as per approved shop drawing. Wherever so specified, trenches shall be filled with fine sand.

### iii. On Trays/Walls

Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

Type of cables	Size	Clamping by	Fixing intervals
MV	Upto and including 25 sq mm	Saddles 1 mm thick	45 cm
MV & HV	35 sq mm to 120 sq mm	Clamps 3 mm thick 25 mm wide	60 cm
MV & HV	150 sq mm and above	Clamps 3 mm thick 40 mm wide	60 cm

**Note :** The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the center of the bend on both sides.

### iv. Cable Trays

Cable trays, of sizes as per schedule of quantities and drawings, shall be of doubled bend channel design unless otherwise stated. Cable trays shall be fabricated from minimum 2 mm thick perforated sheet steel and shall be complete with tees, elbows, risers, and all necessary hardware. Trays shall be galvanized or painted as specified. Cable trays shall be erected in perfect level and plumb and shall comply with the following:

Trays shall not have sharp edges, burrs or projections injurious to cable insulation.

Trays shall include fittings such as bends, risers etc. for changes in direction and elevation.

Trays shall be supported adequately at minimum 1 m distance from the building structure by means of painted/galvanized MS structural members secured to the structure by dash fasteners or by grouting. The entire cable tray system shall be rigid. Cost of support arrangement shall be included in the rates quoted for supply and installation of trays. Complete details of this support arrangement shall be shown in shop drawings to be prepared by the Contractors and submitted for Owner's approval before execution. Works shall be carried out only as per approved shop drawing.

Each run of cable tray shall be completed before laying of cables.

Cable trays shall be exposed and accessible.

**v. Laying in Pipes/Closed Ducts**

In locations such as road crossings, entry to buildings/poles in paved areas etc., cables shall be laid in pipes or closed ducts.

Spun reinforced concrete pipes shall be used for such purposes and the pipe shall not be less than 100 mm in diameter for a single cable and not less than 150 mm for more than one cable.

These pipes shall be laid directly in ground without any special bed. Sand cushioning and/or brick tiles need not be used in such installations.

Unless otherwise specified the top surface of pipes shall be at a minimum depth of 1000 mm from the ground level when laid under roads, pavements etc.

The pipes for road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing.

Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

No deduction shall be made for sand and bricks not used for cables passing through RCC Hume pipes or for parts of vertical cables at the lighting poles.

**vi. Laying of Cables in Floors**

Laying of cables directly in floors shall be avoided and GI pipes of adequate size shall be used wherever necessary. However if the cables have to be laid direct in the floor specific written approval of OWNER shall be obtained and the Contractor shall cut chases, lay the cables and make good the chases to original finish.

**vii. Cable Entry into Buildings**

Cable entry into buildings shall be made through RCC pipes recessed in the floor. RCC Hume pipes shall be provided well in advance for service cable entries. The pipe shall be filled with sand and sealed at both ends with bitumen mastic to avoid entry of water. Suitable size manholes shall be provided wherever required to facilitate drawing of cables as per requirements.

**viii. Cable Joints**

Cable joints shall be resorted to and permitted only if length of cable run is more than standard cable drum length. Cable joints shall not be permitted in any other circumstances. Wherever unavoidable these joints shall be made with specific approval of OWNER, and shall form a part of cable run.

**ix. Measurement of Cable Runs**

The cable runs shall be measured upto the outer end of the boxes without any allowances for overlap in joints. The actual run of the cables shall be measured and the rate shall include all the above mentioned material, labour etc for laying as required.

**x. Cable Loops**

At the time of the installation approximately 3 meters of surplus cable shall be left as below or as directed by Engineer-in-charge.

- at each end of the cable
- on each side of underground straight through/tee/termination joints.
- at entries to buildings

This cable shall be left in the form of a loop.

Wherever long runs of cable length are installed cable loops shall be left at suitable intervals as specified by the Owner.

**xi. Termination/Jointing of Cables**

Soldered jointing/termination shall be totally avoided. Solderless terminations by using Dowel crimping tools and suitable lugs shall be adopted for all cable terminations. Double compression brass glands shall be used. Any termination without use of proper crimping tool shall be liable to be rejected.

In the case of aluminium conductors, it is to be ensured that the conductor oxidation is cleaned by means of emery paper and then a thin coat of tin is applied before pinching into any equipment.

**e. TESTING OF CABLING****i. Tests at Manufacturer's Works****• Type Tests**

Cables shall be subjected to type tests and acceptance test at manufacturers work as per IS : 1554 – 1988 carried out in accordance with appropriate parts of IS : 10810 – 1984. Copies of the type test reports shall be furnished if so required

**• Routine Test**

Cables shall be subjected to routine test as per IS : 1554 – 1988, as below.

- Conductor resistance test
- High voltage test at room temperature.

Copies of routine tests carried out at manufacturers works shall be furnished alongwith the cables

**ii. Testing at Site****• Before Laying**

All cables before laying shall be pressure tested for one minute with 1000 volts megger. Cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors

- **After Laying**

After laying and jointing, cables shall be subjected to a 1.5 minutes AC/DC pressure test.

## **15 PLANT AND EQUIPMENT**

### **a. GENERAL**

All plant and equipment shall be new and of appropriate grade and quality suitable for and adequately protected against the prevailing climatic conditions and in accordance with specifications and shall be of approved manufacture. Any plant which is found to be unsuitable for use under these conditions shall be dismantled and replaced by suitable entirely at the expense of the Contractor.

The complete installation shall be carried out in a neat and orderly manner by competent personnel with adequate experience of respective trade of work.

Materials shall be the best of their type available and shall conform to the appropriate standards. Materials of constructions shall be certified by a recognised testing authority and shall be suitable for use in the stipulated environment. Installation of materials and equipment shall be strictly in accordance with manufacturer's recommendations.

### **b. TESTING AND COMMISSIONING**

#### **i. General**

The Contractor shall be responsible for testing and commissioning the entire services installation described in these specifications and will demonstrate the operation of the system of the entire satisfaction of the Owner/Architect.

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purposes.

The entire pipe work in the plant room shall be tested at minimum 14 kg/cm<sup>2</sup> pressure. The test pressure shall be maintained for at least 2 hrs.

#### **ii. Water for Testing**

Water for testing shall be obtained by the Contractor from an approved source. It shall be free from bacterial contamination, silt, grit, sand etc. After testing, the Contractor shall satisfactorily dispose off all water, or it may be re used providing it is clean and is not contaminated.

**iii. Test Records**

The Contractor shall be responsible for the keeping all records of tests and on completion shall provide records and reports of the tests in triplicate. All test records shall clearly identify the item of the test and must be signed by a witness to the test.

**iv. Unsatisfactory Works**

If the tests reveal unsatisfactory materials, installation or adjustment, the Contractor shall, at his own expense, carry out such alternations or replacements as may be necessary to rectify the defective work. The Contractor shall then repeat the tests as necessary to establish the satisfactory nature of the alterations or replacements.

**v. Testing at Works**

All plants and equipments shall be tested at maker's works before despatch and the test certificate in duplicate shall be forward to Owner/Architect.

The Contractor shall similarly provide a set of manufacturer's certified test curves for any pump installed under the Contract. All tests shall be in accordance with the appropriate Indian Standards.

**vi. On Site Testing**

The Contractor shall provide on site all the necessary instruments, plant, equipment, materials, water, electricity and labour necessary for carrying out the specified tests. All tests shall be carried out as required to meet the construction programme and the contractor shall include for all necessary isolation and other works as may be required for testing the whole or parts of the installation. The Contractor shall also be responsible for re-testing, if necessary, until satisfactory tests are achieved.

**c. IDENTIFICATION OF PIPES LINES & EQUIPMENT**

All pipeline installation shall be provided with a colour identification system. The system in general shall be as per IS:2379-1983-Specification of Colour Code for the Identification of Pipe Lines. The colour identification system shall comprise of :

- i. Basic Identification Colour over the whole length of pipe
- ii. Code indication bands for precise determination of the contents being carried by the pipe

The code indication bands shall be minimum 150mm wide and shall be placed at all junctions, at both sides of valves, service appliances, bulk heads, wall penetrations and at any other place where identification is necessary.

The colour of code indication bands shall be as directed by the Engineer-in-charge.

The direction of flow shall be clearly marked on the pipe lines.

The equipment shall be identified with identification plates as directed by the Engineer-in-charge.

**SECTION 9      Technical Information for Water Supply & sump drainage Pumps to be furnished by Bidder:****a. Pumps**

- i. Make
- ii. Model
- iii. Pump Discharge - Max/Min
- iv. Pump Head Min/Max,
- v. Impeller Material
- vi. Motor HP
- vii. (Specify make, class of insulation & rated voltage  $\pm$  %)
- viii. Shaft Seal Type & make
- ix. Type of Coupling
- x. Efficiency of Pump
- xi. Type of Bearings
- xii. RPM

**b. Pressure Tanks ( Where specified)**

- i. Make
- ii. Material of Construction
- iii. Internal finish
- iv. External finish
- v. Air balloon/ diaphragm
- vi. specifications

**c. Motor Control Centres ( Give detail on separate sheets if required )**

- i. Make
- ii. Type (floor/wall mounted)
- iii. Make of switch gear
- iv. Make of meters
- v. Make of accessories
- vi. Confirm that all switch gear starters match the capacities of pumps offered.

**d. Power & control cables**

- i. Make

**e. Electronic Level controllers**

- i. Make
- ii. Model No.

**f. Electronic High Water Alarm**

- i. Make
- ii. Model No.

**g. Electronic Level Indicator**

- i. Make
- ii. Model

**h. Pipes /CPVC**

- i. Make offered
- ii. Heavy Class 150 mm dia. & below
- iii. Heavy Class 200 mm dia. & above
- iv. CPVC Pipe

**i. Butterfly Valves**

- i. Make
- ii. Material
- iii. Test pressure

**j. NRV Slim Type**

- i. Make
- ii. Material
- iii. Test pressure

**k. Vibration eliminators**

- i. Make
- ii. Material
- iii. Test pressure

**l. Pressure**

- i. Working pressure
- ii. Test pressure
- iii. Filtration/holding Capacity
- iv. Inlet/outlet sizes

**m. Painting/coating**

- i. Inside
- ii. Outside

**n. Equipment - Air Blower Chlorinator**

- i. Make
  - ii. Model
  - iii. Pump Discharge -Max/Min
  - iv. Pump Head - Min/Max,
  - v. Impeller Material
  - vi. Motor HP (Specify make, class of insulation & rated voltage  $\pm$  %)
  - vii. Shaft Seal
  - viii. Type of Coupling
  - ix. Efficiency of Pump
  - x. Type of Bearings
  - xi. Speed of Pumps
- o. Motor control centres**
- i. Type (floor/wall mounted)
  - ii. Make of switch gear
  - iii. Make of panel meters
  - iv. Confirm that all switch gear starters are of capacities for pumps offered.

- p. Pipe fitting scheduled.
- q. C.I. Pipe
- r. RCC Pipe.
- s. L.A. Pipe.
- t. HDPE Pipe.
- u. Insulation Material
- v. Flow Meter.
- w. PRV
- x. Hyroneumatic Pump.
- y. Water meter.





## CHAPTER D

### TECHNICAL SPECIFICATIONS: - SOLAR WATER HEATER

#### SECTION 1.

##### 1 Designing of Water Heating System :

Designing shall essentially include but not limited to the following:

- a. Process Design
- b. Preparation of general arrangement drawing with sufficient information for the Structural Engineering Consultant to design the structure of various components.
- c. Selection of all mechanical and electrical equipment like Solar Panels, Heat Exchangers, Hot Water Storage Tank, Hot Water Recirculating Pumps, Electric Heating Elements, pipes, valves and other appurtenances, switchgear, cables etc.
- d. Preparation of detailed engineering drawings

##### 2 Supply and Installation of Mechanical & Electrical Equipment.

- i) It is understood that this Contract includes supply, installation, testing and commissioning of all the equipment, components etc. whether explicitly mentioned above or not for the successful commissioning of the Hybrid (Solar cum Electrical) Water Heating System
- ii) The tenderer must clearly indicate the material of construction, performance parameters, sizes etc of each equipment being offered by him.
- iii) The Civil Work, if any, like equipment foundations etc. is **not included** in the Scope of this work. However, the Contractor will have to provide complete details regarding the requirements of Civil Works, so that these can be executed by a separate agency.

##### 3 Interconnecting Pipework : All interconnecting pipework between various components of the complete system, starting from cold feed to storage tank and terminating at the hot water supply n connection of the storage tank and suction side of hot water return (from distribution side) pumps.

##### 4 Electrical Works: All interconnecting power and control cabling for pumps, drives etc. and Motor Control Center to respective motors and drives, interlocking of thermostats etc.

#### SECTION 2. SOLAR HOT WATER GENERATION CAPACITIES

The following is hot water requirements for various blocks which shall be generated by the Solar Water Heating System:

S.NO	BLOCKS	HOT WATER GENERATION THROUGH SOLAR AT 60 deg C	NOS. OF SOLAR COLLECTOR PANELS

2.	Guest House – 32 Units	Hot Water Generation @ 50Litre/DU = 1650 Litres/ Day	12 Nos
3.	Girls Hostel – 600 Nos including Mess Hot water requirement	Hot Water Generation @ 21.6Litre/User = 13000 Litres/ Day	87 Nos
4.	Boys Hostel – 600 Nos including Mess Hot water requirement	Hot Water Generation @ 21.6Litre/User = 12000 Litres/ Day	87 Nos
8.	Admin cum Academic Block(Labs+Cafeteria)	Hot Water Generation = 3200 Litres/ Day	22 Nos.

### SECTION 3. GENERAL SPECIFICATION AND REQUIREMENTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT

1. Solar Collector Panels — Solar Collector Panel with 2 Sq.m. absorbing area for each panel, 0.95 absorptivity factor, 0.1 Emittance Factor, constructed of non corrosive materials and totally sealed outer casing (no ingress of water) – ( Nos. Solar Collector Panels of shall be as specified in Bill of Quantities)
2. Hot Water Storage Tank —Constructed with 6mm thick MS sheet and internally lined with 2mm thick SS 304 sheet; suitable for a working pressure of 6 kg/cm<sup>2</sup> ; complete with inlet, outlet, return and vent connections, pressure and temperature gauges, safety valve,etc.; fully insulated with 100 mm thick mineral wool or similar suitable insulating material and clad with 24 G aluminium sheet ; mounted on an MS frame and provided with access ladder. The hot water storage tank shall be suitable for installing on terrace in open. The hot water storage shall be fitted with required nos. of electric heating elements, switchable in set of two by the system Controller Unit. ( Capacity of Water Storage Tank shall be as specified in Bill of Quantities)
3. Hot water circulating pump on distribution side : One no. suitable pump for each system with bronze impellers.
4. Interconnecting Piepwork : All interconnecting pipework as shown in the enclosed schematic diagram.

Material of Pipe and Fittings : G.I Pipes ( Medium Class) pipes and fittings shall be used.. All piping material shall conform to relevant Indian Standards of BIS and International Standards for which Indian Standards are not available.

Valves and other appurtenances : Non-corrosive material, of construction suitable to handle hot water.

Method of laying, fixing, jointing, Testing and commissioning : Relevant Codes of Practice Manufacturers Instructions CPWD Specifications

5. Electrical Works : a) All interconnecting power and control cabling from control panel to respective motors and drives, electric heating elements, temperature sensors. level controllers etc.
6. Main Control Panel : Metal clad cubicle type suitable for 415 V AC three phase 4 wire 50Hz supply system. The panel shall be completely compartmentalised and complete with main incoming fuse switch unit / MCCB, metering devices, relays, contactors, protective switches for each motor, starters, single phase preventers for three phase motors, Aluminium Bus Bars, designation labels as per requirement, Continuous earth bar, panel separators, protective screens, cable clamping support system, panel illuminating lamps, top/bottom cable gland plates for incoming and out going cable entries.

## CHAPTER E

### TECHNICAL SPECIFICATIONS: - SEWAGE TREATMENT PLANT

#### SECTION 1:- SCOPE OF WORK

This Contract is for execution of Sewage Treatment Plant based on MBBR Technology on 'Turnkey Basis', the plant shall be totally underground and which shall include but not limited to the following:

##### 1 Designing of Sewage Treatment Plant :

Designing shall essentially include but not limited to the following:

- a. Process Design
- b. Preparation of general arrangement drawing with sufficient information for the Structural Engineering Consultant to design the structure of various components. Also to provide the requirement of air quantities for ventilation of the STP area.
- c. Selection of all mechanical and electrical equipment like pumps, motors, pipes, valves and other appurtenances, switchgear, cables etc.
- d. Preparation of detailed engineering drawings
- e. Preparation and Submission of as built drawings.
- f. Supply and Installation of Mechanical & Electrical Equipment like bar/ perforated screens, raw sewage transfer pumps, all mechanical and electrical equipment for the reactor, sludge recycling / lifting pumps, filters, disinfecting units, sludge handling equipment etc. as generally described in Section D and of makes as mentioned in Section E of Scope of Work.

#### IMPORTANT NOTES

- i) It is understood that this Contract includes supply, installation, testing and commissioning of all the equipment, components etc. whether explicitly mentioned above or not for the successful commissioning of the Sewage Treatment Plant as per the parameters mentioned herein.
  - ii) The tenderer must clearly indicate the material of construction, performance parameters, sizes etc of each equipment being offered by him.
  - iii) The major Civil Work like construction of underground tanks, equipment foundations etc. are not included in the Scope of this work. However, the Contractor will have to provide complete details regarding the requirements of Civil Works, so that these can be executed by a separate agency.
- g. Interconnecting Pipework : All interconnecting pipework starting from Bar Screen Chamber to the discharge header of the treated effluent transfer pumps including making

arrangement for STP bypass and surplus effluent disposal, supplying and fixing all pipe sleeves in the civil work is also included in the scope of work.

- h. Electrical Works: Pump control panel and all interconnecting power and control cabling for pumps, drives etc. and from pump control panel to respective motors and drives, interlocking of dosers etc.
- i. MS Structural works for the walkways, ladders, pipe supports, manhole covers etc.
- j. Testing and commissioning of the Plant (including the cost of the consumables).
- k. Training the personnel of the Employer for operation and maintenance of the plant.
- l. Obtaining statutory approvals from Local Pollution Control Board.
- m. To maintain & operate the entire STP for a period of defect liability period plus 6 MONTHS thereafter round the clock basis under first available load conditions as per availability. Required trained operating staff is to be deputed during above period. All tools, equipment & testing devices to be provided by the contractor. Consumables including lubricants & chemicals will be provided by owners after the defect liability period only."

## SECTION 2. BASIC PARAMETERS

The following basic parameters are to be considered for the designing:

1. Nature of Waste Water : Domestic sewage comprising waste water from Toilets, Kitchen.
2. Expected Daily Flow : 300 M3/day
3. Average Hourly Flow for designing of primary and secondary level treatment units : 15 M3/hr. (Minimum)
4. Basic & Tertiary Treatment: Pre and post Chlorination, Multi Grade Sand Filtration, Activated Carbon Filter, UV Disinfection Unit
5. Average Hourly Flow for designing of Tertiary Treatment units : 20 M3/hr.
6. Expected Raw Waste Characteristics pH : 6.5 to 8.0
7. BOD : 250 mg/litre — 350 mg/litre
8. Suspended Solids : 250mg/litre — 400 mg/litre
9. COD : 450 mg/litre — 600 mg/litre
10. Oil & Grease : Upto 50 mg/litre
11. Desired Treated Effluent Characteristics

**After Basic Tertiary Treatment\***

- a. pH : As per standards
- b. BOD : Less than 20 mg/ litre
- c. Suspended Solids : Less than 10 mg/litre
- d. COD : Less than 70 mg/litre
- e. Oil & Grease : Less than 5 mg/litre

\* OR as per the norms of CPCB/Orissa State Pollution Control Board

- 12. Reuse of Treated Effluent :
  - a) WC Flushing
  - b) HVAC Make-up
  - b) Landscape Irrigation
- 13. Statutory Requirement : Discharge Effluent from STP quality shall meet the requirements of Local Pollution Control Board and Central Pollution Control Board

**SECTION 3. SITE CONDITIONS**

The tenderer must carefully consider the site constraints of the site while offering the technology/ preparing the proposal.

**ACCEPTABLE TECHNOLOGY FOR THE REACTOR**

Moving Bed Bio Reactor (MBBR)

**SECTION 4. GENERAL SPECIFICATION AND REQUIREMENTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT****1. Bar Screen — 1 No.**

Duty : To trap any floating matter and solids from the raw waste water

Type : Manually cleaned bar screen/perforated screen, suitably inclined

Material of Construction : Stainless Steel. (Grade SS-304)

**2. Submersible Pumps**

a. Raw Sewage Lifting Pumps — 2 Nos. ( 1 working + 1 standby)

b. Plant Room Sump Pump — 2 Nos. ( 1 working + 1 standby)

Type : Non-clog fully floodable submersible type suitable to handle raw sewage.

Material of Construction : Corrosion Resistant in general Pump & Motor

Housing — Stainless Steel 304 AISI

Impeller — Stainless Steel 304 AISI

Shaft — Stainless Steel 304 AISI

Bearings — Anti friction, pre-lubricated ball bearings, packed with grease for life.  
 Motor — Dry Motor Protection degree IP68 Insulation class F. Built-in thermal overload protection

Installation — In Equalization / holding tank. Permanent installation with lifting system incorporating duck foot and stainless steel guide.

3. Centrifugal mono block self-priming Sludge Transfer Pump : 2Nos. ( 1 working + 1 standby)

4. Air blowers : 2 Nos. ( 1 working + 1 standby)

Type : Twin Lobe type  
 Material of Construction : Casing — Cast Iron: Shaft — Alloy Steel

5. Media for MBBR/FAB Reactor : Plastic Floating Media

6. Media for Settling Tanks : PVC Tube Settler

7. Equipment for Tertiary Treatment : The equipment shall be selected and designed to render the effluent fit for reuse for cooling tower makeup, GARDENING and flushing toilets.

a. Filter Feed Pump : 2 Nos. ( 1 working + 1 standby) (for Tertiary Treatment)

b. Softner Feed Pump : 2 Nos. ( 1 working + 1 standby)

c. Garden irrigation water tytransfer Pump: 2 Nos. ( 1 working + 1 standby)

Type : Centrifugal Water Transfer Pump.

Material of Construction:

Corrosion Resistant Pump & Motor

Casing — Cast Iron/ Stainless Steel 304 AISI

Impeller— Stainless Steel 304 AISI

Shaft — Stainless Steel 304 AISI With mechanical seal

8. Filter Vessel : FRP

9. Chemical Doser : Electronic Metering Pumps with PVC/HDPE Solution Tank\

10. UV Unit : Suitable for treated sewage application ( with Supplier`s suitability certificate for treated sewage application

11. Interconnecting Pipework: All interconnecting pipework starting from Bar Screen Chamber to the header of the treated effluent transfer pumps including pipework for air supply.

12. Material of Pipe and Fittings: Non corrosive material suitable for raw and treated sewage. The preferred material is PVC pipes and fittings of minimum 10 Bar pressure rating. All piping material shall conform to relevant Indian Standards of BIS and International Standards for which Indian Standards are not available.

13. Valves and other appurtenances: Non-corrosive material, of construction suitable to handle raw and treated sewage.
14. Method of laying, fixing, jointing, testing and commissioning : Relevant Codes of Practice  
Manufacturers Instructions  
CPWD Specifications
15. Flow Meters : As specified.
16. Electrical Works :
  - a. All interconnecting power and control cabling from control panel to respective motors and drives, level controllers as required.
  - b. Main Control Panel: Metal clad cubicle type suitable for 415 V AC three phase 4 wire 50Hz supply system. The panel shall be completely compartmentalised and complete with MCCBs/MCBs , metering devices, relays, contactors, protective switches for each motor, starters, single phase preventers for three phase motors, level controllers, sequential controllers, auto manual change over switches, metering devices, indicating lights, Aluminum Bus Bars, designation labels as per requirement, Continuous earth bar, panel separators, protective screens, cable clamping support system, panel illuminating lamps, top/bottom cable gland plates for incoming and out going cable entries.  
The panel shall have powder coated finish of an approved shade. The panel should preferably be from the same Vendor who is supplying the main electrical panels for this project.
  - c. Automation: The operation of the pumps shall be controlled by the level controllers.
  - d. Provision for BMS Connectivity. The panel should have sufficient no. of potential free contacts for connectivity with Building Management System for monitoring purposes



## **CHAPTER F**

### **TECHNICAL SPECIFICATIONS - HORTICULTURE WORKS:**

#### **1. Scope of work**

The work shall in general conform to the Latest CPWD Specifications for works. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities for Horticulture works.

#### **2. Excavation**

The top excavated soil shall be collected, stacked, preserved for use in landscaping / horticulture works. Surplus top excavated soil may be given to the nurseries or put to use in other Horticulture works.

#### **3. GRASSING**

##### **a. Preperation**

- i. During period prior to planting the ground shall be maintained free from weeds.
- ii. Grading and final leveling of the lawn shall be completed at least three weeks prior to the actual sowing. Clods of excavated earth shall then be broken upto the size not more than 75mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds that re-germinate shall be uprooted carefully. The rubbish arising from this operation shall be removed and disposed of in a manner directed by Engineer. Regular watering shall be continued until sowing by dividing the lawn area into portion or approx 5 mts. Square by constructing small bunds to retain water. These 'bunds' shall be level just prior to sowing of grass plants. At the time of actual planting of grass, it shall be ensured that the soil has completely settled.
- iii. Slight unevenness, ups and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the final levels by adding suitable quantities of good earth brought from outside, if necessary as directed by the Engineer. In fine dressing, the soil at the surface and for 40mm depth below shall be broken down to particles of size not exceeding 6mm in any direction.

- b. **SOIL:** The soil itself shall be ensured to satisfaction of Engineer to be a good, fibrous loam, rich in humus.

##### **c. SOWING THE GRASS ROOTS :**

- i. Grass roots (Cynodon dactylon or a local approved by the Engineer) shall be obtained from a grass patch, seen and approved beforehand.
- ii. The grass roots stock received at site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry winds.
- iii. Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained.

**d. EXECUTION :**

- i. Small roots shall be debbled about 15 cms (or at other spacings as per BOQ item) apart into the prepared grounds. Dead grass and weeds shall not be planted.
- ii. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.
- iii. All planting is to be done in moderately dry to moist (not wet ) soil and at times when wind does not exceed a velocity of 8 kilometer per hours.

**e. MAINTENANCE OF LAWN**

- i. As soon as the grass is approximately an inch high it shall be rolled with a light wooder, roller in fine, dry weather and when it has grown to 2 to 3 inches above the ground, weeds must be removed and regular cutting with the scythe and rolling must be begun. A top dressing of announce of guano to the square yard on well decomposed well broken sludge manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine. It should be possible to use the inch above the normal level of the first two or three cuttings. That is to day the grass should be cut so that it is from 1 to 2 inches in length, instead of the  $\frac{1}{2}$  to  $\frac{3}{4}$  of an inch necessary for mature grass.
  - ii. In absence of rain the lawn shall be watered every ten days heavily, soaking the soil through to a depth of at least 25 cms.
  - iii. Damage failure or dying back of grass due to neglect of watering especially for seeding out of normal season shall be the responsibility of the contractor.
  - iv. Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.
  - v. The contractor is to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.
- f. **ROLING:** A light roller shall be used periodically, taking care that the lawn is not too wet and sodden. Rolling should not be resorted to, to correct the levels in case certain depressions are formed due to watering
- g. **EDGING:** The contractor shall establish a neat edge where planting areas meet grass areas with spade or edging tool immediately after all planting, including lawn planting, is completed. Particular care shall be exercised in edging to establish good flowing curves as shown on the plans or as directed by the Engineer. Edging must be cut regularly and shall be maintained by the contractor.
- h. **FERTILIZING:** The lawn shall be fed once a month with liquid manure prepared by dissolving 45 grams of ammonia sulphate in 5 litres of water.
- i. **WATERING:** Water shall be applied daily during dry weather. Watering whenever done should be thorough and should wet the soil at least upto a depth of 20 cms to eliminate air pockets and settle the soil.
- j. **WEEDING:** Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.
4. **MAINTENANCE:** The landscape contractor shall maintain all planted area within the landscape 1contract boundaries until the period of one year after the complete plantation. Maintenance shall include replacement of dead plants. Watering, weeding, cultivating,

control of insects, fungicide and other disease by means of spraying with an approved insecticide or fungicide, pruning and other horticulture operations necessary for the proper growth of the plants and for keeping the landscape sub-contract area neat in appearance.

5. **PRUNING & REPAIRS:** Upon completion of planting work on the landscape sub-contract all trees should be pruned and all injuries repaired where necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots and the results of transplanting operations. Pruning shall be done in such a manner as not to change the natural habit or special shape of the trees. In general, one third to one fourth branching structure of the plants to be removed to compensate the loss of roots during transplantation by thinning or shortening branches but no leaders shall be cut. All pruning shall be done with sharp tools in accordance with instructions of the consultant. Pruning cuts shall be painted with recommended paints.
6. **TREE GUARDS:** Where tree guards are necessary, care should be taken to ensure that they do not impede movement or restrict growth.
7. **NURSERY STOCK:** Planting should be carried out as soon possible after reaching site. Where planting must, of necessity, be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled in as soon as received or otherwise protected from drying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly labeled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.
8. **PROTECTIVE FENCING:** According to local environment shrubs may have to be protected adequately from vandalism until established.
9. **COMPLETION:** On completion the ground should be formed over and left tidy.
10. **RATE:** The rates quoted for the horticulture items listed in BOQ shall provide for the cost involved in all the operations described above.

## **CHAPTER G**

### **SPECIAL CONDITIONS FOR ELECTRICAL SERVICES**

#### **1.0 GENERAL**

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The requirement offered by the contractor shall be complete in all respects. Any materials or accessories which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost of the purchaser. This shall also include spares for commissioning of the equipment.

**2.0** The contractor shall obtain all sanctions (electrical loads, approval of drawing/ ESS/ D.G.'s estimator/ approval of meter room etc. from the concerned authorities and permits required for the electrical installation work. All actual fee payable in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the contractor shall obtain NOC from SEB & Director of Safety of the concerned state; a copy of the same shall be delivered to the Owner through consultant. Contractor shall be responsible for handing over to SEB (OSes) and other authorities shall be responsibility of contractor till commissioning and getting electricity in the complex.

The Consultant/Owner shall have full power regarding the materials or work got tested by independent agency at the electrical contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/suggestions pointed out by Consultant/independent agency through HLL/Owner at his own expenses.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations as amended up to date, thereunder and special requirements, if any, of the State Electricity Boards etc. The bidder is liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

#### **3.0 DRAWINGS**

i) The list of drawings along with these specifications is given in Annexure. These drawings are meant to give general idea to bidder regarding the nature of work covered by these specifications.

ii) Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder/tenderer for successfully completing the work shall be obtained by him.

##### **iii) Shop Drawings**

The contractor shall prepare detailed coordinated electrical shop drawing indicating lighting/lighting fixtures, convenience outlets, D.G.'s, H.T., Transformer, M.V. Panel Boards/Relay Panel, PCC, DB's, Rising Mains, Cable Schedule with other relevant services and submit to the Consultant for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. 11 KV Panel Board, Control and Relay Panel Package Substation, D.G.'s, PCC's, MCC's, cable schedule and routes, manhole trap and fixing details as well as for conduit indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. for the above mentioned work. All work shall be carried out on the approval of these drawings. However,

approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution.

iv) Completion Drawings/As Built Drawings

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the consultant 4 sets along with soft copy of 'As Built' drawings (in AutoCAD & PDF format) of the work along with 01 Nos. cloth tracing originals including write up (trouble shooting, installation, operation and maintenance manual with instructions) incorporating all such changes and modifications during engineering and execution along with warrantee & guarantee certificates from manufacturers.

These drawings must provide:

- Run and size of conduit, inspection and pull boxes including routing and locations.
- Number and size of conductor in each conduit.
- Locations and rating of sockets and switches controlling the light and power outlet.
- A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.
- Location of outlets of various services, junction boxes, light fixtures.
- Location of all earthing stations route and size of all earthing conductors.
- Layout and particulars of all cables.
- Location and details of PCC's, MCC's, Feeder Pillars, capacitor control panels, PLC D.G. set panel, UPS panel, and relay panels with description detailed control wiring diagram.
- Location of transformer and its details and control wiring diagram.
- Location of Hume pipe and manhole including HT/LT cable layout and scheduling.
- Location of D.G.'s, exhaust and auxiliary equipment with schematic drawings.
- Layout of cable trays with support and their fixing details.
- Location of all earthing station, route and size of all earthing conductor.
- Layout and particulars of rising mains with fixing details.

v) Position of HT/LT Switch Boards/Transformer & D.G.'S

The recommended position of the switch boards, transformer & D.G.'s as shown on the layout drawings will be adhered to as far as practicable.

The contractor shall submit 2 sets of samples of each type of accessories and apparatus, proposed to be used in the installation at site for approval (drawings or samples) as required shall be submitted by contractor and the choice of selection out of the approved list lies with the Owner. For all non-specified items, approval of the Owner/Consultant shall be obtained prior to procurement of the same. HLL/Owner shall in no way be liable for rejection of the any material due to poor quality, poor workmanship, poor material etc.

#### **4.0 MANUFACTURER'S INSTRUCTIONS**

Where manufacturers have furnished specific instructions, relating to the material/equipment to be used on this job, covering points not specifically mentioned in this document, manufacturers' instructions should be followed.

## **5.0 MATERIALS AND EQUIPMENT**

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by Consultant/Owner's Engineer-in-Charge, only the best quality materials and equipment shall be used.

The contractor shall fill in the data sheet for capital equipment as attached elsewhere in this document. The Material/Equipment shall be rejected due to not giving / filling in the details of the said equipment.

## **6.0 GENERAL DETAILS**

### **6.01 Space Heaters & Lighting.**

One of more adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation. CFL lamp shall be provided in any panel compartment.

### **6.02 Fungistatic Varnish**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### **6.03 Ventilation Opening**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

### **6.04 Degree of Protection**

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as called for in specification / BOQ whenever it is not mentioned it shall be as given below.

- Installed out door: IP-55.
- Installed indoor in air-conditioned area: IP-52.
- Installed in covered area: IP-52.
- Installed indoor in non air-conditioned area where possibility of entry of water is limited: IP-42.
- For L.T. switchgear (AC and DC distribution boards): IP-52.

The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

### **6.05 Rating Plates, Name Plates and Labels**

Main PCC, PCC's, MDB and auxiliaries items installed in the building are to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together

with details of the loading conditions of equipment in question has been designed to operate and such diagram plates as may be required by the purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

#### **6.06 First Fill of Consumables, Oil and Lubricants**

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, welding/soldering/brazing material for all copper/G.I. earthing and essential chemicals etc. which will be required to put the equipment/scheme covered under the scope of the specifications, into successful operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

#### **7.0 DESIGN IMPROVEMENTS**

The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply.

If for any reason, Contractor wishes to deviate from specification, prior permission from Consultant /Owner will be sought.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly in the specification.

#### **8.0 QUALITY ASSURANCE PROGRAMME**

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Purchaser's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

- His organization structure for the management and implementation of the proposed quality assurance programme.
- Documentation control system.
- Qualification data for bidder's key personnel.
- The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
- Control of non-conforming items and system for corrective actions.
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring instruments and field activities.
- System for indication and appraisal of inspection status.
- System for quality audits.

- System for authorizing release of manufactured product to the Purchaser.
- System for maintenance of records.
- System for handling storage and delivery.
- A quality plan-detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his Vendor's quality management and control activities.

## **9.0 QUALITY ASSURANCE DOCUMENTS**

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

- All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- Welder and welding operator qualification certificates.
- Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.
- Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- Stress relief time temperature charts/oil impregnation time temperature charts.
- Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
- The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

## **10.0 INSPECTION, TESTING AND INSPECTION CERTIFICATE**

- The Purchaser and the Consultant or duly authorized representative shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test is pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.



- The Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.
- The Consultant/Owner shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.
- When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of clearance by the Owner/Architect.
- The contractor shall arrange all necessary instruction and testing facilities free of cost for this purpose including air travel, lodging and boarding expenses.
- For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.
- The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.
- The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.
- The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

## **11.0 TESTS**

### **11.01 Charging**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programme.

### **11.02 Commissioning Tests**

- The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.
- All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.
- The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by Owner on production of requisite documents.

### **12.0 PACKAGING**

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Consultant/Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

### **13.0 PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

### **14.0 FINISHING OF METAL SURFACES**

#### **14.01 General**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

#### **14.02 Hot Dip Galvanizing**

- The minimum weight of the zinc coating shall be 700 gm/sq.m and minimum thickness of coating shall be 85 microns.
- The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered

surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

- After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.
- Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
  - Coating thickness,
  - Uniformity of zinc,
  - Adhesion test,
  - Mass of zinc coating.
- Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

#### **14.03 Painting**

- All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, staving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shovelled.
- Powder coating/electrostatic painting of approved shade shall be applied.
- The exterior color of the paint shall be as per shade no.697 of IS-5 or as approved by Architect and inside shall be white or as approved by Architect. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.
- In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

#### **15.0 HANDLING, STORING AND INSTALLATION**

- In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

- Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.
- In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.
- Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- The words 'erection' and 'installation' used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

#### **16.0 PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

#### **17.0 DESIGN CO-ORDINATION**

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

#### **18.0 DESIGN COORDINATION MEETING**

The Contractor will be called upon to attend design co-ordination meetings with the Engineer, and the Consultants of the Owner during the period of Contract. The Contractor shall attend

such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during those discussions.

#### **19.0 TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipments.

## **CHAPTER H**

### **TECHNICAL SPECIFICATIONS FOR ELECTRICAL SERVICES- GENERAL REQUIREMENTS**

#### **1 GENERAL**

To provide a complete electrical system for the distribution of electric power from the point of supply (SEB), D.G.s to the utilization equipment, all as shown in the drawings and described in these specifications. The quantities mentioned in BOQ are tentative. It will be the bidder's responsibility to work out the exact quantities from drawings or from work site, which trade provides said equipment, materials, tools and labour.

#### **2 SCOPE**

The bidder shall supply, install and commission along with requisite spare, maintenance tools and tackles the following equipment and system in the Project. The scope also covers the detailed engineering and calculations of the various equipment/system mentioned hereunder and the same shall be approved by the Consultant/Architect prior to execution of the job.

- 11 KV H.T. Switchboards.
- 11 KV Transformers
- Medium voltage switchgear.
- Battery and battery charger.
- Earthing.
- Lightning protection system.
- Capacitor with control panels.
- Laying and termination of H.T. cables.
- Laying and termination of L.T. cables.
- Conduiting for Fire Alarm and Public Address System
- Rising Main / Distribution Boards / Sub-Distribution Board.
- Complete internal building wiring as per specification.
- Safety to personnel and equipment during both operation and maintenance.
- Reliability of Service.
- Minimum fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future expansion and modification.
- Maximum interchange ability of equipment.
- Fail-safe feature.
- Suitability for applicable environmental factors.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the commercial complex. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere.

Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.

All work to be performed and supplies shall be affected as a part of contract requires specific approval/review of Owner or his authorised representative. Major activities requiring approval/review shall include but not be limited to the following:

The engineering activities shall comprise the submission for approval of the following:

- Basic engineering documents e.g. overall single line diagram, area classification drawing, overall cable layout, testing, type test report, guaranteed particulars of all equipment and maintenance manuals.
- Quality assurance procedures.
- Field testing and commissioning procedures.
- Basic engineering calculations viz. load analysis; load flow, fault level calculations, and voltage drop calculations during motor start-up/re-acceleration etc.
- Control and protection schemes.
- Load sharing and annunciation scheme,
- Sizing calculation for cable trays/cable trenches.
- Area-wise illumination level calculation and preparation of power supply distribution drawing.
- Calculation for earthing system and lightning protection.

**Bidder shall be responsible for:**

- Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, lighting layouts, cabling layouts, earthing and lightning protection layouts, including equipment installation and cable termination details etc. prior to start of work.
- Preparation of bill of materials for cabling, lighting, earthing and miscellaneous items etc.
- Cable schedule.
- Lighting/power panel schedule.
- Interconnection drawing.
- Protection co-ordination drawings/tables for complete power system.
- Shop inspection and testing procedures.
- Field testing and commissioning procedures.
- Preparation of as built drawings for all services.
- Any other work/activity which is not listed above however is necessary for completeness of electrical system.

### 3 CODES & STANDARDS

The design engineering manufacturing and the installation shall be in accordance with established codes, sound engineering practices, and specifications and shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities' e.g. Electrical inspector, pollution control boards, SEB as applicable before commissioning of electrical/DGs.

- Indian Electricity Act.
- Indian Electricity Rules.
- Factory Act.
- Pollution Control Act.

IS-732:	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-3043:	Earthing.
IS-2309:	Code of practice for the protection of buildings and allied structure against Lightning
IS-7689:	Guide for control of undesirable static electricity.
IS-3716:	Insulation co-ordination application guide.
IS-8130:	Conductors for insulated electrical cables and flexible cords.
IS-5831:	PVC insulation and sheath of electric cables.
IS-3975:	Mild steel wire, strips & tapes for armouring cable.
IS-3961:	Current rating of cables
IS-694:	PVC insulated (heavy duty) electric cables for working. Voltage up to and including 1100 volts.
IS-424- 1475 (F-3):	Power cable flexibility test.
IEC-439/IS-7098:	Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage up to 1.1 KV.
IS-1554:	PVC insulated cables up to 1100 volts.
IS-10810:	Test procedures for cables.
IS-6121:	Cable glands.
IS-10418:	Cable drums.
IEC-754(1):	FRLS PVC insulated cable.
ASTM-D-2863:	Standard method for measuring minimum oxygen concentration to support candle-like combustion of plastic (oxygen index).
ASTM-D-2843:	Standard test method for measuring the density of smoke from burning or decomposition.
ASTM E-662/IEC 754(A)	Standard test method for specific optical density of smoke generated by solid materials.
IEEE-383:	Standard for type test class-IE, electric cables, field splicers and connections for power generation station.



IS 13947/IEC 947:	Air circuit breaker/moulded case circuit breaker.
IS-8623:	Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000vac/1200vdc
IS 1018:	Switchgear and control gear selection/installation and maintenance
IS-1248:	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS-13779:	Digital measuring instruments and testing accessories.
IS-3156:	Voltage transformer
IS-2705:	Current transformer for metering and protection with classification burden and insulation.
IS -2147:	Degree of protection provided by enclosures for low voltage. PART 1, 11,111 Switchgear and control gear
IS-3427:	Metal enclosed switchgear and controlgear
BS-162:	Safety clearance
IS-3202:	Code of practise for climate proofing of electrical equipment.
IS-375:	Marking and arrangement for switchgear, busbars, main connections and auxiliary wiring.
IS-722:	Ac electric meters
IS-3231 /IEC-255:	Electrical relays for power system protection.
IS-5082:	Electrolytic copper/aluminium bus bars
IS-2834:	Capacitors
IS-2713:	Steel tubular pole
IS-335:	Specification for insulating oil
IS-3837:	Specifications for accessories for rigid steel conduit for electrical wiring.
IS-2026& 335:	Distribution transformer (PART I, II, III) GI/STEEL /PVC conduit pipe for electrical wiring.
IS-2274:	Code of practise for electrical wiring installation system voltages exceeding 650 volts.
IS-6665:	Code of practise for industrial lighting
IS-3646:	Interior insulation part 1&2
IS-1944:	Code of practise for lighting of public through fares.
IS-7752:	Guide for improvement of power factor consumers installation.
IS-13346:	General requirement for electrical for explosive gas atmosphere.
IS-13408:	Code of practise for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
IS-12360:	Voltage and frequency for ac transmission & distribution system.
IS-5572:	Classification of hazardous area for electrical installations.

IS-5571:	Guide for selection of electrical equipment for hazardous area.
IS-4201:	Application guide for Current Transformer
IS-4146:	Application guide for Voltage Transformer
IS-10028:	Code of practise for installation and maintenance of transformer
IS-8478:	Application guide for on load tap changer
IS-10561:	Application guide for power transformer
IS-1646:	Code of practise for fire safety of buildings electrical installation
IS-3034:	Code of practise for fire safety of industrial building-electrical generating and distribution station
IP-30:	National electrical code (NEC) BIS publication.
IS-4722:	Rotating electrical machines.
IS-4889:	Method of determination of efficiency of rotating electrical machines.
IS-325:	Three phase induction motors.
IS-4729:	Measurement and evaluation of vibration of rotating electrical machines.
IS-900:	Installation and maintenance of induction motors.
IS-4029:	Air break switches.
IS-2208-9224:	HRC cartridge fuses.
IS-2959:	Contactors.
IS-9537:	Rigid steel conduit.
IS-1030-1982:	Specification for carbon steel castings for general engineering purpose.
IS-1601/ BS-649:	Performance & testing of Internal Combustion (IC) engines for general purpose.
AIEE-606(1959):	Recommended specification for speed governing of I.C. engine generator units.

BS-5514/IS-3046 8528(Part-2): Reciprocating IC engine driven A.C. generators.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern.

- a) Specification, particular specification if any, and drawings.
- b) Indian regulations/codes and standards.

#### 4 SITE CONDITIONS

i)	Design ambient	50 Deg.C. Maximum, 2 Deg. C. minimum
ii)	Relative Humidity	85% maximum
iii)	Site environment	Normal

## 5 DESIGN CRITERIA

### I Electrical Details of Incoming Supply

a	Supply Voltage	11 KV as per SEB approved.
b	Fault level (sym.) at supply of point (designed)	350 MVA (to be confirmed from State Electricity Board by Tenderer).
c	Neutral Earthing	Solid Earthing
d	Voltage Regulation	$\pm 10\%$
e	Frequency Regulations	$\pm 3\%$
f	Combined	$\pm 10\%$

### II L.T. Power Distribution Systems

a	Voltage	415 V / 240 V
b	Frequency	50 Hz
c	Neutral Earthing	Grounded
d	Short Circuit Fault withstand Capacity	10 KA - 50 KA (1 Sec.) as per B.O.Q. and specification.

### III Emergency Lighting (Battery Operated With Self Charger)

a	Voltage	12 V, DC
b	Source	Mains/D.G. Set

### IV Control Supply for Electrical System :- The various supply voltage to be used in the control panels for main equipment are

a	Spring Charge Motor	230 Volt A/C
b	Closing/Trip Coil	24 V DC / 230V AC
c	Alarm/ Indication/ Relay	24 V DC/ 230 V AC
d	Heaters	230 V AC

V	Power Supply Load Control / Distribution Panel.	433 V TPN / 240 V 1 phase A.C. (other supply if required shall be derived by package vendor
VI	Painting of Panel.	Powder coating of approved shade

VII	Painting of Cable Tray & Structure Steel.	Powder coated of approved shade
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## 6 CABLE DETAILS

i.	Internal Wiring.	Copper conductor PVC insulated 1.1 KV grade as called for in BOQ.
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- ii. Power Cables (L.T.). XLPE insulated Al. Armoured Cable as per BOQ.
- iii. 11 KV. Aluminium conductor XLPE insulated armoured cable.
- iv. Grounding Conductor. Copper/G.I. strip as per BOQ.
- v. Lightning Conductor. G.I. Strip.

## **7 ACCURACY CLASS OF METERS**

- a Revenue Metres. Class-0.5 or as per SEB approved.
- b Ammeter, Voltmeter and Other Instruments. Class – I Digital / Analogue as per BOQ.

## **CHAPTER I**

### **TECHNICAL SPECIFICATIONS FOR ELECTRIFICATION**

#### **1.0 11 KV H.T. SWITCHBOARD**

This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type high voltage switch boards upto 11 KV including necessary termination, cabling, bus work required for satisfactory operation .

Specific requirements shall be in accordance with single line diagram/specification/data sheet. In case of conflicting requirement between the Technical Data and General Specification the former shall prevail.

The technical parameters of switchgear equipment, transformers etc. shall be submitted by the Contractor for approval by the consultant/ client.

This specification shall cover both Single Panel as well as 4 Panel Board.

#### **1.1. STANDARDS**

All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.

Some of the relevant Indian and British Standards are listed below:

IS 13947 - A.C. Circuit Breakers (Relevant Parts/SCC)

IS 13941 - High voltage Circuit Breaker (Relevant Parts/SCC)

IS 3427 - Metal enclosed Switchgear & Control Gear

BS 162 - Safety Clearances

IS 2705 - Current Transformers (Parts 1 to 4)

IS 3156 - Voltage Transformers (Parts 1 to 4)

IS 3202 - Code of Practice for climate proofing of electrical equipment

**IS 375** - Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.

IS 722 - A.C. Electric Meters

IS 1248 - Direct acting Electrical Indicating Instruments

IS 3231 - Electrical Relays for Power System Protection

IS 2544 - Epoxy Cast Resin Insulators

IS 5082 - Electrolytic Copper and Aluminium

IS 5792 - High Voltage HRC fuses

IEC 60694- High Voltage Switchgear

IEC 60947- High voltage Circuit Breaker

IEC 60298- Metal Enclosed High Voltage Switchgear

### **Vacuum Circuit Breaker**

#### **1.1 Scope**

Manufacturing, testing and supplying of integrated cubicle type metal clad, floor mounted and draw out type free standing, front operated indoor type 11kV switchgear as per specifications given below and mentioned in drawing.

##### **System**

The switchgear enclosure shall conform to degree of protection IP 4 X.

The switchgear shall be made from Pretreated Galvanized ( GI ) sheet 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrester.

#### **1.2 Breaker Compartment**

Vacuum Circuit Breaker shall be of cassette type draw-out with front plate which covers the cubicle when the breaker is in service position. This front plate shall be provided with view glass to facilitate observation of mechanical ON/OFF indication of Circuit breaker, Spring-charged / discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.

The vacuum interrupters shall be completely enclosed inside Epoxy housing.

#### **1.3 Bus Bar Compartment**

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents minimum 26.3kA for three second for 11 KV system shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

#### **1.4 CT and Cable Compartments**

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of double core and two numbers three core cable termination. The cable entry shall be from the top / bottom.

#### **1.5 Separate Compartments**

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in different compartments. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.

**1.6 Technical Particulars of Vacuum Circuit Breaker**

S.NO.	DESCRIPTION	11 KV
A	Rated Current	800 / 1250 A
B	Rated Voltage	12 KV
C	Rated Frequency	50 Hz
D	Rated Short Circuit breaking Current	26.3 KA
E	Rated Short Circuit withstand capacity 3 sec	26.3 KA
F	Rated short circuit making current (KAP)	66 KA
G	Rated Power Frequency Withstand Voltage	42kV
H	Rated Lighting Impulse Withstand Voltage	75kV
I	Mechanical Life Operations	20,000

**1.7 Earthing Switch**

Cable earthing switch shall be provided in the cable chamber and shall be operated from the front of the panel. The ON/OFF position of switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

Earthing switch shall also be provided on bus bar side. The ON/OFF Switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

**1.8 Isolating Contacts**

The breaker isolating contacts shall consist of electrolytic copper silver plated multi-fingers in tulip round shape design with ball point contacts to give a tolerance of  $\pm 10$  mm in any direction.

**1.9 Low Voltage Plug and Socket Connector**

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position

**1.10 Interlocks and Safety Devices**

The following interlocks shall be provided:

- The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is 'ON'.
- The circuit breaker can not be switched 'ON' when the truck is in any position between test and service position.
- Front part of the truck can not be removed when the breaker in 'ON' position.

- d. The low voltage plug and socket can not be disconnected in any position except test/isolated position.
- e. The truck can not be moved inside the panel, when the LT plug and socket is disconnected.
- f. Earthing switch can not be switched 'ON' when the truck is inside the panel.
- g. The truck can not be inserted when the earthing switch is 'ON'.

#### **1.11 Safety Devices**

The following Safety devices shall be provided for the safety of the operating personnel :

- a. Individual explosion vents shall be provided for breaker/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.
- b. Circuit breaker and sheet metal enclosure shall be fully earthed.
- c. Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

#### **1.12 Protective Earthing**

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

#### **1.13 Current Transformer**

##### **I. General Requirements**

Accommodation shall be provided in the circuit breaker panel, to mount one set of dual ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

##### **II. Rating**

Dual ratio CTS of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondaries.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT'S shall have 2 Nos. of cores for following application:

- Core -1                                      for metering
- Core -2                                      for over current & earth fault protection.

Class of accuracy of each winding



Metering class	1
Protection class	5P10

#### 1.14 Potential Transformers

The potential transformers shall be confirming to IS 3156/ IEC 60185. The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential transformer (PT'S) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS – 9385/ IEC – 60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

Ratio	:	6600 / 11000/ 33000 $\sqrt{3}$ / 110/ $\sqrt{3}$ / 110 V
V A Burdan	:	100 V A for 110/ $\sqrt{3}$ and 110 V winding
Class	:	CL –1 for both the windings.
Basic Insulation level	:	Same as mentioned for VCB in clause -6.
Over voltage factor	:	1.2 Continuous

Single phase PT'S shall be used and shall be connected in Star/ Star.

PT compartments shall be at the bottom of the panels.

#### 1.15 Protection and Tripping Arrangement

##### Protection

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be :

- i. Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- ii. Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.
- iii. Numeric type ground fault protection Device No.50G. CT's. Range 20 – 80% shall be provided.
- iv. Lockout and trip supervisory relays etc shall be provided with manual reset facility.
- v. Auxiliary relay for transformer fault.
- vi. Surge Arrestor

#### 1.16 Control Wiring

The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

## DETAIL OF DESIGN

## CONSTRUCTION

The switch boards shall be cubicle type, suitable for indoor/outdoor installation, floor mounting and free standing. The design shall be totally enclosed, dust - tight, dam proof and vermin proof offering degree of protection not less than IP-42 for Indoor Application & IP-54 for Outdoor application.

Separate segregated compartments shall be provided for circuit breakers, bus bars, cable box, voltage transformers, wire ways, relays, and instrument and control devices. Switchgear cubicles/ modules shall be provided with hinged doors in front with facility for padlocking door handles.

Vent openings shall be covered with grills so arranged that hot gases cannot be discharged through them in a manner that can injure the operating personnel. These vent openings shall be vermin proof.

All the High Voltage compartments i.e. Circuit Breaker, Bus Bar, and Cable Compartments shall be separated from each other by metallic partitions in line with IEC-600298. These compartments must have pressure relief flaps for exit of gas due to internal arc to ensure operators safety. All the HV design must ensure conformity to IEC-600298 and must be Type tested for Internal Arc Test. The supplier shall submit Type Test report from CPRI or other independent agency to prove the above.

All panels shall be of same height, width and depth. Panels shall be bolted together to form a continuous flush front switch board, suitable for front of board operation.

The switchgear cubicles shall be rigid and robust in design and construction, fabricated out of CRCA sheet steel. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed/formed sheet steel of not less than 2mm thickness. The frames shall be enclosed by sheet steel of at least 2mm thickness, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary. Height of the operating handle, push button etc. shall be restricted between 300 mm to 2000 mm from the finish floor level. Fixing screws and nuts shall be used. Self-tapping screws shall not be used in the construction.

All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.

All doors shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.

Floor mounted cubicles with minimum 75 mm high channel and 5 mm thick channel base frame. Approx 200 mm-blank space between the floor of the switchboard and bottom most unit shall be provided. The total height of the cubicle shall not exceed 2400mm.

## BUSBARS & BUSBAR CHAMBER

Three phase bus bars shall be of high conductivity electrolytic copper as stated in B.O.Q. The bus bars shall be air insulated and housed in a separate compartment, which segregated from all other compartments, in case of Vacuum Circuit Breaker. Current density of Cu.Bus-Bar shall not exceed 1.5 Amps / mm<sup>2</sup>

Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. The bus bars connections shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified. Normal operating

temperature for bus bars shall be 85 Deg.C. Short circuit rating of the bus bars shall be 35 KA for 1 sec.

All bus bar joints and bus tap joints shall be silver or tin plated. Joints shall be bolted type and shall be insulated. Spring/Lock washers shall be provided to ensure good contact the joints.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental shorting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.

## **CIRCUIT BREAKERS**

The circuit breakers shall be Triple Pole double break type and the Insulation and Arc interruption medium shall be Vacuum. The Breaker shall be enclosed in a sealed Vacuum Tank.

The circuit breakers shall be of horizontal draw out construction with horizontal/vertical isolation. The circuit breaker including its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement on the circuit breaker. There shall be three discrete positions viz. Service, Test and Isolated. Locking facility in all three positions shall be available. Position indicator shall be provided on the panel to indicate the position of the circuit breaker. Test position shall offer testing of circuit breaker operation/interlocks without energizing the power circuit.

Circuit breakers shall have stored energy spring mechanism charged by manually operated handle as well as electrically operated mechanism. The closing mechanism of the circuit breakers shall be Motor operated, spring charged with a provision for manual charging.

The operating mechanism shall be mechanically and electrically trip free and non-pumping. Anti-pumping feature may be built in or separate anti-pumping relay may be provided. In case spring charged mechanism, spring charged indication shall be provided.

Local manual trip device shall be provided on the operating mechanism. The trip device shall be suitable for front operation and positive mechanical 'ON-OFF' indication shall be provided.

Main contacts of circuit breaker shall have ample area and adequate contact pressure to carry the rated and short time current without excessive temperature rise. The contacts shall be adjustable for wear and easily replaceable. Main contacts shall open before and close after the arcing contacts when these are provided. Arcing contacts shall be easily accessible for inspection and replacement in case of VCB.

Each breaker shall normally be provided with auxiliary contacts of 6 NO+6NC directly operated from breaker operating mechanism. These contacts shall be in addition to these used in circuit breaker internal wiring. These contacts shall be rated for 10 Amps at 240V AC and 20 Amp (inductive breaking) at 220V D.C. If more breaker auxiliary contacts are required latching relay shall be used to multiply the contacts.

Shunt trip coil as called for shall be provided for tripping the circuit breaker. The trip coil/s shall operate satisfactorily between 50% - 110% of rated control voltage. Wattage of trip coils will be sufficiently high to prevent it from picking up or holding on with specified number of trip circuit supervisory indicating lamps wired in series.

It shall be possible to trip the breaker, in case of failure of control supply

Circuit breaker type duty and rating shall be submitted in Data Sheet by the Contractor.

Circuit breakers of similar rating shall be interchangeable.

#### **RING MAIN UNIT/ LOAD BREAK SWITCHES (If Applicable)**

All the live parts of the Load break switches, Copper Bus Bars of the RMU shall be enclosed in SF6 gas medium sealed in stainless steel tank. All connection for Bus-bars shall be capable for short time rating of 21 KA for 3 seconds and shall also be capable of breaking full load current and having fault making capacity of 52 KA.

The RMU shall be equipped with following mechanical Mechanical Interlocks:

1. Between Load break switch & earth switch, i.e., load break switch only can be turned on when the earth switch is in OFF position and vice versa.
2. Between breaker, off load break switch (disconnecter) & earth switch: The breaker must be in OFF position to operate the off load break switch & earth switch. When the earthing switch is in closed position it will be impossible to operate the disconnecter.
3. Between Earth switch & Cable compartment doors, i.e., doors are accessible only when the earth switch is ON; further the main isolator switch/ breaker disconnectors cannot be switched ON unless the doors are closed-

#### **CURRENT TRANSFORMERS**

Current transformers shall be of ratio, burden (shall be worked out by panel supplier), class/accuracy as specified in Single Line Diagram/BOQ.

Current transformers shall conform to latest edition to relevant standards. Current transformers shall be epoxy resin cast with bar Primary or ring type.

CT core laminations shall be of high grade silicon steel. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full load current, without overheating or damage. Short time current rating and rated withstand time shall be same as corresponding C.B.

Secondary terminals of CT shall be brought out to a terminal block which will be easily accessible for testing and external connections. Facility shall be provided for short circuiting and earthing of CT secondary leads through a removable and accessible link with provision for attaching test link.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Current transformers (core) shall be used for metering and protection. Each CT shall be provided with rating plate indicating: Name and Make, Serial number, Transformer Ratio, Rated burden, Rated voltage and Accuracy class.

#### **POTENTIAL TRANSFORMERS**

Potential Transformers shall conform to latest edition of "IS-3156 (Part I, II & III) as applicable relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.

The PT shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg.C above an ambient of 45 Deg.C.

The PT's shall be fixed at rear bottom / top of the panel as called for. An interlock or automatic shutters shall be provided to prevent access to live HV parts when PT is withdrawn.

HRC Fuses shall be provided both primary & secondary side. It shall be possible to replace PT fuses easily without having to de-energize the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the BOQ and shall be stated in data sheet by the Vendor/Contractor. Nameplate as per relevant standards shall be provided on the PT.

### **PROTECTIVE RELAYS**

Relays type and numbers shall be in accordance with the protective scheme required or as per drawings and B.O.Q.

Relays shall be digital microprocessor based or analogue type, as called for in BoQ. It shall be enclosed in rectangular shaped cases, suitable for flush mounting only, dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicalized. The relays shall be either self-powered or a 24V DC Power-pack of suitable capacity with charging device shall be provided within the HT panel.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be drawing out type. Where it is not possible to provide protective relays of the drawout pattern, fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self reset type with indicator. The indicator/s shall be visible from the front.

Relays conform to relevant standards in all respects. Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as required and shall be in data sheet by the Vendor / Contractor.

### **SAFETY/PROTECTION INTERLOCKS/FEATURES**

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe, positive and full-proof.

- a) It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.
- b) Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

- c) Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.
- d) Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.
- e) 1 no. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB.
- f) Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.
- g) Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.
- h) Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.
- i) Annunciation window shall be provided for winding temperature trip / alarm as required.
- j) Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.
- k) All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.
- l) Components within cubicles shall be properly labelled to facilitate testing.

#### **EARTHING**

The switch board shall be provided at the bottom throughout its entire length with a earth bus of copper of adequate size to carry the fault current for the duration same as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.

All non-current carrying metal parts, frames and equipment mounted in the switchboard shall be bonded to earth bus.

Earthing of moving carriage of drawout equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables or bus bars and common for all circuit breakers of the same type/rating shall be provided.

#### **INSTRUMENT & METERS**

Electrical indicating instruments shall be digital type with zero adjustment, probe from outside the cover.

Multi function meter of CL 1.0 accuracy with RS 485 port shall be provided.

Instruments/meters shall be suitable for flush mounting on the panel with flanges protecting outside the panel.

All meters shall be industrial grade with accuracy of class 1.0 unless specifically indicated.

#### **CONTROL WIRING**

All wiring for control, protection, alarm, indicating circuits and remote tripping mechanism on all equipment shall be carried out with at least 650V grade, PVC insulated, stranded, copper, 2.5 Sq.mm conductors.

All wiring shall be run on the sides of the panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel. Where wiring enters or passes through compartments containing HT apparatus then they shall be in earthed metallic conduits or ducts.

All wiring shall be taken to terminal blocks without joints or tees in their run.

All wiring shall be colour coded as follows:

Instrument Transformer AC circuit	-	Red, Yellow & Blue determined by the phase with which the wire is associated.
AC Phase Wire	-	White
AC Neutral	-	Black
DC Circuits	-	Grey
Earth connections	-	Green

Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire. Ferrules shall fit tightly on the wires, without falling off when wire is removed. Ferrules shall be of white colour with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.

All unused auxiliary contacts of the circuit breaker and relays shall be wired upto terminal block.

## **FITTINGS AND ACCESSORIES**

### Indicating Lamps:

Neon type indicating lamps or LED indicators shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.

Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	-	Circuit Breaker 'ON'
Green	-	Circuit Breaker 'OFF'
White	-	Continuous trip supply supervision
Amber	-	Auto trip
Blue	-	Spring charged
R.Y.B	-	Potential indication
Green	-	Earth

### Push Buttons:

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

#### Control & Selector Switches:

Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in colour. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

All other instruments and selector switches shall have stay put contacts.

Circuit breaker control switches shall normally have three positions close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

Contacts of all control and selector switches shall be rated for 10 Amps at 240V AC or 20 Amps at 220V dc (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.

#### Control Terminal Blocks:

Box - clamp type, 650V grade line up terminals of minimum 2.5 Sq.mm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated. Terminal blocks at different voltage shall be segregated into groups and distinctly labelled. Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminal stems shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate undrilled removable gland plate shall be provided for the control cables at the bottom of each panel.

Minimum 10% of total number spare terminals shall be provided for future use.

#### **NAME PLATES AND LABELS**

One Name plate giving designation of the HV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.



Labels giving following details shall be affixed on each feeder panel:

- i) Feeder Name.
- ii) Equipment reference no. & Description
- iii) Rating (KVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labelled with reference number/letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plate, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

#### SPACE HEATERS:

Adequately rated anti-condensation space heaters shall be provided in each cubicle.

Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.

Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature.

#### CUBICLE LIGHTING:

Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from a 240V single phase, 50 Hz. A.C. supply.

#### AUXILIARY SUPPLY:

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

#### FUSES:

All fuses in control, indication and metering circuit shall be HRC link type of approved make. Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

#### CABLE TERMINATION:

The switch board panel shall be provided with separate compartment for cable termination complete with suitable cable end termination for XLPE insulated cables suitable for bottom entry. Cable and sealing box shall preferably be mounted inside the panel. Cable compartment doors shall be self-locking type, interlocked and shall have Arc withstand capability due to short circuit. The compartment shall be provided with cable testing facility in case of gas insulated medium. For XLPE cables adequate space and clearances shall be made for heat/cold shrinkable termination e.g. Reychem or cold flowing stress grading joints.

Two earthing terminals shall be provided in each panel in cable box/cabling chamber for earthing armour/screen.

Where more than one core is terminated on each phase, links suitably designed and properly supported shall be provided to avoid unnecessary bending of cable cores without decreasing

the length of insulated cable tail. Electrical clearances which would normally be required when using one core per phase shall be maintained.

Where core balance type current transformers are provided on switchgear feeder circuit cable/s for earth fault protection sufficient space, clearance and support, mounting arrangement shall be provided for the CT.

**PAINTING:**

All steel work shall be pretreated in tanks and finally powder coated of approved shade of the levels not less than 100 microns.

**TESTING & INSPECTION**

Four copies of all test certificates and certificates from sub-vendor shall be furnished. After completion of all work at the manufacturers works the switchboards shall be inspected and tested in presence of Purchaser's/Consultant's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.
- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.
- xi) Power frequency voltage withstand test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switch boards.

**DRAWINGS AND INFORMATION**

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.
- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) Equipment List.
- vii) Bus bar sizing calculations.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

- i) Technical literature giving complete information of the equipment.
- ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii) A comprehensive spare parts catalogue.

## **TOOLS**

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

## **SPARES**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

## **QUALITY ASSURANCE**

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

## **DEVIATIONS**

Clause wise deviation for the specification must be stated in writing at the quotation stage. In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

## **1.0 DISTRIBUTION TRANSFORMER**

### **2.0 (A) DRY TYPE DISTRIBUTION TRANSFORMERS**

#### **PART 1 – GENERAL**

##### **1.1 WORK DESCRIPTION**

- A. This section of Specification defines the technical requirements for 3 phase 50Hz 11000/433V (no-load) cast resin, dry type Distribution Transformers.
- B. The works shall comprise design, manufacture, routine testing at the factory, supply, delivery to site, installation, testing and commissioning at site of the indoor type, cast resin, dry type distribution transformers specified herein.
- C. All items of accessories, fittings, and protective devices/relays shall be incorporated.

## 1.2 PARTICULAR REQUIREMENTS ON QUALITY ASSURANCE

- A. All items shall be designed, manufactured and type tested generally in accordance with the latest revision of the following standards except where specifically directed otherwise:
  - 1. IS 11171(Part 0/Sec 0):1985 / IEC 60726(1982) : Dry type power transformers
  - 2. IS 2026(Part 1/Sec 0):1977 : Power transformers: Part 1 General (first revision) / IEC 60076(1977)
  - 3. IS 2026(Part 2/Sec 0):1977 : Power transformers: Part 2 Temperature-rise / IEC 60076(1977)
  - 4. IS 2026(Part 3/Sec 0):1981 : Power transformers: Part 3 Insulation level and dielectric tests (Second revision) / IEC 60076(1977)
  - 5. IS 2026(Part 4/Sec 0):1977 : Power transformers: Part 4 Terminal marking, tapping and connections (first revision) / IEC 60076(1977)
  - 6. IS 2026(Part 5/Sec 0):1994 : Power Transformer: Part 5 Transformer/Reactor bushings minimum external clearance in air - Specification
  - 7. IS 3639(Part 0/Sec 0):1966 : Fittings and accessories for power transformers
  - 8. IS 8478(Part 0/Sec 0):1977 : Application guide for on-load tap changers
  - 9. IS 13964(Part 0/Sec 0):1994 : Methods of measurement of transformer and reactor sound levels
  - 10. IS 13956(Part 0/Sec 0):1994 : Testing transformers
  - 11. ISS-2099-1973 : Specification for High voltage Porcelain Bushing
  - 12. IS-7421/1976 : Specification for Low voltage Porcelain Bushing
  - 13. IS-12444/ASTM B – 49 : Specification for Cu Wire rods
  - 14. IS-5484/ ASTM B – 233 : Specification for Al Wire rods
  - 15. ISS-5/1961 No. 632 : Specification for Colors for ready mixed paints
- B. If the specifications conflict in any way with any or all of the above standards, the above specifications shall have precedence and shall govern.
- C. Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above would also be acceptable. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English Translations shall be furnished along with the offer.

## 1.3 SUBMITTAL

- A. Type tested transformers shall be provided.

- B. Upon the request of the Engineer, the Sub-Contractor shall submit type test certificates issued by a National or International Testing Authority. Certificates from NEMA, ASTA will be accepted. Located Test Certificate recognized by Local Supply Authority is also required.
- C. The Type Test Certificates shall show evidence of the following tests:
  - a. Routine tests at the manufacturer's works in accordance with IS: 2026 and IS: 1180 (Part I).
  - b. Calculations in accordance with IS: 2026 to demonstrate the thermal ability of the transformers to withstand short-circuit.
- D. Should modifications be made to the design on the transformer that may affect any or all of the performance obtained from type tests already carried out, the relevant type tests shall be repeated at the expense of the Sub-Contractor.

## **PART 2 – PRODUCT**

### **2.1 FREQUENCY**

- A. The frequency of the transformer shall be rated at 50Hz.

### **2.2 POWER**

- A. The rated power of the transformer is shown on the single line drawings. This being related to the continuous maximum rating (CMR) under the climatic condition specified in this Section for cast resin dry type distribution transformer.

### **2.3 RATED VOLTAGE RATIO AND TAPPING RANGE**

- A. The rated voltage ratio of the transformer at no load shall be 11,000/433V, this being related to the principal tapping of the transformer. Tappings shall be provided on the high voltage winding to provide variation of transformer ratio by +5.0%, +2.5%, -2.5%, -5.0%, -7.5%, -10.0%.
- B. Tap changing shall be carried out by means of an off circuit externally operated self-positioning switch and when the transformer is in de-energised condition. Switch Position No. 1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5 percent in voltage. Provision shall be made for locking the tap changing switch handle in position.

### **2.4 INSULATION LEVELS**

- A. The insulation levels of the transformer windings shall be rated as follows:

Voltage	Impulse Voltage (kV Peak)	Power Frequency Voltage(kV)
433	-	3
11000	75	28
33000	170	70

### **2.5 LOSSES AND IMPEDANCE**

- A. Transformer Losses are to be as per ECBC. The manufacturer can offer losses less than as mentioned in IS: 2026/ECBC. The offer will be evaluated as per the loss evaluation formula given in REC, K-5 Standard – as amended up to date.

**2.6 LIMITS OF TEMPERATURE RISE**

- A. The transformers shall be designed for continuous operation at their rated power without exceeding 90°C corresponding to Class-‘F’.

**2.7 WINDING CONNECTION**

- A. The transformers shall have three high voltage windings and three low voltage windings per transformer.
- B. The High Voltage Windings shall be connected in Delta and the Low Voltage Windings shall be connected in Star with the neutral point brought out.

**2.8 VECTOR GROUP SYMBOL**

- A. The vector group symbol shall be Dyn11 in accordance to IEC76.

**2.9 OVERFLUXING**

- A. The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5 percent on any tapping without injurious heating at full load conditions.
- B. The maximum flux density in any part of the core under such condition shall not exceed 1.9 Tesla. The supplier shall furnish necessary design data in support of this stipulation.

**2.10 CORE MATERIAL :**

- A. Core is to be built up from Cold Rolled Grain Oriented (CRGO) Electrical Grade steel sheets. Corner Losses are to be reduced by using mitred joints, staggered in alternate layers. Core surface is to be applied a resin coating to protect it from atmospheric pollutants.

**2.11 WINDING CONDUCTOR MATERIAL**

- A. Winding conductor material shall be Copper, statutory directives prohibiting use of copper shall also be taken into account. The Copper used shall be double paper covered with 50% percent overlap.

**2.12 TERMINALS**

- A. The terminals shall be provided as required for 433 volt may be with 1.1 kV bushing as per IS: 3747 for normally polluted atmosphere suitable for bus duct connections.

**2.13 LOADING**

- A. In accordance with IS: 6600 - 1972, the transformer shall be capable of being overloaded as per guidance given in IS: 6600 - 1972.

**2.14 FITTINGS & ACCESSORIES**

- A. The dry type transformer shall have the following fittings..
  - 1. Base channels suitable for mounting on floor and plinth.
  - 2. Winding temperature indicator with Alarm and Trip Contacts.
  - 3. Earthing terminals.
  - 4. Lifting Hooks.
  - 5. Diagram & rating plates
  - 6. Plain rollers
  - 7. Platform lugs.
  - 8. Inspection cover.

- B. Surface preparation and painting of enclosure shall be done as per clause of painting elsewhere.

### **PART 3 – SCHEDULE OF TESTS FOR POWER TRANSFORMER**

#### **3.1 GENERAL**

A. The following tests shall be carried out by the contractor to determine whether the plant items and materials comply with the specification and to provide the necessary operating data.

B. Not less than twenty-one days notice of all tests shall be given to the Owner/ Consultant in order that he or his representative may be present if he so desires. As many tests as in the opinion of the Owner/ Consultant are possible shall be arranged together. The plant items selected for type tests shall be identical to those to be supplied by the Sub-contractor in all details likely to be encountered in service. Details of testing equipment and measurement and recording instruments shall be submitted to the Owner/ Consultant as required. All instruments shall be to approval and if necessary shall be calibrated at the expense of the Sub-contractor at a recognized national laboratory.

- A. Notwithstanding reference to British Standards referred to in this specification the Sub-contractor may submit for approval plant tested to technically equivalent National Standards of the Country of Origin. Test certificates and reports shall be furnished to the Owner/ Consultant. The tests shall be classified under following categories.

1. Routine Tests (at works)
2. Site Tests

B. The Sub-contractor shall submit any reports on Type Tests which have been successfully performed on the plant items tendered. If in the opinion of the Owner/ Consultant these reports are acceptable as evidence of the plant items having been satisfactorily tested, the Owner/ Consultant may exempt the Sub-contractor from carrying out the tests.

C. In the event that modification are made to the design of any plant items which may affect any or all of the performance obtained from Type Tests already completed, the relevant Type Tests shall be repeated at the expense of the Sub-contractor.

#### **3.2 APPROVAL OF TEST REPORTS**

- A. All test reports other than those for site tests shall be submitted to the Owner/ Consultant for approval at least six weeks before shipment of the plant items.
- B. It shall be the responsibility of the Sub-contractor to ensure that written approval obtained for the items prior to shipment. Failure to comply with this requirement may result in the rejection of the plant items.

#### **3.3 FACTORY ROUTINE TEST**

- A. Prior to despatch the transformer out of the factory, each transformer shall be routine tested (in presence of representatives of the Purchaser if so required).
- B. The routine tests to be performed shall be:
1. Measurement of winding resistance.
  2. Measurement of voltage ratio and check of voltage vector relationship
  3. Measurement of impedance voltage/short circuit impedance and load-loss

4. Measurement of no-load loss and current
5. Measurement of insulation resistance
6. Induced over-voltage withstand test
7. Separate-source voltage withstand test.
8. Partial Discharge test to IEC 270.
9. Transformer noise measurement.

### **3.4 Type Tests:**

A. In addition to the routine tests, the following type tests may be made as per details in IS 2026.

1. Lightning impulse-test.
2. Temperature rise test.
3. Short-circuit test
4. Air pressure test
5. Unbalanced current test: the value of unbalance current shall not be more than 2% of the full load current.

### **3.5 SITE TESTS**

- A. The transformers shall be fully tested on site prior into putting into service to ensure that all items are in proper working condition, correctly installed and free from damage.
- B. An authorised testing Professional Engineer shall be engaged by the contractor to perform the site testing and commissioning.
- C. The following tests shall be made on the plant item together with any other tests which the Sub-contractor deems necessary.

### **3.6 SEPARATE SOURCE POWER FREQUENCY WITHSTAND VOLTAGE TEST**

A. The windings of each power transformer shall be power frequency voltage tested in accordance with BS 171.

### **3.7 OPERATION TESTS**

- A. Transformer tap-changers, cooling equipment, emergency stop, door interlocks, temperature relays, their controls and all other auxiliary equipment shall be operated to prove that they are functioning satisfactorily before the transformers are put into service.

### **3.8 SECONDARY WIRING TEST**

- A. The insulation of all secondary wiring shall be tested with injection test and megger test after installation.
- B. Measurement of voltage ratio at every tap position and check of voltage sector.

### **3.9 INSPECTION**

- A. All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge to satisfy him that the material is being furnished in accordance with this specification.



- B. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

### **3.10 SEPARATE SOURCE POWER FREQUENCY WITHSTAND VOLTAGE TEST (As Applicable)**

The windings of each power transformer shall be power frequency voltage tested in accordance with BS 171.

### **3.11 OPERATION TESTS**

- A. Transformer tap-changers, cooling equipment, emergency stop, door interlocks, temperature relays, their controls and all other auxiliary equipment shall be operated to prove that they are functioning satisfactorily before the transformers are put into service.

### **3.12 SECONDARY WIRING TEST**

- A. The insulation of all secondary wiring shall be tested with injection test and megger test after installation.
- B. Measurement of voltage ratio at every tap position and check of voltage sector.

### **3.13 INSPECTION**

- A. All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge to satisfy him that the material is being furnished in accordance with this specification.
- B. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

Outdoor type step-down transformer shall be **11 KV to 0.415 KV**, three phase 50 cycles copper wound of rating **1250 KVA** respectively. Transformer shall be having high efficiency, low magnetic field and impedance shall not exceed 6.25 %. Transformer shall not exceed 3.6 and 12 KW at 50% and 100% loading respectively. It shall be double wound core type with ONAN cooling having delta connection on HT side and star on secondary side having automatic On load tap changing device on high tension side for tapping –10% to +5% in step of 1.25%. The transformer shall be complete with the following accessories.

- On Load tap changer with Remote tap changing control panel with Automatic Voltage Regulating relay.
- OLTC conservator with drain valve, filling hole with cover and silica gel breather and oil level indicator.
- Oil conservator with sump and drain valve with cover plate.
- Dehydrating breather with silica gel and oil seal.
- Oil filling valve 32mm dia with cover plate.
- Thermometer pockets with thermometer.
- 150mm dia magnetic oil level indicator with low-level alarm and trip contacts and minimum filling and maximum level markings. Plain oil level gauge with minimum level marking.
- Diagram, rating plate, terminal-marking plate.
- Two earthing terminals.
- Lifting lugs for active part only.

- Four bi-directional plain rollers.
- First filling of oil.
- Double diaphragm explosion vent pipe with sight glass.
- 150mm dial type winding temperature indicator with maximum reading pointer and alarm and trip contacts. Pocket for above item.
- 150mm dia magnetic oil level indicator with low level alarm and trip contacts and minimum filling and maximum level markings
- Double float Buchholz relay with testing sampling cocks, alarm and trip contacts.
- Marshaling Box for contacts for alarm & trip for OTI, WTI, OSR, MOG & Bucholtz relay.
- Air release plug on tank cover.
- Isolation valve on both sides of bucholtz relay.
- W.P. thermo / plastic junction box.
- Detachable radiator with top and bottom stop valves and drain and air release plugs.
- Jacking pads with haulage holes.
- Oil surge relay for OLTC.
- Shut off valve for OLTC oil surge relay.
- Access windows for OLTC connections.
- Drain cum bottom filter valve 32mm with cover plate.
- Vector group – Dyn11
- Cable end box suitable for 1 No. 3 core x 240 Sq.mm XLPE cable, 11 KV (E)
- Cable end box suitable for 8 Nos. 3.5 core x 300 Sq.mm XLPE cable, for connection in L.T. side (1100 Volt grade).
- Extra neutral bushing for solid earthing.
- Pressure equalizer pipe.
- Provision of terminals & Space for mounting Neutral CT for REF relay.

The transformer shall be rated for a maximum temperature rise of 50 Deg. C for oil and 55 Deg. C for winding over 45 Deg. C ambient temperatures.

The transformer shall conform to the IS: 335 and 2026/1977.

## **WINDINGS**

Windings shall be subjected to shirking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent lighteners of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

All low voltage windings for use in the circular coil concentric winding shall be wound on a preformed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

Windings shall not contain sharp bends, which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or be otherwise affected under the operating conditions.

Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

All threaded connections shall be locked. Leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Windings and connections shall be braced to withstand shocks during transport or short circuits.

Coil clamping rings shall be of steel or of a suitable insulating material.

Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistance material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

Terminate of all windings, also of stabilizing windings, shall be brought out of the tank for external connections.

Windings shall be of copper, the conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along with the windings.

The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over tank or in the transformer tank. Vapor phase dry-out shall be preferred.

## **TANK**

Tank shall be made from good commercial grade low carbon steel and shall be of welded construction.

Tank shall be designed to permit lifting, by crane or jacks or the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

Tank together with radiators, coolers, conservator, bushings, vessel and other fittings shall be designed to withstand without permanent distortion the following conditions:

- a) Full vacuum of 760mm of Hg. for filling with oil by vacuum.
- b) Internal gas pressure of 0.35 Kg/cm<sup>2</sup> (5 lbs/sq.in) with oil at operating level.

The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rain water.

Manholes with bolted covers shall be provided in the top or sides of transformer for easy access to the lower ends of bushings, tap changers and to permit replacement auxiliaries without removing tank cover.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

The transformer base shall be designed to permit skidding of the complete transformer unit in any direction, when using plates or rails. The under base shall be detachable unless transport facilities permit a fixed base. Pulling eyes shall be provided for moving the transformer in either direction.

The material used for gaskets shall be cork-neoprene or approved equivalent. Gasketed joints for tank and manhole covers, bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather. Spare gaskets shall be provided for all openings as shipping gaskets will not be reused.

Tank shall be provided with valves etc. as required.

Tank shall be provided with a pressure release device which shall be operated at a pressure below the test pressure for the tank and radiators. The device shall be rain-proof after blowing and shall be provided with a device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied. Explosion vent shall be equipped with remote monitoring/alarm contracts with oil indicator.

The transformer be rated for a maximum temperature rise of 50 Deg. C by thermometer in oil and 55 Deg. C by resistance at CTR with a daily average ambient temperature of 45 Deg. C and peak ambient temperature of 50 Deg. C. poxy paint shade of IS: 631.

The external surface of transformer shall be painted with e

#### **ON LOAD TAP CHANGING (OLTC)**

The diverter switch contacts shall be housing in separate oil chamber not communicating with oil of the main transformer tank. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

The OLTC oil chamber shall have oil filling and drain plug, relief vent and level glass. It shall also be fitted with a separate oil surge relay. The outlet of this relay shall be connected to a separate conservator tank or a totally partitioned compartment of the main conservator. A magnetic oil level gauge with separate potential free contacts for alarm and trip shall be provided.

The equipment shall be suitable for local and remote electrical control and local manual control. The features to be provided with these controls are detailed below:

##### **i) Manual Control**

The cranking device for manual operation of OLTC gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:

- a) Mechanical tap position indicator which shall be clearly visible from near the transformer.
- b) Mechanical operation counter.
- c) Mechanical stoppers to prevent over cranking of the mechanism beyond the extreme position.
- d) The manual control considered as backup to the motor operated tap control shall be interlocked with the motor to block motor start up during manual operation. The manual operating mechanism shall be labeled to show the direction of operations for raising the secondary voltage and vice-versa.

##### **ii) Electrical Control**

This includes the following:

- a) Electrical local control from transformer marshal box.
- b) Electrical remote control from remote control (RTCC Panel).
- c) The control scheme shall have the following features:
  - i) An interlock to cut off electrical control automatically upon recourse being taken to manual control.
  - ii) Selection of point of control local or remote, it shall not be possible for any two electrical controls to be in operation at same time.
- d) Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated.
- e) Step by step operation, ensuring only one tap change for each tap changing command.
- f) An interlock to cutoff the electrical control when it tends to perate the gear beyond either of the extreme tap positions.
- g) An interlock to block a counter command for reverse tap change during a tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

The equipment shall be so arranged so as to ensure that when a tap change has commenced it shall be completed independent of the control relays and switches. If a failure of auxiliary supply during a tap change or any other contingency would result in the movement not being completed adequate means shall be provided to safeguard the transformers and its auxiliary equipment. A supply monitoring relay with alarm contacts shall be provided for the tap changer.

The auxiliary device for electrical controls of the OLTC shall be housed either in the OLTC driving mechanism box or in Transformers marshalling box. It shall be provided with a circuit breaker with magnetic and thermal O/L devices for controlling the auxiliary supply of the OLTC motor.

Tap position indicator shall be supplied loose for mounting on the RTCC.

On the RTCC there shall be following components also:

- i) Raise/Lower switch for manual operation.
- ii) Lamp indicating ON LOAD TAP CHANGE in progress.

RTCC panel shall have automatic tap changing feature i.e. whenever voltage fluctuations occur the tap switch shall change automatically to set net output voltage of  $0.415 \text{ KV} \pm 1\%$ . For this purpose, an Auto/ Manual selector switch shall be provided in RTCC.

OLTC shall have separate breather.

### **Erection & Installation**

The installation, testing and commissioning shall conform to IS Code of Practice IS: 1886-1967 with latest amendment and regulations of local authorities.

When lifting a transformer core shall be taken to see that lifting chain will not interfere with any part of the transformer. Never fix the sling to any other part of the transformer except the lifting lugs. Lifting lugs and jacking pads shall be used for lifting of the transformer. While using jacking pads utmost care shall be taken in proper application of jacks. Where transformer is dragged or pulled on sleeper or rollers the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles. Tank cover should always be fitted lifting the tank.

The transformer shall be lifted by lugs or shackles or by any other suitable means (such as dragging on rollers) and mounted on MS channel embedded in cement concrete. Care shall be taken to see that transformer is not tilted during lifting and erection of transformer. The rollers shall be choked to prevent movement of the transformer after being positioned on the plinth. Adequate and necessary clearances from wall etc.. shall be provided as required as per IS: 1886 - 1967.

Before energizing the transformer the oil must be got tested and approved from any of the Government Test House or from approved appropriate authority. The oil shall be tested in accordance with the requirement of IS - 335/1970. In case the results obtained are substandard the entire quantity of oil is replaced with the approved quality of oil and test taken again. The process shall be repeated till satisfactory results are achieved. In case of presence of foreign matter/moisture etc., in the oil, the oil may be got filtered through oil filtration plant. The temperature of oil in the spray tank shall not exceed 80 Deg. C. during the purification process. The minimum IR value by the end of purification process shall be at least 20 Mega-ohm at an oil temperature of 60 Deg. C. Topping up of oil if required shall be done with tested oil.

The insulation resistance of the winding shall be measured with 2500 V DC meggar and results shall correspond to the factory test results. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained.

- a) Transformers will be delivered without oil, filled with inert gas and without externally mounted accessories.
- b) The Contractor shall place the transformer on its foundation assemble parts, erect the separate cooler banks where provided, erect the supporting structure for detachable type cable chamber, conduit and wiring connecting and filling of transformer with oil.
- c) The Contractor shall arrange to fill transformer oil and also arrange for oil filtration before filling. H.V. Test/Breakdown strength of transformer oil shall be carried out taking a sample from individual transformer and till the result is not found to satisfaction of Engineer, oil conditioning shall have to be carried out.
- d) Jack for the above transformers shall have to be provided by the Contractor.
- e) If vacuum oil filling in transformer is envisaged the Contractor shall arrange the necessary equipment.
- f) All the cable terminations and control wiring is to be carried out by Contractor.

#### **TESTING OF TRANSFORMER**

The transformers shall be subjected to the following routine tests at the manufacturer's works before dispatch.

- a) Measurement of winding resistance.
- b) Voltage ratio, polarity and phase relationship
- c) Measurement of impedance voltage
- d) Excitation Current Measurement
- e) Load losses
- f) No load losses and no load current
- g) Induced over voltage withstand

- h) Separate source voltage withstand
- i) Partial discharges tests.
- j) Insulation resistance measurement test.

The insulation resistance of the winding shall be measured with 2500 V DC meggar and results shall correspond to the factory test results. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained.

The power frequency test voltage for the secondary winding shall be 2.5 KV R.M.S. The transformer shall be charged only after the tests are conducted and approval of local authorities is obtained.

### **CONTROL WIRING**

All the cable terminations and control wiring is to be carried out by Contractor.

The Contractor shall supply, install, test and commission all control/instruments wiring as found necessary. The job is turnkey and shall remain the responsibility of Contractor to ensure its functioning in useful and defined manner.

All the indoor control wiring shall have copper conductor and PVC insulated.

The indoor control wiring shall conform to IS: 694 for voltage grade of 1.1 KV for A.C./230 V for D.C.

The conductor cross sectional area shall not be less than 2.5 Sq.mm.

The indoor wiring shall be in surface conduit neatly placed on wall or ceiling either in horizontal or vertical run.

The control wiring which are to be placed outdoor or which are to run in cable trench shall be of 650/1100 voltage grade and shall conform to IS: 1554. The cable shall have minimum dia of conductor to 2.5 sq.mm.

### **TESTING AND INSPECTION**

- a) The Contractor shall draw up and carry out a comprehensive inspection and testing programme during manufacture and commissioning of the transformer. The programme shall be duly approved by the Consultant/Client.
- b) Contractor shall ensure that type tested equipment only is offered and routine tests shall be conducted as per relevant standards. Type test certificates shall be submitted along with the bid.

### **DRAWING AND INFORMATION**

The vendor shall furnish following drawings/documents in accordance with enclosed requirement.

- a) General arrangement of transformer.
- b) General arrangement of HV cable box with connection diagram.
- c) General arrangement of LV Bus duct flange/Cable box and connection arrangement.
- d) General arrangement of marshalling box and wiring diagram.
- e) Rating and diagram plate indicating % impedance etc.
- f) Type test and guaranteed technical parameters.

### **QUALITY ASSURANCE PROGRAMME**

Quality Assurance Programme shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance Programme involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

## **DEVIATIONS**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

## **2.0 (B) OIL TYPE TRANSFORMERS**

TECHNICAL SPECIFICATIONS FOR 750 KVA 11/0.415 KV STEP DOWN NATURAL OIL COOLED OUTDOOR TYPE TRANSFORMER WITH OLTC, RTCC & AVR

### **1.1 Scope**

This section covers the detailed requirements regarding Design, Manufacture and supplying the following Natural Oil Cooled Transformer suitable for out door use with OLTC, RTCC & AVR as described in the Tender Documents.

a. 750 KVA 11/0.415 KV step down natural oil cooled Transformer with OLTC, RTCC & AVR ----- 3 Nos.

### **1.2 General Construction**

1.2.1 The Transformer shall comply with the following Indian Standards as amended upto date:

- (1) IS 2026 - Part I to V power Transformer.
- (2) IS 335 - Transformer Oil.
- (3) IS 1886 - Installation and Maintenance of Transformer.
- (4) IS 2099 - Bushings.
- (5) IS 2705 - Current Transformer.
- (6) IS 6600 - Guide for loading of oil immersed Transformer.

### **1.2.2 Tanks and Radiators**

Tanks shall be of M.S. Plates and structural, electrically welded. The construction shall be robust and substantial, suitable for Road/Rail transport and to withstand vibration. Radiator tubes shall be electrical resistance welded type, round or elliptical or rectangular. They may be welded to the transformer tank or in case of very large sizes to separate detachable radiator banks connected through intermediate leak proof valves. Detachable Radiator banks shall have top and bottom headers with flanged connections, with drain and vent fittings. Tanks shall be provided with lifting lugs and jacking lugs. Inspection hole with cover should also be provided for large Transformer. Oil Conservators shall be mounted on brackets attached to the top cover on tank. Dimensions of the Conservator shall be such as to allow change in volume of oil due to change in temperature from 10 degree C to 95 degree C.

Tanks shall be thoroughly cleaned, degreased and sand blasted inside and outside. A coat of rust resisting primer shall immediately be given on outside surface. Inside surface shall be painted with oil resistance enamel paint. Tank and radiators shall be hydraulically pressure



tested. In case of Transformer of 750 KVA and above, tanks shall also be tested for full vacuum. The procedure for testing shall be as follows:

(a) Vacuum Test - The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sqm (25mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in Table 'A' without affecting the performance of the transformer.

(b) Pressure test - When specified, one transformer tank of each size together with its radiators, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/Sqm (0.35 kg/Sq.cm.) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified in Table 'A'.

TABLE 'A'

Horizontal length of Flat plate (in mm)	Permanent deflection (in mm)
Upto and including 750	5
750 to 1250	6.5
1251 to 1750	8
1751 to 2000	9.5
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
Above 3300	19

### 1.2.3 Cores

Cores shall be built from cold rolled grain oriented silicone steel laminations. The core laminations shall be insulated from each other by a suitable high temperature resistant, oil proof, adherent coating materials. Core clamps and clamping bolts shall be heavily insulated from the core laminations. The insulation of core bolt shall be minimum of class 'A'. The bottom and top frames shall be connected with the tie rods to make a complete structure rigid for carrying the weight of core-coil assembly without unduly stressing the laminations or windings. Lifting eyes shall be provided on the frame for removal of core assembly from the tank. Completed core shall be flash tested for insulation with 2500 volts between the core and each of the clamps or core bolts (core being connected to earth). The flux density of core shall not be more than 1.5 tesla..

All the core frames shall be bonded together with two metallic strips and connected to the tank for earthing, to ensure earth return and operation of protective gear in the event of a fault. Lifting eyes (or any other provision) for lifting the core from the tank shall be provided.

#### 1.2.4 Winding and Insulation

Winding shall be three phase with minimum class 'A' insulation. High conductivity electrolytic quality copper shall be used for winding. Windings shall be suitably braced to withstand the dynamic forces due to short circuit. Winding insulation shall be uniform and windings shall have full insulation.

Windings shall be individually vacuum dried before assembly as well as after assembly. Provide winding temperature indicator.

#### 1.2.5 Insulation Oil

Insulation oil shall conform to IS 335. Transformer shall be supplied with initial fill of filtered oil. Plus 10% additional quantity for make up at site while installation.

#### 1.3 General Requirements

The transformer shall be outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short circuit as per clause 9 of IS 2026 (Part I) 1977.

#### 1.4 Capacity and Rating

Rating shall be continuous rating specified irrespective of the winding tap position.

#### 1.5 Temperature Rise

The reference ambient temperature assumed for the purpose of this specification is as follows:-

- (a) Maximum ambient air temperature 50 degree C.
- (b) Maximum daily average ambient air temperature 42 degree C.
- (c) Maximum yearly weighted average ambient temperature 32 degree C.
- (d) Minimum ambient air temperature (-) 5 degree C.

The temperature rise at the above conditions and at an altitude not exceeding 1000 metres shall be as follows:

By resistance method 55 degree C.

By thermometer 50 degree C.

#### 1.6 Tap Changing Device

##### a. 11/0.415 KV Transformer

Tap changing device shall be provided on H.V. side, On Load Tap Changing (OLTC) device with Remote Tap Changing Control panel (RTCC) and Automatic Voltage Regulator (AVR) shall be provided. Automatic Tap changing arrangement shall be provided with AVR etc. with provision for manual tap changing arrangement. Tap changing arrangement shall be suitable to correct the voltage variation upto minus 25% and plus 10% in 17 steps. The tap changing shall be automatic and correction speed shall be fast. Remote and local operation of tap changer shall be provided with motor and manual push button.

Provide pressure relief valve with contacts for remote control for OLTC.

Provide the following provision in the RTCC Panel.

- i. The tap changing shall be automatic/ manual.

- ii. Whenever the HT supply fails, the tap changer should come to the normal position (11KV) and when the HT supplies resumes, the tap changer should correct the voltage accordingly.

#### 1.7 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/415 V on no load.

#### 1.8 Vector Group

In case of step down Transformer, the winding connection shall conform to vector group Dyn 11 unless otherwise specified.

#### 1.9 Cooling

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

#### 1.10 Accessories

The transformer shall be a single tank type with termination on cable end box as specified both on HV and MV side. The MV side cable termination box shall be suitable to receive 5 Nos. 3.5 C x 300 Sq. mm. AYFY cable connections for 750 KVA Transformer and inter-connection suitable for full load current of the transformer with Bus bars etc. H.V.Side cable box suitable for 3C x 240 sq. mm 11 K.V. XLPE Cable.

#### 1.11 Fittings for Transformer

Each 11000/415 Volts Step down Transformer shall be provided with the following fittings and accessories:

- (a) Oil conservator with oil level indicator, minimum level marking and drain plug for Transformer and OLTC.
- (b) On Load Tap Changer (OLTC), Remote Tap Changing Control Panel (RTCC), and Automatic Voltage Regulator (AVR) with local & remote changeover with A.C. motor as required.
- (c) Thermometer pocket with plug on the Transformer and OLTC.
- (d) 100mm dia dial type thermometer to indicate oil temperature with metal guard Dial type thermometer shall have max. Temperature indicator with contacts for Remote indication & tripping and resetting device for Transformer and OLTC
- (e) Lifting lugs for transformer and OLTC.
- (f) Bi-directional Rollers.
- (g) Rating diagram and terminal marking plate for transformer and OLTC.
- (h) Explosion vent for transformer and OLTC.
- (i) Additional Neutral Terminal separately brought out on a bushing for earthing the neutral of transformer.
- (j) Earth terminals (2 Nos) for body earthing for Transformer and OLTC.

- (k) Valves for filtration, drainage and filling etc. with necessary plugs for Transformer and OLTC.
- (l) Radiator assembly with shut off valves for Transformer and OLTC.
- (m) Silica gel Breather for Transformer and OLTC.
- (n) Air release plug for Transformer and OLTC.
- (o) First filling of insulated oil conforming to IS 335/1972 including make up fill during installation for Transformer and OLTC.
- (p) Provide double float Buchholtz relay with contacts for remote tripping of Transformer and OLTC.
- (q) Inspection covers on tank cover for access to terminal connections for Transformer and OLTC.
- (r) Suitable cable termination arrangement for M.V. side with extended Bus bars for cable connection and cable box terminations on H.V. Side, suitable for 3Cx 240 sq. mm 11 K.V. XLPE Aluminum Conductor cable.
- (s) Necessary hardware, clamps, lugs etc. for terminations of H.V. Cables on HV side and cable termination on M.V. Side.
- (t) Marshalling box for Transformer and OLTC control wiring.
- (u) Winding temperature indicator with contacts for remote alarm and tripping for all the Three phase.

#### 1.12 Explosion Vent/Pressure relief Valve

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

#### 1.13 Rating and Diagram Plates

The following plates shall be fixed to Transformer tank in a visible position.

- (a) Rating plates of weather proof material bearing the data specified in the appropriate clauses IS: 2026-1977 for transformer
- (b) A diagram plate showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS: 2026-1977 and a plan view of the transformer giving the correct physical relationship of the terminals for Transformer

#### 1.14 Joints and Gaskets

All gaskets used for making oil tight joints shall be of proven material such a granulated cork bonded with synthetic rubber gaskets or synthetic rubber.

#### 1.15 Gas and Oil Actuated (Buchholtz) Relays

Buchholtz relay shall be provided for transformer and OLTC.

Oil actuated relay equipment where specified to be fitted shall conform to IS: 3637-1966 and shall be double float type having contacts which close following oil surge or under incipient faults conditions.

Each gas and oil actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.

Where specified to allow gas to be collected at ground level, a pipe approximately 5mm inside diameter shall be connected to the gas release cock of the gas and oil actuated relay and brought down to a point approximately 1.25m above ground level, where it shall be terminated by a stop cock. A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay.

The design of the relay mounting arrangements, the associated pipe work shall be such that maloperation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bared ends of stranded wire shall be sealed together to prevent creepage of oil along the wire. There shall be no possibility of oil entering connection boxes used for cables or wiring.

#### 1.16 Cable Box

Cable box shall not be mounted on the tank covers. It shall be possible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or dilink in oil approachable through inspection cover in tank cover etc. After lowering coil shall be provided for test purpose.

#### 1.17 Guaranteed Technical Data

Guaranteed technical particulars shall be submitted as detailed in enclosed Schedule 'A'.

#### 1.18 Tests

##### 1.18.1 Tests at Works

All routine and other test prescribed by IS 2026 shall be carried out at the manufacturer's works before the dispatch of the transformer in the presence of inspecting officer. Copies of the test certificates shall be furnished to the Owner. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate carried out on the same type/design of the transformer shall be furnished in accordance with IS for purpose of record. If impulse test was not carried out in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost.

Copies of the certificates for pressure test for bushings, and type test for short circuit shall be supplied to the Owner.

#### 1.18.2 Tests at Site

In addition to tests at manufacturers premises, all relevant pre-commissioning checks and test conforming to IS code of practice No. 1886 shall be done before energisation. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking.

- (a) Insulation test between HV to earth and HV to MV with a 5000 volts megger.
- (b) Insulation test between MV to earth with 500 volts megger.
- (c) Insulation test on oil.
- (d) Buchholtz relay operation by simulation test.

All test results are to be recorded and reports should be submitted to the Owner.

#### SCHEDULE 'A'

##### SCHEDULE OF TECHNICAL PARTICULARS FOR 750KVA NATURAL OIL COOLED TRANSFORMER 11 KV to 415 VOLTS WITH OLTC, RTCC&AVR.

S.No.	Particulars	Guaranteed Data
(A) TRANSFORMER		
(1)	Specification to which it conforms	- IS - 2026
(2)	Type and make	- Out Door
(3)	Core type or shell type	- Core Type
(4)	Output in KVA (continuously rated)	- 750 KVA
(5)	Frequency	
(6)	Voltage between phases (HV on no load) on each tap position.-	11000 Volts Normal position
(7)	Voltage between phase (MV on no load) on each tap position. -	415 Volts On all steps
(8)	Impedance at normal voltage ratio at 75 degree C	- 5%
(9)	Iron losses at normal voltage ratio	- As per ECBC 2007 or minimum
(10)	Load copper losses at normal voltage ratio, at full load	- 6300 W (less than ECBC Norms) Maximum
(11)	Regulation at unit P.F. at 75 degree C.	
(12)	Regulation at 0.8 P.F. at 75 degree C.	
(13)	Reactance at normal voltage and ratio.	
(14)	Resistance at H.V. windings at 75 degree C. -	
(15)	Resistance at M.V. windings at 75 degree C.	
(16)	Efficiency at unity Power factor	
(a)	Full Load	

(b) 75% Load

(c) 50% Load

(17) OVER-LOAD: The Transformer is capable of carrying

Overload as follows:

Percentage Load	When starting Cold (in hrs)	after running continuously in hrs
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(a) 25%

(b) 50%

(c) 100%

(18) Type of tank

(19) Width of oil duct between core and Winding

(20) Type of insulation

(a) H.V Conductors - 'A' Class (Minimum)

(b) M.V. Conductors - 'A' Class (Minimum)

S.No.	Particulars	Guaranteed Data
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(21) APPROXIMATE WEIGHT

(a) Core lamination

(b) Copper

(c) Transformer coils and insulation -

(d) Oil

(e) Tank fittings

(f) Total weight including complete transformer with oil, Tank and fittings.

(22) Approximate quantity of oil required for first filling.

(23) Guaranteed no load losses. (No Positive tolerance)- 1200 Watts

(24) Guaranteed full load losses. (No Positive tolerance)- 6300 Watts

(B) OLTC, RTCC & AVR

(1) Specification to which it conforms (- /+) 10% and -25% In Steps of 2.05 %

(2) Number of steps - 17

- (3) Voltage between steps on H.V. Side. - 2.05%
- (4) Manual /Remote Operation - OLTC, RTCC & AVR
- (5) Diagram plate
- (6) Tap position Indicator

### 3.0 L.T. PANELS & SWITCHGEARS

Medium voltage switch boards/distribution boards, the combination of both these and components shall conform to the equipments of the latest revision including amendments of the following codes and standards.

The drawings, specification and BOQ complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

#### CODES & STANDARDS

The design, manufacture and performance of equipment shall comply with all the currently applicable statues, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (B.S.), International Dutro Technical Commission (IEC) Publication, NEMA, IDE & DEMA standard as amended upto date.

- a) IS: 13947- 1993/IEC 60947-1989: Air circuit breaker/moulded case circuit breaker.
- b) IS:3156 Voltage transformers.
- c) IS:2705 Current transformers for metering and protection with classification Part-I, II burden and insulation & III 1964
- d) IS:9224 Low voltage fuse and protection.
- e) IS:3231 Specification for electrical relays for power system protection.
- f) IS:8623 Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000-V AC/1200 V-DC.
- g) IS:4237 General requirements for switch gear and control gear for voltage not exceeding gear.
- h) IS:2147 Degree of protection provided by enclosures for low voltage switch gear and control gear.
- i) IS:1018 Switchgear and control gear selection/installation and maintenance.
- j) IS:1248 Direct acting electrical indicating instruments.
- k) IS:375 Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
- l) IS:2959 AC contactors for voltage not exceeding 1000V.
- m) IS:5578 Guide for marking of insulated conductors.
- n) IS:11050 Guide for forming system of marking and identification of conductors & apparatus terminal.
- o) IS:1248 Direct acting indicating analogue electrical measuring instruments and Testing accessories.



p) IS:600 Code of practice for phosphating of iron & steel.

The board shall be metal enclosed single front, indoor, floor mounted, free standing type or wall mounting type as mentioned in BOQ. The panel shall be designed for a degree of protection of IP-55. However bus bar chamber shall have IP: 42 degree of protection incase bus bar rating exceed 1600 Amps. Keeping in view the operating height of the top switch 1750mm from finish floor. 400mm clear space shall be left throughout the panel at bottom. The cold rolled sheet steel will be of 2mm thick. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 50mm height.

All cutouts and covers shall be provided with synthetic rubber gaskets (preferably neoprene).

The panel shall be divided into distinct vertical sections each comprising of:

- i) Complete enclosed bus bar compartment for running horizontal and vertical bus bars.
- ii) Complete enclosed switchgear compartment one for each circuit for housing air circuit breaker, MCCB/MPCB with starters etc.
- iii) Compartment for power and control cables of at least 300mm width covering entire height provided.
- iv) The panel shall have sufficient space at least 20% of outgoing feeders for future use.

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. Isolators and MCCB/ACBs and accessories shall be of fixed/drawout type as per BOQ.

Each feeder shall have compartmentalized or non-compartmentalized for MCB feeders only. Ri-tall type with separate construction cable entry shall be from top/bottom (3mm thick gland plate with suitable numbers & sizes of knockout holes (as called for in schematic/fabrication drawings) shall be provided.

The panel shall be provided with three phase buses & neutral bus bars of high conductivity electrolytic copper/Aluminium sections throughout the length of the panel & shall be adequately supported and braced to withstand the stressed due to the short circuit current of 35 KA rms. for 1 sec. as called for in BOQ/Data Sheet. Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 40 Deg.C over an ambient temperature of 50 Deg.C. The Current density of Bus Bar shall be 1.0 Amp/mm<sup>2</sup> for Aluminium and 1.5 Sq.mm/mm<sup>2</sup> for copper.

The minimum clearance in air between phases and between phases and earth for the entire run of the bus bar connections shall be 32mm minimum. Bus bars support insulators shall be made of non-hydroscopic non-combustible track resistant and high strength SMC or polyester fiberglass moulded material.

All bus bars shall be colour coded as per IS: 375.

Copper /G.I./Aluminium earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly suitable size of strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

Sheet steel hinged lockable doors shall be interlocked with MCCB to prevent opening of the panel when MCCB is on position. Safety interlock with operating handle shall be provided.

Contactors shall be electromagnetic type with interrupted duty as per IS: 2959. The main contacts shall be of silver or silver alloy, provided with minimum 2 NO and 2 NC auxiliary contacts. The push button should be of shrouded type and each should be provided with 1 NO and 1 NC contact. Colour coding shall be as per IS: 6875 (Part-II).

**ACB (IEC 60947-2; IS 13947)**

The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI, ERDA any accredited international lab. The circuit breaker shall be suitable for 415 V  $\pm$  10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version with no duration upto 50degC as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.( Icu= Ics= Icw=100% for 1sec)

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have Class-II with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC and impulse withstand voltage 12KV

**Cradle**

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 3 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated:

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision for locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

### Protections

The breaker should be equipped with micro-processor based, modbus communicable type release and shall offer complete current protection to the electrical system in the following four zones:

- Long time protection.
- Short time protection
- Instantaneous protection.
- Ground fault protection.

The protection release shall generally have following features and settings :

a. True RMS Sensing

The release shall sample the current to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current

b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Facility to diagnose faults, their thresholds and fault history, min. 10 required

e. Self powered

The release shall draw its power from the main breaker CTs

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. to implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows:

Type of Protection	SETTING RANGE OF RELEASE	
	PICK-UP CURRENT	TIME DELAY
Long Time	0.2 to 1.0 times $I_n$ ( $I_r$ )  Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00.  Operating Limit : 1.05 to 1.2 times $I_r$	0.5 to 30 sec at 6 $I_r$  Steps 0.5, 1, 2, 4, 6, 8, 12, 18, 24 and 30 secs  Tolerance : Corresponding to $\pm 10\%$ of current.
Short Time	1.5 to 12 times $I_r$  Steps : 2, 3, 4, 5, 6, 7, 8, 9 & 10  Tolerance : $\pm 10\%$	20 ms to 600 ms  Steps 20, 60, 100, 160, 200, 260, 300, 400, 500 and 600 ms  Tolerance : $\pm 10\%$ or 20ms whichever is higher
Instantaneous	2 to 15 times $I_e$  Steps : 2, 3, 4, 6, 8, 10, 12 Tolerance : $\pm 10\%$	
Ground Fault	0.1 to 1 time $I_n$  Steps : 0.2, 0.3, 0.4, 0.5, 0.6  Tolerance : $\pm 10\%$	100 ms to 400 ms  Steps : 100, 200, 300, 400ms Tolerance : $\pm 10\%$ or 20 ms whichever is higher.

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Trip Circuit supervision with PS class CT's.
- Reverse power ( for DG set only)

The release should provide current metering. Parameters of the Protection Release should be changeable from Release. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type
- Release should be self powered.
- Phase voltages (running)

- Energy & power parameters (active, reactive and apparent)
- Frequency
- Maximum Demand ( KVA & KW)

All O/G ACBs shall have following functions.

#### **Protection**

The ACB control unit shall offer the following protection functions as standard:

- Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay; instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

#### **Measurements**

- A current metering (ammeter) release with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- It should display the load level on the three phases.

#### **Safety Features**

- The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.
- The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- The insulation material used shall conform to Glow wire test as per IEC60695.
- The ACB shall provide in built electrical and mechanical anti-pumping.

All EDO ACB's Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

#### **Additional**

The circuit breaker shall be of air break type in order to eliminate fire and explosion risk and shall comply with the IEC with a rupturing capacity of not less than 35 MVA at 415 volts or as specified elsewhere (The service short circuit breaking capacity shall be as specified and equal to the short circuit with stand value  $I_{cs} = I_{cu}$ ). The breaker shall be provided with variable microprocessor based releases within built fault differentiation for integral over load, short circuit and earth fault & other protection as called for in BOQ, LED indication for type of fault, CT's for protection and measurement class as called for in BOQ, and LCD display of curves and parameters. Electrical endurance without maintenance shall be greater than 2000 cycles.

Mechanical & electrical anti pumping devices shall be provided in breaker, as required.

The breaker shall have memory for logging history for type of fault, load, time & date and the Vendor shall mention in the data sheet for no. of loggings available in the breaker memory.

The breaker shall consist of a horizontal draw out pattern triple/four pole, fully interlocked, independent manual/motorized spring operated mechanism. The mechanism should be such that the circuit breaker is at all times free to open immediately. The trip coil is energized. Current carrying parts should be silver plated and suitable arcing contacts shall be provided to protect the main contact arc-chutes for each pole shall be provided and shall be lifted out for the inspection of main and arcing contact.

Self-aligning cluster type isolating contacts shall be provided on breaker for interlocking protection metering and for any other purposes. The breaker should have 3 distinct positions - SERVICE/TEST/ISOLATED within the cubicle.

The ACB shall be with molded housing class II front fuse and shall be suitable for Isolation as per the annexure 7.1.2 in the standard.

Breaker shall be provided with automatic safety shutters to screen the main live contact when the breaker is withdrawn. The frame of the circuit breaker could be positively earthed when the breaker is racked into the cubicle.

The following safety arrangements shall be provided for the safety of the personnel to prevent mal-operation.

- i) Interlock to prevent the truck from being withdrawn or replaced except in the fully isolated position.
- ii) Interlock to prevent earth connection from being made by the earthing device except breaker is open.
- iii) Interlock to prevent the breaker being closed unless it is fully raised.
- iv) Interlock to prevent the breaker from being made alive without its rack in position.

#### **Protection Releases**

Self-powered & true RMS sensing microprocessor based release with following features.

##### **a) Incomer ACB of Panels:**

Long time short circuit protection with time delay. Instantaneous and earth fault protection with LCD display to show RMS current in all three phases, neutral (for 4pole) simultaneously. The other features of the release to be as under.

- The release should display distinct fault indication for each type of tripping for faster fault diagnosis and reduce down time & should protect ACB from over temperature and Phase unbalance.

- Release should provide contact wear indication in display no. of operation seen by the breaker for case of maintenance.
- The release shall be self-diagnosis & should provide fault history including cause of fault as well as level of fault current. It should be possible to store minimum 20 last trip data with nonvolatile memory.
- The protection setting of release should be accessible to change locally.
- LCD display should be at least 4 line display and should be able to display current in all the 3 phases and neutral (4 pole) simultaneously.

**b) For Outgoing ACB feeder:**

Long time Short circuit protection with time delay (for discrimination), instantaneous. The other features of the release to be as under.

The release should have distinct fault indication for each type of tripping for faster fault diagnosis and reduced down time and shall protect ACB from over temperature and phase unbalance.

- Operation counter
- Alarm and warning indication

Type test certificate : The ACB's shall be type tested and certified for compliance to IS 13947/equivalent / EC standard from Indian / International testing authority, supplier to submit certificate of the same.

**MOULDED CASE CIRCUIT BREAKER (MCCB)**

The MCCB should be current limiting type. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, double break arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs suitable for line and motor application, should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM

**Current Limiting & Coordination**

The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB.

- Protection Functions
- MCCBs upto 250 Amps ratings shall be equipped with Thermal-magnetic releases and above 250 Amps shall have microprocessor based releases
- Protection settings shall apply to all poles of circuit breaker.

**Testing**

- a) Original test certificate of the MCCB as per IEC 60947-1 & 2 or IS13947 shall be furnished.

- b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

### Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

- a) Handle interlock to prevent unnecessary manipulations of the breaker.
- b) Door interlock to prevent the door being opened when the breaker is in ON position.
- c) Defeat-interlocking device to open the door even if the breaker is in ON position.
  - The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs upto 250 Amps ratings shall be equipped with Thermal-magnetic releases and above 250 Amps shall have microprocessor based releases
  - All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit .Provision for external earth fault protection
  - The trip command shall override all other commands.

### Additional

MCCB shall confirm to the latest IS13947-1993/IEC 60947. The Service Short Circuit Breaking Capacity (Ics at 415 VAC) should be as specified.

MCCB shall be Current Limiting and comprise of Quick Make – Quick Break switching mechanism & Double Break Contact system. The arc extinguishing device and the tripping unit contained in a compact, high strength, heat resistant, flame retardant, insulating molded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload short circuit and earth fault adjustment with thermo-magnetic releases upto 250A and with electronic release above 250A onwards.

The Service Short Circuit Breaking Capacity (Ics at 415 VAC) should be as called for in BOQ and is the required minimum value for that feeders/ panel, however if the rating of feeder mentioned is not available, the contractor shall used next higher rating without any extra charges. The service short circuit breaking capacity shall be equal to ultimate breaking capacity of MCCB, i.e.  $I_{cs} = 100\%I_{cu}$

The trip command shall over ride all other commands. MCCB shall employ maintenance free double break contact system to minimize the let thru' energies and capable of achieving discrimination upto the full short circuit capacity of downstream MCCB. The manufacturer shall provide both the discrimination tables and let thru' energy curves. The MCCB shall not be restricted to Line/Load connections.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection upto full rating. The remote tripping coil should be of continuous duty. The general-purpose control switch shall be provided for ON/OFF Auto/Manual. The switch shall be provided with engraving plates on the front with the complete inscription.

The switch shall be normally a fixed control box type heavy-duty unit.

Indicating lamps shall be of the panel mounting, LED type and shall have execution plates marked with its function wherever necessary. The color of the lamp cover shall be red for 'ON' and green for 'OFF' indicating lamps shall be provided with series resistor. MCCB shall



be provided with interlocking device for interlocking the door of switchboard. Following shall be included if specified in the drawing or in the schedule of quantities:

- Under voltage trip
- Shunt trip
- Alarm Switch
- Auxiliary switch

## **CONTACTORS**

The contactors should comply with the latest IEC947-4 and the corresponding IS13947-4 standards. They shall have UL and CSA approval. The contactors should be rated for AC3 duty at 415V and 50Hz. The contacts should be fast closing and fast opening type. The making and breaking capacity values of the contactors should be as follows (as per IEC947-4):

For AC3 Duty

- Making Capacity equal to or more than 10 Ie
- Breaking Capacity equal to or more than 8 Ie

For AC4 Duty

- Making Capacity equal to or more than 12 Ie
- Breaking Capacity equal to or more than 10 Ie

The contactors should be capable of frequent switching and should operate without derating at 600C for AC3 applications. They should be climate proof as standard. The coil of the contactor should have class H insulation to support frequent switching.

The rated voltage of the contactor shall be equal or superior at 690 V, and rated insulation voltage shall be 690 V. The rated impulse voltage of the contactor should be 8 KV.

The contactor should be modular in design with minimum inventory requirements and built in mechanically interlocked 1NO 1NC auxiliary contact up to 32A. They should be suitable for the addition of auxiliary contacts and other electrical auxiliaries without any compromise on the performance or the operation of the contactors. The contactors from 4 KW to 400 KW will be associated with the same auxiliary contact block range.

Wherever D.C control is required, the contactor should have wide range (0.7 to 1.25Uc) D.C coil with built in interference suppression as standard.

The control and power terminals should be at separate layers preferably with colour coding (black for power and white for control)

All contactors power connection will be finger safe (IP2X) as standard.

They should be capable of being integrated into automated system (PLCs etc.) without any interposing components in minimum operating conditions.

The thermal over load relay if used will be directly mounting under the contactor without any specific connections.

## **NAME PLATES & LABELS**

- i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

- ii) All nameplates shall be of non-rusting metal or 3-ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to Owner's approval.
- iii) Suitable stencilled paint marks shall be provided inside the panel/module identification of all equipments in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

## **PAINTING**

All steel work shall be pretreated in tanks and finally powder coated of approved shade.

## **WIRING**

Control and protective wiring shall be done with copper conductor PVC insulated 1100 volts grade multi-stranded flexible wire of 2.5sq.mm cross section. The colour coding shall be as per latest edition of IS: 375.

Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spliced between terminal points.

Terminal blocks shall preferably be grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than one wire shall be connected to any terminal block. All doorframe of L.T. switchboard shall be earthed with bare braided copper wire.

## **TESTING & INSPECTION**

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of Purchaser's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by primary or secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test.
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.
- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out alongwith copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before despatch of switchboards.

**DRAWINGS AND INFORMATION**

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.
- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

- i) Technical literature giving complete information of the equipment.
- ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii) A comprehensive spare parts catalogue.

**TOOLS**

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools with his quotation.

**SPARES**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

**QUALITY ASSURANCE**

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

**DEVIATIONS**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

## 4.0 BATTERY & BATTERY CHARGER

### 1. SCOPE

The specifications give details of the Battery Charger suitable for HT/ LT Panels. The batteries are housed in the Bottom Compartment of the Battery Charger. Sealed maintenance Free Batteries upto 24V – 200AH or Lead Acid Batteries upto 24V – 150AH can be housed in the Battery Compartment. The Battery Charger is a composite Battery Charger cum DC Distribution Board.

### 2. GENERAL

The Battery Charger shall be Float cum Boost type, Thyristor controlled. The Charger shall have selector switch for Auto Float – Boost/Manual Float/Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to Trickle charge.

### Construction Feature

Float cum Boost Charger and DC Distribution Board shall be housed in Sheet Steel Cubicle with Panels of 1.6mm thickness, louvers for ventilation, gland plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens Grey Shade. The Battery Charger shall be divided into two Compartments. The Upper Compartment shall house the Battery Charger & DCDB with all the necessary controls. The Lower Compartment shall be suitable for housing the Batteries.

### PERFORMANCE

- The D.C. Output Voltage of Float/Boost Charger shall be stabilized to within  $\pm 2\%$  for A.C. Input variation of  $230V \pm 10\%$ , frequency variation of  $50 \text{ Hz} \pm 5\%$  and D.C. Load variation of  $0 - 100\%$ . The Voltage Regulation shall be achieved by a constant voltage regulator having fast response SCR controlled. The ripple content in output shall be within 3% of D.C. Output Nominal Voltage.
- There shall be provision to select Auto Float/Manual Float /Manual Boost Modes. During Auto Float Mode the Battery Charging shall automatically changeover from Boost Mode to Float Mode and vice – versa. During Manual Float/Boost Modes it shall be possible to set the output volts by separate potentiometers.
- The Battery Charger shall have automatic output Current Limiting feature.

### COMPONENTS

The Battery Charger shall essentially comprise of the following:

- 1 No. Double Pole ON/OFF MCB at A.C. Input.
- 1 No. Pilot Lamp to indicate Charger ON.
- 1 No. MAIN TRANSFORMER: Double Wound, naturally air – cooled, having Copper winding.
- 1 Set Single Phase full wave Bridge Rectifier consisting of 2 nos. Diodes and 2 nos. SCR's, liberally rated, mounted on Heat Sinks and complete with Resistor/Condenser network for surge suppression.

- e. 1 No. Rotary Switch to select AUTO FLOAT/MANUAL FLOAT/MANUAL BOOST. During Auto Float Mode Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa.
- f. 1 Set Solid state constant potential controller to stabilize the DC Output Voltage of the Float cum Boost Charger at  $\pm 2\%$  of the set value for AC Input Voltage variation of 230V  $\pm 10\%$ , Frequency variation of  $\pm 5\%$  from 50Hz and simultaneous Load Variation of 0 - 100% and also complete with Current Limiting Circuit to drop the Float Charger Output Voltage upon overloads to enable the Battery to take over.
- g. 1 No. Electronic Controller to automatically changeover Battery Charging from Boost to Float and vice – versa.
- h. 1 No. DC Ammeter and Toggle Switch to read Charger Output Current and Battery Charge / discharge current.
- i. 1 No. Moving Coil DC Voltmeter to read the DC Output Voltage.
- j. 2 Set Potentiometer to adjust the output Voltage during Manual / Auto Float and Boost Modes.
- k. 1 No. Double Pole ON/OFF MCB at Charger Output.
- l. Dc Distribution Board :-  
 INCOMER : 1 No. 63A DP MCB, as called for in BOQ.  
 OUTGOING: Suitable No. 16A/20A DP MCB, as called for in BOQ.

#### Alarm Annunciation :

Visual and Audible Alarm with Manual Accept/Reset Facility shall be provided for the following:

- a) A.C. Mains Fail.
- b) Charger Fail.
- c) Load/Output overvoltage.

RATING	:	
A C INPUT	:	230V $\pm 10\%$ AC 50 Hz Single Phase
D C OUTPUT	:	To Float/Boost charge 24V / 100AH
Batteries and also supply a continuous load		
CURRENT RATING	:	15.0 Amps
FLOAT MODE	:	27.0 V Nominal (Adj. between 24.0 – 28.0V)
BOOST MODE	:	28.0 V Nominal (Adj. between 24.0 – 30.0 V)
Voltage Regulation	:	$\pm 2\%$ of the set value
RIPPLE	:	Less than 3%.

For 24V / 100 AH Batteries the Charger Rating is given in the Specification for Batteries of other capacities refer to the Table as given below:

BATTERY CAPACITY	CHARGING RATING
24V / 40AH	10.0 Amp.
24V / 60AH	15.0 Amp.

24V / 100AH	15.0 Amp.
24V / 120AH	20.0 Amp.
24V / 150AH	25.0 Amp.
24V / 200AH	30.0 Amp.

## 5.0 EARTHING

All electrical equipment is to be earthed by connecting two earth tapes from the frame of the equipment to a main earth ring. The earthing ring will be connected via several earth electrodes. The cable armour will be earthed through cable glands. Earthing shall be in conformity with provision of rules 32, 61, 62, 67 & 68 of Indian Electricity Rules 1956 and as per IS-3843-1966.

The following shall be earthed:

1. Transformer & D.G. Set neutrals.
2. Transformer Housing.
3. H.T. Panels.
4. Non-current carrying metallic parts of electrical equipment such as switchgear, bus ducts, rising mains, panel boards, motor control centres, power panels, distribution boards, cable trays, metal conduits, welding sockets etc.
5. Generator & motor frames.
6. All fixtures, sockets outlets, fans, switch boxes and junction boxes etc. shall be earthed with PVC insulated copper wire as specified in item of work. The earth wires ends shall be connected with solderless bottle type copper lugs.
7. The third pin of Outlets on UPS shall be provided with a separate PVC insulated Cu. Wire (green with yellow stripe) as Isolated ground earth wire apart from the earthing of box.

The earth connections shall be properly made. A small copper loop to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastened bolts, when there is a lightning surge, high voltage surge or failure of bushings.

The shop drawing for earthing system shall be prepared by the contractor and be got approved by Owner/Architect. The work shall be done in accordance with approved drawings.

All earth electrodes shall be given to a depth sufficient to reach permanently moist soil. Their location shall be marked and approval taken from Engineer-in-Charge before excavation for the same.

The earth electrodes shall be tested for earth resistance by means of a standard earth test ohms meter. All tests shall take place during the dry months, preferably after a protected dry spell.

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 1 ohm in order to ensure satisfactory operation of protective devices.

The resistance to earth shall be measured at the following: -

- a) At each electrical system ground or system neutral ground.
- b) At one point on each grounding system used to ground electrical equipment enclosures.

- c) At one point on each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. as per B.O.Q. and shall be protected against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender.

#### **Pipe Earth Electrode**

G.I. pipe shall be of medium class and of the size and dia as specified in BOQ. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2m of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 20cm below ground level.

#### **Plate Earth Electrode**

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 2.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it on all sides.

A watering pipe as specified in BOQ, of medium class G.I pipe shall be provided. The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided as per drawing. This will be housed in a masonry sump (with cement plastering) of not less than 40 cm square and 40 cm deep. A C.I. frame with hinged cover of 10mm thickness and locking arrangement shall be suitably provided over the sump. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a suitable dia medium class PVC/ HDPE pipe. The overlapping in G.I. strips in joints shall be rivetted with revets and welded in approved manner. The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth. In the case of plate earth electrode, two nos. 50mm x 6mm GI/Cu. Strip the earthing lead shall be securely bolted to the plate with two zinc passivated bolts, nuts, checknuts and washers. In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket. Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 2.5M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flowerbeds or water taps. The distance between two earthing stations shall be at least 3.0 meters.

#### **Testing and Commissioning**

Testing and commissioning shall be done as per the programme/ instructions to be given by Owner's authorised representative. All testing equipments necessary to carry out the tests shall be arranged by the electrical Contractor.

Before the electrical system is made live, the electrical Contractor shall carry out suitable tests to the satisfaction of Owner that all equipment wiring and connections have been correctly done and are in good working condition and will operate as intended.

All tests shall be conducted in the presence of the Owner authorised representative by the electrical Contractor and shall be notified one week before tests are to take place.

All measurements shall conform to establish minimum acceptable test values. Owner's Engineer reserves the right to approve all test results before circuit or equipments are energised for the first time.

## **6.0 LIGHTNING PROTECTION SYSTEM**

Protection of buildings against lightning shall generally be done in accordance with latest IS-Code. The installation shall be done as per routes and location of equipment indicated on the drawing and bill of quantities. The conductors and the earth electrode conductor shall be fixed so that they are free to expand and contract. Special care shall be taken in the fixing of support to allow free movement.

The materials of lightning conductors, down conductors, earth termination etc. shall be reliably resistant to corrosion or be adequately protected against corrosion. All air terminations shall be GI and the conductors shall be GI.

The entire lightning protection system should be mechanically strong to withstand the mechanical forces produced in case of a lightning strike. The system shall be installed such that it does not spoil the architectural or aesthetic beauty of the buildings but on other hand it should meet IS code/safety code.

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 metres away from the nearest horizontal conductor. For a flat roof horizontal air termination along the outer perimeter of the roof is used. For a roof of larger area a network of parallel horizontal conductors shall be installed. Horizontal air terminations shall be laid along contours such as ridges, parapets and edges of flat roofs and where necessary area flat surfaces in such a way as to connect each air termination to the rest and shall, they form a closed network.

All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flag staff, on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. All air terminations shall be effectively recessed against over turning either by attachment to the object to be protected or by means to substantial braces and fixing which shall be permanently and rigidly attached to the buildings.

Down conductors shall be distributed around the outside walls of the structure. They shall preferably be run along the corners and other projection, due considerations being given to the locations of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors. Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such conductors shall have disconnecting joints. All vertical conductors shall be plumbed before fixing. Insulation shall be provided between down conductors and wall.

The lightning protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. The joint overlap shall not be less than the width of the tape. In the down conductor below ground level there shall be no joint. The joints may be clamped, screwed, bolted, revitted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

Conductors shall be securely attached to the building to be protected by fasteners, which shall be substantial in construction, not subject to breakage and shall be of steel. The conductors shall be secured at not more than 900mm apart for horizontal run and 750mm for vertical run.



Where tape are required to pass through roof asphaltting or other waterproofing membrances, a special seal shall be used comprising a 38mm diameter plastic, copper or aluminium tube with 100mm diameter flange 50mm from the top of the tube. The tube length shall suit the thickness of the roof through which the conductor passes, allowing for the tube to protrude 50mm above the membrane. The seal is to be asphalted in position and the conductor shall be sealed in the tube by a setting waterproof compartment.

Each down conductor shall have an independent earth termination. The interconnection of all the earth termination shall be preferable. It should be capable of isolation for testing purpose by "testing joints" at position approachable easily for the meggar testing. The whole of the system could have a combined resistance to earth not exceeding 2 ohm before any bonding has been affected to metal in or on structure or two surfaces below ground.

## **7.0 CAPACITORS & CAPACITOR CONTROL PANEL**

Power factor correction capacitors shall conform in all respects to IS 2834-1964. The capacitors shall be suitable for 3 phases 415V at 50Hz. frequency and shall be available in units as per B.O.Q. to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper busbars of adequate current carrying capacity having S.C rating of 25 KA for 1 sec. Each capacitor bank shall be for PVC insulated aluminium conductor armoured cables. Two separate earthing terminals shall be provided for each bank for earth connection. The capacitor bank shall be housed indoor.

The capacitor bank shall be subject to routine tests as specified in relevant Indian Standard and the test certificate shall be furnished. The capacitor shall be suitable for indoor use upto 45 Deg.C over and above ambient temperature of 50degree C. The permissible overloads shall be as given below:

- a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.
- b) Current overloads 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.
- c) Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space with protective guard or fencing. The capacitor bank shall be provided with 7% Detuned reactor filter to compensate third harmonics from being generated.

Capacitors shall be of aluminium foil and craft paper. Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnants. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V A.C. is applied shall not be less than 50 megohms.

- Capacitor bank and switching equipments shall be housed in a cubicle having degree of protection IP-51 and constructed with sheet steel of minimum 2mm thickness.
- Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.
- Necessary discharge resistor shall be provided externally to reduce the terminal voltage to or less then 50V in 60 seconds of disconnection from supply.

- Testing shall be done as per applicable standards for shunt capacitors.

**Capacitor Control Panel**

The capacitor control panel shall general comprise of the following:

- a) Automatic power factor correction relay.
- b) Step controller with reversing motor.
- c) Time delay and no-volt relays.
- d) Protection MCCB / MCB.
- e) Contactor (AC-3 duty) for individual capacitors of suitable rating.
- f) Change over switch for either automatic operation or manual operation with push button control.
- g) C.T.s with ammeter and selector switch as asked for in BOQ.
- h) Voltmeter with selector switch.
- i) Indicating lights RYB.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar shall be provided in panel as required.

The above control gear, P.F. meter, Digital Microprocessor based P.F. correction relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, free standing front operated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed design completely dust tight and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

All sheet steel material used in the construction of capacitor control panel should have undergone a rigorous rust proofing process comprising Alkaline Degreasing, descaling in dilute sulphuric acid and recognised phosphating process. The steel work should then receive two coats of primer before applying final coat of epoxy paint of approved shade.

**Quality Assurance**

Quality Assurance shall follow the requirement of Client/ Consultant. Q.A. documents as applicable.

Q.A. involvement will commence at enquiry and follow through to composition and acceptable thus ensuring total conformity to purchaser's requirement.

**Deviations**

Deviations from the specification must be stated in writing at the quotation stage.

In the absence of such a statement it will be assumed that the requirements of the specifications are met without exception.

**SPARES**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

## 8.0 **H.T. CABLE (XLPE) (33 KV & 11 KV)**

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 900mm for cable upto 33 KV (E) below the ground level in a trench 450mm wide.

Insulation tests shall be done before and after laying of cables.

After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

## 9.0 **L.T. CABLES & WIRE**

### a) **Wires**

The design manufacture, testing and supply of single core **LEAD FREE FRLS PVC** insulated 1.1 KV grade multi-stranded twisted wires under this specification shall comply with latest edition of following standards.

IS : 3961 Current rating for cables.

IS: 5831 PVC insulation and sheath of electric cables.

IS : 694 PVC insulated cables for working voltage upto and including 1100 volts.

IEC: 754(i) FRLS PVC insulated cable.

Copper multi-stranded twisted conductor FRLS PVC insulated wires shall be used in conduit as per item of work.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of wire.

The material & insulation of wires shall be **ROHS compliant** (Reduction Of Hazardous Substance) and shall comply the following directives:

- EU Directive 2002/95/EC Issued Jan 2003
- EU Directive 94/62/EC and 2004/12/EC (amendment)
- EU Directive 91/338/EEC
- EU Directive 91/157/EEC & 98/101/EC (amendment)

### **Summary on related directives**

Directive Ref.	Date	Objective	Remarks
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2002/95/EC	27Jan03	Restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) and to contribute to the protection of human health and the environmentally sound recovery and disposal of waste EEE.	6 banned materials included Pb (Lead), Hg (mercury), Cr6+ (Hexavalent Chromium), Cd (Cadmium) and Flame Retardants- Polybrominated Biphenyls – PBB 1000ppm & Polybrominated Diphenyls Esters- PBDE 1000ppm. • <i>Max. conc. value - 0.1% by weight in homogeneous material for Pb, Hg, Cr6+, PBB/ PBDE</i> • <i>Max. conc. value - 0.01% weight in homogenous material for Cd.</i>
94/62/EC 2004/12/EC (amendment)	20Dec94 2Nov04	Amending directive 94/62/EC, on <b>Packaging</b> and Packaging Waste is to prevent packaging waste by encouraging packaging re-use and recycling while at the same time avoid distortions in the internal market.	The targets defined are the following: • <i>Recovery of minimum 60% by weight of the packaging waste</i> • <i>Recycling of at least 55% and a maximum 80% by weight of the totally of packaging materials, with a material-specific minimum recycling rate for plastic of 22.5%</i> • <i>Max. sum of concentration levels of Pb, Cd, Hg and Cr6+ &gt; 100 ppm by weight</i>
91/338/EEC	18Jun91	Restriction on the use of Cadmium pigment (amending for the 10th time Directive 76/769/EEC)	The cadmium content (expressed as Cd metal) exceeds 0,01 % by mass is prohibited in the finished products or components of products manufactured from polymers or copolymers of vinyl chloride and stabilized by substances.

#### b) Cables

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards:

- IS: 8130 Conductors for insulated electric cables and flexible cords.
- IS: 7098 XLPE insulation and sheath of electric cables.
- IS: 3975 Mild steel wires, strips and tapes for armouring cables.
- IS: 7098 Current rating of cables.
- IS: 7098 XLPE insulated (heavy duty) electric cables for working voltage upto and including 1100 volts.
- IS: 424-1475(F-3) Power cable-flammability test.
- Specification for cross-linked polyethylene insulated XLPE sheathed cable for working voltage upto 1.1 KV.
- Specification for XLPE insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.
- ASTM-D: 2863 Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
- ASTM-D: 2843 Standard test method for measuring the density of smoke from the burning or decomposition.

IEEE : 383 Standard for type of test Class-IE, Electric cables, field splicers and connections for power generation station.

ASTME:662IEC:754(x) Standard test method for specific optical density of smoke generated by solid materials.

IS : 10418 Cable drums.

**c) Technical Requirements:**

- vii. The cables shall be suitable for laying in racks, ducts, trenches conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- viii. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
- ix. The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
- x. The cable should withstand 25 KA for 0.5 sec with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
- xi. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
- xii. Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'FRLS' marking in case of 'FRLS' cables.
- xiii. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
- xiv. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
- xv. The normal current rating of all XLPE insulated cables shall be as per IS: 7098.
- xvi. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
- xvii. Outer sheath shall be provided by extrusion process as per IS: 5831
- xviii. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
- xix. In plant repairs to the cables shall not be accepted.
- xx. All the cables shall be supplied in non-returnable drums as per IS: 10418.

**d) In Case of FRLS Cables**

- i) The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD: 2863.
- ii) The maximum acid gas generation by weight as per IEC: 754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.
- iii) The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD: 2843). In case the test for light

transmission is conducted as per ASTM E: 662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTM D: 2843.

- iv) The cable shall pass the fire resistance test as per SS: 42, 41, 475 (I) and flammability test as per EEE: 383.

**e) Inspection:**

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

**f) Joint in Cables**

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilisation and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

**g) Joint Boxes for Cables**

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

**h) Jointing of Cables**

All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Metre on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

**i) Testing of Cables**

Cables shall be tested at factory as per requirement of IS: 7098 Part-I. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to laying of cables, following tests shall be carried out:

- i) Insulation test between phases and phase to earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Architect/Owner.

- ii) Insulation resistance test (Sectional and overall) 1000/5000V depending upon the voltage grade of cable.
- iii) Continuity resistance test.
- iv) Sheathing continuity test.
- v) Earth test.

**j) Laying of Cable**

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 12 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3-meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms. All around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion are provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms. Over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are to be laid in ducts (pucca trenches) inside the building, they will have to be laid on MS rack/ on MS cable trays grouted in walls trenches. Cables sizing through

floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.

Where the cables are laid in open (in building) along walls, ceiling or above false ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape & bitumen compound or by any other proven to prevent ingress of water.

After the cables are laid, these shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

#### **k) Fire Seal System**

- i) All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.
- ii) The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fireproof seal system shall have minimum one hour fire resistance rating.
- iii) The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, **antirodent** and anti-termite.
- iv) The material used in fireproof seal system shall be non-toxic and harmless to the working personnel.
- v) Type of fireproof seal system shall be foaming type or **flamemastic** type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separation shown in the table below are observed.

HV Cable (11 KV/ 33 KV) - HV Cable (11 KV/ 33 KV)	50 mm
ELV & LV 230 V/433 V - ELV & LV cable 230 V/433 V	Equal to the diameter of the bigger cable.
HV cables (11 KV/33 KV) - ELV & LV cables 230 V/433 V	300 mm
LV cables 433 V - Telephone/Instrument cable	350 mm



All cables - All hot pipe work 200 mm

**l) Quality Assurance**

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable. Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

**m) Deviations**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

**n) Spares for Commissioning Including Consumables**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools and consumables. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

**10.0 CABLE TRAYS**

**a. Ladder type Cable tray – for Power Cables only**

Cable trays shall be ladder type fabricated out of mild steel/slotted angles and flats of required width as per design. Bends shall be prefabricated. The cable tray shall be hot dip galvanized or primed and painted with powder coating as asked for in BoQ or as approved by Owner/ Consultant. The minimum weight of the zinc coating shall be 460 gm/sq.m and minimum thickness of coating shall not be less than 75 microns.

**b. Perforated Cable tray – for Power Cables & Low current service both**

The perforated cable trays are fabricated out of 1.6mm thick CRCA sheet steel having minimum 50mm depth or as called for in BOQ, hot dip galvanized or epoxy coated of approved shade. Perforations are maximum 10mm spaced at maximum 20mm distance. The cables shall be tied with the cable tray with nylon strip/aluminium clamps/M.S. clamps as per requirements.

Suitable provision shall be made where a tray crosses expansion joints. The width of the tray shall allow for a suitable separation between cables the design shall allow for adequate bending radius for the sizes of cables. No sharp bend to be allowed in cable tray. Joints between sections shall be bolted.

The tray shall be suspended from the surface of the concrete slab by means of approved steel hangers spaced at a distance of not more than 125cms. Suitable bushes shall be provided where cables pass through apertures in the tray. Cables must be securely fixed to the tray with clamps or cable ties. In routing necessary barrier and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angle and these two shall not run in close proximity. Full details of the tray shall be approved by the Consultant/Site Engineer before fabrication. Earth continuity shall be maintained between each section of cable tray and each total run of tray shall be effectively bonded to the nearest earth continuity Oconductor. All nuts and bolts used shall be of galvanised steel.

Depending on the size of cable trays space of 20-33% has to be maintained for future expansion.

Cable tray is manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

## 11.0 INTERNAL ELECTRICAL WORKS

### A. Conducting (M.S Conduit)

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and of 14 (2 mm) gauge for sizes higher than this. Both inner and outer surfaces shall be smooth without burrs, dents and kinks. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards and shall never be exceeded. The minimum size of the conduit shall be 20mm dia. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit shall be used.

### B. PVC Conduit

All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit 2mm thick as per IS-9537/1983 (Part-III). All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces. Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be M.S. or otherwise mentioned. Conduit shall be terminated with adopter/PVC glands as required.

### Accessories

Conduit accessories such as normal bends, unions, circular junction boxes and pull boxes, locknuts etc. shall be heavy gauge type and approved make. Conduit accessories shall conform in all respects to IS: 3837-1966 with latest amendment. Wherever several conduits are running together, adequately sized adoptable boxes common to all runs shall be used to avoid inserting inspection boxes in the individual run. Where it is necessary to segregate wiring metal filler shall be fixed with in the box.

Conduits shall be laid before casting in the upper portion of a slab or otherwise, as may be instructed or in accordance with approved drawings, so as to conceal the entire run of conduits and ceiling outlet boxes. Vertical drops shall be buried in columns or walls. Wherever necessary, chases will be cut by the contractor with the help of chase cutting m/c or by hand. Nothing extra shall be paid to the contractor on this account. In case of exposed brick/ rubble masonry work special care shall be taken to fix the conduit and accessories in position along with the building work. Sufficient depth of the chases will be made to accommodate the required number of conduits. The chase will be filled with cement, coarse sand mortar (1:3) and properly cured by watering for one week.

If a chase is cut in an already finished surface the contractor shall fill the chase and finish it to match the existing finish. Contractor must not cut any iron bars to fix conduits. Conduits shall be kept at a minimum distance of 100mm from the pipes of other non-electrical services. Where the conduit is to be embedded in a concrete member it shall be adequately tied to the reinforcement to prevent displacement during casting, conduits in chases shall be held by steel hooks of approved design at maximum of 100 cm centres. The embedding of conduits in walls shall be so arranged as to allow at least 12mm plaster cover the same. All threaded joints of conduit pipes shall be treated with some approved 'preservative compound' to secure protection against rust.

Suitable expansion joints fittings of approved make and design shall be provided at all the points where the conduit crosses the expansion joint in the building. (Preferably with Pilca metallic watertight conduits). Conduits shall cross at right angles of the joints only.

Separate conduit shall be used for:

- 1) Normal light, fan call bell
- 2) 16 A power outlets
- 3) Emergency Light Point
- 4) Fire alarm System
- 5) Computer Outlets
- 6) P.A System
- 7) Telephone system
- 8) TV Network
- 9) Or any other services not mentioned here.

Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc. shall be installed in flexible conduits. Flexible conduits shall be formed from a continuous length of spirally wound interlocked wire steel with a fused zinc coating on both sides. The conduit shall be provided with approved type adaptor. A separate and accessible earth connection shall bond across the flexible conduit.

Conduit runs on surfaces shall be supported with metal 1.2 mm thick saddles, which in turn are properly secured on to GI spacer to the wall or ceiling. Fixing screws shall be with round or cheese head and of rust proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building and shall be painted in color matching the adjoining area. Unseemly conduit bends and offsets shall be avoided by using better appearance. Cross cover of conduits shall be minimum and entire conduit installation shall be clean and with good appearance. For surface work, the boxes shall be raised back pattern type, designed for use with distance saddles to give clearance of 6mm between the back of conduit and the fixing surface.

Where conduits are run on steel work, they will be fixed by means of purpose made GI Caddy clips in manner meeting with the approval of the Engineer prior to the installation being carried out. Other methods of fixing may be agreed in special circumstances, but approval must first be obtained from the site engineer.

The spacing of saddles shall be not more than 600mm centers for up to 32mm diameter conduits and at 750mm for conduit sizes of 40mm diameter and above in case of MS conduit and not more than 600 mm for PVC conduit. In addition, saddles shall be fixed at each side of any bend/Tee, or set at a distance of 200mm from the bend/Tee. The holes in the brickwork or concrete for fixing plugs shall be neatly drilled by means of a masonry drill of the appropriate size.

All the GI sheet steel /passivated boxes used for housing switches, plugs, fan regulator etc. shall be five sided conforming to IS: 5133 Part I-1969. Suitable size of boxes shall be provided a minimum of 2 adjustable fixing lugs on vertical sides. Suitable earth terminal inside each box shall be provided. All fixing lugs shall be threaded to receive standard machined chromium plated brass screws. Sufficient number of knockouts shall be provided for conduit entry. Conduits carrying wires of different circuit can terminate in common J.B having metal compartments. Necessary GI pull wires shall be inserted into the conduit for drawings wires. In case conduit pipe is required to cross any RCC beam special adaptor boxes shall be provided for crossing & nothing shall be paid extra.

Where conduits are used for non-air-conditioned space to air-conditioned space or into a fan chamber or duct, a junction box shall be installed to break the continuity of such conduit at the point of entry or just outside and conduit shall be sealed around the conductors.

Particular care shall be taken during the progress of the work to prevent the ingress of dirt and rubbish such as plaster droppings into erected conduits. Conduit which has become so clogged shall be entirely freed from these accumulations or will be replaced. Screwed plastic or metal caps or turned wooden plugs shall be employed to protect all open ends. Plugs of waste wood, paper, cotton or other fibrous matter shall not be used. All unused conduit entries shall be blanked off in an approved manner and where conduits terminate in adaptable boxes, all removable box covers shall be firmly secured to provide complete enclosure. If considered necessary by the Engineer-in-charge, the conduits shall be swabbed out by drawing swabs of rag through the conduit to remove moisture prior to any cables being drawn in.

All conduit installations must be completed and erected in their totality before they are wired and must be fully rewirable from outlets to distribution boards or trunking systems etc. to which they connect. No wiring of any part of the installation shall be commenced until instructions are received to do so by the Engineer-in-charge at such time as he is satisfied that the wiring will not be damaged due to building operations.

Conduits shall be installed so that they are self-draining in the event of ingress of moisture due to condensation or any other reason. A suitable drainage hole shall be drilled at the bottom of the lowest conduit box in every 9-meter of horizontal run.

PVC bush of good quality shall be used in each conduit termination in a switch box, draw box, lighting fixtures and circular junction boxes.

Exposed conduits running above false ceilings shall be suitably clamped independently along with the dropped ceiling. Perforated straphangers or twisted attachment shall not be acceptable. In no case shall raceways be supported or fastened to other pipe for repair and maintenance. They shall be arranged symmetrically and in the most compact design, in no way unduly criss-crossing each other. Proper spacing shall be maintained when two or more conduits run side by side. The layout of the pipes shall be co-ordinated with other services if any. The junction boxes and conduits used in hazardous areas shall be flameproof type with cast iron construction complete with threaded covers. The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements by means of special approved type of earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between the earth and conduit.

The conduit system shall be so laid out that it will obviate the use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two-quarter bends from inlet to outlet. The conduit itself being given required smooth bend with radius of bends suiting to the site conditions but not less than 6 times overall diameter.

Outlet boxes shall be of heavy-duty sheet steel installed as to maintain continuity throughout. These shall be so protected at the time of laying that no mortar finds its way inside during concrete filling or plastering. For fluorescent fittings, the outlet boxes heavy duty shall be provided 300mm off centre for a 1200mm fitting and 150mm off centre for a 600mm fittings or as per B.O.Q.

Draw boxes of ample dimensions shall be provided at convenient points to facilitate pulling of long runs of cables. They shall be completely concealed with MS covers flush with

plasterwork painted to match the wall. These boxes will be as few as possible and located where found suitable by the consultant.

### Switch Boxes

The switch boxes shall be zinc passivated & shall not be less than **18 SWG** thick or shall be as called for in BOQ. It will be so designed that accessories could be mounted on integral pedestals or on adjustable flat iron mounting straps with tapped holes by brass machine screw. Leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on either side of their walls. These shall be completely concealed leaving edges flush with wall surfaces. Earthing terminal inside box shall be provided.

Moulded plate switches screw less as specified in item of work shall be provided. No timber shall be used for any supports. Boxes, which come within concrete, shall be installed at the time of casting. Care shall be taken to fix the box rigidly so that its position is not shifted while concreting.

### Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 660/1100 volts grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used and shall be as per B.O.Q. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for submains sub-circuit wiring. The ferrules shall be provided at both end of each submain and sub-circuit.

Where single-phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single-phase switches connected to different phase shall be mounted within one box.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of moulded plastic BoQ and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Maximum number of PVC insulated 650/1100 V grade/copper conductor cable conforming to IS: 694-1990.

Conduit size	20mm		25mm		32mm		40mm		50mm		60mm	
Wire size in sq.mm.	S	B	S	B	S	B	S	B	S	B	S	B
1.50	7	5	12	10	20	14	-	-	-	-	-	-
2.50	6	5	10	8	18	12	-	-	-	-	-	-
4	4	3	7	6	12	10	-	-	-	-	-	-
6	3	2	6	5	10	8	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	-	4	3	7	6	-	-	-	-
25	-	-	-	-	3	2	5	4	8	6	9	7

**Notes:**

- 1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- 2) The columns heads 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- 3) Conduit sizes are the nominal external diametres.

**12.0 TELEPHONE SYSTEM AND LAN WIRING****Enhanced Category 5 UTP specifications**

- a) The UTP shall be 4-pair, with 24 SWG solid or standard copper conductors.
- b) The UTP-based cabling system shall have a 160 MHz channel bandwidth over a maximum distance of 100m (328 ft) and a channel power sum attenuation-to-crosstalk ratio (PSACR) of 9.6 dB@ 100 MHz using an interconnect or BIX cross connect configuration.
- c) The UTP-based cabling system shall use matched components from a single manufacturer, certified to deliver system performance over the lifetime of the application that the cabling system was originally designed to support.
- d) All component used in the UTP-based cabling system shall be warranted for a period of 25 years from date of installation against defects in materials and workmanship.
- e) The UTP-based cabling system shall comply with the following standards:

Enhanced Category 5 – TIA/EIA Addendum

Category 5 – ANSI/TIA/EIA-568, TIA/EIA TSB67

Class D – CENELEC EN50173

Class D – ISO/IEC 11801

**UTP Outlets**

- a) The outlet UTP connection module and its optional cover shall be available in the following colors: grey, almond, white, black, orange, red, yellow, green, blue, purple and brown.
- b) The outlet UTP connection module shall be Power Sum rated, with a power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 5 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
- c) The eight-position outlet UTP connection module shall accommodate six-position modular plug cords without damage to either the cord or the module.
- d) It shall be possible to inspect and/or re-terminate the UTP cable at the outlet through front access at the face plate.
- e) The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
- f) The faceplate housing the outlet UTP connection module in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubical) access points using manufacturer – supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.

#### **UTP System Testing**

- a) There are two primary field test parameters for an UTP-based end-to-end cabling system. These are continuity/wire mapping and a visual inspection, both to be performed by the vendor.
- b) Continuity/wire mapping is used to verify consistency pair-to-pin terminations at each end of a given cable. It also checks for faulty connections in the run. For each of the eight conductors in the cable, continuity/wire mapping indicates:

Continuity of the channel to the remote end.

Shorts between any two or more conductors.

Crossed pairs.

Reversed pairs.

Split pairs.

Any other mis-wiring.

#### **TELEPHONE TAG BLACK (TTB / IDF)**

CAT-5e (enhanced) unshielded twisted pair cable in MS conduit shall be used to have modern structured cabling network for telephone system, to have latest facilities for Internet and also data cabling. All the telephone Jack must terminated on RJ-11 jacks and installed onto a dual Jack faceplate. Telephone RJ-11 Jacks must be terminated with a **BLACK** Connector/Jack.

For LAN CAT 6 UTP cables shall be used for interconnecting the RJ 45 outlets to Intermediate Switch (Hub) or directly to IT room, if the running length limit permits. These Intermediate switch shall be installed in a rack/cabinet and located in electrical room of the respective floors. Fibre Optic cable or CAT-6 UTP cable shall be used for backbone to interconnect the Intermediate switch to IT room's Server rack, as per the design requirement of the specialised Vendor. All the Data Jack must terminated on an 8 wire, 8-position Jack. Each RJ-45 Data Connection will be terminated with a **BLUE** Data Jack

Only conduit routing & wiring shall be provided by the Electrical contractor and the configuration & wiring shall be done by the Vendor for the IT Networking.

EPABX system, with latest technology will be provided by a separate Vendor to provide Voice Mail & Call Accounting by costing of all calls made by telephones.

A small cabinet for Low current services shall be provided at the false ceiling level at entrance of guest room, to locate all the terminal points like Tel.Tag block, tap-off box for MATV etc., for interconnecting all the low current outlets (jacks) provided in the guest room. Each tel. outlet in guest room shall be provided a separate wire from the room tag block.

Similarly one CAT-5e wire from the floor TTB/IDF shall be provided for each Tel. Outlet proposed.

A Multi pair box as per BOQ Tel. Cable shall be laid from the Service gate to the Telephone switch room MDF for Direct lines from the Service provider. Some of the lines shall be bypassed to EPABX and shall be directly provided to Top management's office & Telephone operators for direct communication to outside. Rest of the lines shall be routed through EPABX for the use of patrons & staff through extensions. The following area/desk shall have direct access to outside Tel. lines:

- a) Telephone Operator's room
- b) Telephone Switch room
- c) Security room
- d) Fire officer room

### 13.0 MATV SYSTEM

#### Co-Axial Cables

13.1 The co-axial cable shall be of wideband type with operation upto 860MHz capability, with PE dielectric and PVC jacket.

The cable shall meet or exceed the following specifications:

	RG-6	RG-11	
<b>14.0 UPS SYSTEM SPECIFICATION FOR THE UPS</b>	<b>SCA4</b>	<b>7CA4</b>	
Centre Copper Conductor Dia	1.02mm	1.63mm	<b>Quality power Supply</b> The UPS shall be ON-LINE double
Dielectric Dia	4.57mm	7.11mm	
Dielectric Material	Cellular PE	Cellular PE	
Outer Dia	7.0mm	10.03mm	
Bending Radius	>75mm	>115mm	
Impedance	75 Ohms	75 Ohms	
Return Loss	>23 dB	>23 dB	
Attenuation at 20°C	Max dB/100Mtr	Max dB/100Mtr	
5 MHz	1.9	1.25	
45 MHz	5.25	3.5	
300 MHz	11.65	7.38	
450 MHz	14.45	9.02	
550 MHz	16.1	9.97	
860 MHz	20.1	12.52	



conversion with filter, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops).

The battery cabinets used in the UPS shall be for longer runtime, The UPS shall have Optional filters, Isolation transformer module, LCD-based remote control panel, LED-based remote control panel & Communication software “professional” version.

### **The Operating mode of UPS**

It should operate in on-line operating mode as follows.

- **Economy Mode:** The UPS should use Line Interactive technology, i.e. the load is powered from the mains; the energy consumption is reduced with a subsequent improvement in efficiency (98%).
- **Smart active mode:** The UPS should automatically selects On Line or Line Interactive operating mode according to the quality of the mains supply, by monitoring the number, frequency and type of disturbances at the mains power input.
- **Stand-by-off mode:** With the mains available the UPS should normally not powered and consequently the power consumption is almost nil. Only when the mains fails or falls outside a preset range, does the inverter take over in 200ms using power from the batteries. This mode shall be suitable for Emergency escape lighting as per standard **EN 50171**.

**The UPS shall have Expandable feature.** The units can be connected in parallel up to 8 units to increase power availability or redundancy. The system can be expanded at any time. For the expandability there shall be “Hot System Expansion” feature, the additional unit can be connected in parallel while the other units are on-line and supplying regular power to the load. The new UPS is on-line and will receive the updated information automatically.

### **High Reliability**

The UPS should be connected in parallel up to 8 units to exponentially increase the reliability of the system.

### **Maximum battery care**

In the UPS there shall be an automatic battery test which shall be able to periodically check the efficiency of the batteries. The batteries should not be used during micro-interruption (40ms), as the required energy is drawn from a group of capacitor. (Battery saving).

### **Maximum safety for personal**

There should be a feedback protection device in the UPS to prevent any voltage back feed in the upstream distribution board, thus ensuring the maintenance personal.

For Advanced communication there shall be software system which displays the most important information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It should also be able to provide information even in the event of a failure, to support the fault diagnostics.

It should also contain the following hardware interfaces:

- RS232 serial port
- Dry contacts
- EPO (Emergency Power Off)
- Contact for UPS shutdown using the remote emergency button.

To allow easy and intuitive operation of the UPS There should be Mimic Panel. This helps in accessing the most important parameters: status and alarm, control and commands, input, output, battery measurements (power, current, voltage, frequency and temperature) and settings.

**Low Input Harmonic Distortion,** The UPS shall have The Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages so that it is ideal in conjunction with motor generator or in installation with other sensitive loads. There shall be built in Active Filter designed to reduce the level of THDi to less than 4% and to increase the input power factor up to 0.99.

This Active filter shall be based on the IGBT's Technologies controlled by the Digital Signal Processor (DSP). This DSP instantly monitors and controls the inputs current absorbed by the UPS in order to eliminate the unlike harmonics and maintain the THDi less than 4%. With the effect of Active Filter the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.

Less harmonics in the UPS input reduces the neutral cable size and consequently the installation cost. Also it gives maximum reliability as any failure of the optional Active Filter has no influence on the power supplied to the load; the only consequence is the increase of current harmonics level rejected to the mains, which gives maximum reliability for the load.

**The input requirements of the UPS are as follows:**

Voltage	:	400 V three-phase + N
Voltage tolerance	:	± 20%+
Frequency	:	45-65 Hz
Current distortion	:	<4% with active filter
Power factor	:	0.99 with active filter

**The Bypass of the UPS are as follows:**

Rated voltage	:	400 V three-phase + N
Phases number	:	3 + N
Voltage tolerance	:	± 15%
Rated frequency	:	50 Hz
Frequency tolerance	:	± 2%
By-pass	:	Static and manual for maintenance
Transfer time	:	nil

**The Battery for the UPS are as follows:**

Type of battery	:	maintenance-free sealed lead-acid
Battery blocks	:	12 V
Recharge time minimum	:	6 Hr

**The Output of UPS are as follows:**

Rated power	:	As per BOQ
Active power	:	As per BOQ
Phases number	:	3 + N

Waveform	:	Sinewave
Rated voltage	:	415V
Frequency	:	50 Hz
Dynamic stability	:	± 5%0.
Static stability	:	± 1% 00
Crest factor	:	3 : 1
Overload	:	110% for 5h, 125% for 10', 150% for 1

**The System of UPS is as follows:**

AC/AC efficiency:	92% in On-line mode, 98% in Economy Mode / Smart active mode/ Emergency mode.
Noise	: 50-56 Db a 1 m.
Operating temperature	: -2° - 45°C
Relative humidity	: 95% non-condensing
Remote controls	: EPO & Bypass
Remote signals	: volt free contacts
Protection degree	: IP20
Communication	: Double RS232/C + slot for SNMP Adapter
Colour	: Dark grey RAL 7024

**The Standards of UPS are as follows:**

1. Safety EN 62040-1
2. EMC IEC 62040-2
3. EN 50091-2 lev. A
4. Directives 73/23, 93/68, 89/336 EEC
5. EN 62040-3.

All the Work desk in front office & Back of the House area Meeting room, Business center shall be provided with 3 Nos 6A 5pin with International outlets option shall be provided for Computers/ Laptops.

All Outlets for power in IT room, Audio-visual media room, EPABX room, Fire Officer Room & Security room shall be on UPS.

A dedicated UPS system (consisting 2 set of equal capacity of UPS rack for Parallel redundancy) shall be provided for IT room & AV room equipments.

All Isolated ground and UPS receptacles should be identified using a different colour, e.g. Orange or Yellow with Green Stripe.

## **15.0 DISTRIBUTION BOARDS & MCBs**

### **General**

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be constructed out of steel sheet all weld enclosure with double

door IP42 protection and shall be powder coated. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry or knockouts plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements. Also on additional/separate adopter box of suitable length and size shall be provided to accommodate wires and cables. No. of conduits etc. and nothing shall be payable on this account. The MCBs shall be mounted on high-grade rigid insulating support and connected by electrolytic copper bus bars. Each incoming MCB isolator shall be provided with solderless cable sockets for crimping. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall nitch or if required mounted on the surface of the wall with necessary clamp bolts etc. The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification nameplate and danger sticker/plate as per requirements.

All the distribution boards shall be provided with engraved nameplates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have a separate neutral connection bar and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

#### **Earth Leakage Circuit Breaker**

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as specified in BOQ. These shall be suitable for manual closing and opening and automatic tripping under earth fault circuit of 30-300mA as specified in item of work. The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardent, anti-tracking, non-hygroscopic, impact resistant and shall with stand high temperature. All parts of switching mechanism shall be non-greasing, self-lubricating material so as to provide consistent and trouble free operation. Operation of ELCB shall be independent of mounting position and shall be trip free type. The RCCB shall be protected against nuisance tripping by protective device.

#### **Miniature Circuit Breaker**

1. The MCB shall be current limiting type and suitable for manual closing and opening and automatic tripping under overcurrent and short circuit. The MCB shall also be trip free type.
2. Single pole/three pole versions shall be furnished as required.
3. The MCB shall be rated for 10 KA/15 KA fault level.
4. The MCB shall be suitable for its housing in the distribution boards and shall be suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.
5. The terminal of the MCBs and the open and close conditions shall be clearly and indelibly marked.

6. The MCB shall generally conform to IS: 8828. -1996
7. The MCB shall have 20,000 electrical operation upto 63A.
8. The MCB shall have minimum powerloss (Watts) as per I.S./ IEC.

#### **16.0 NURSE CALL SYSTEM(if Applicable)**

Nurse Call System shall be designed for patient in the Hospital to call for assistance in case of emergency and reduce the critical time for receiving medical attention by pressing a button which shall be located on the bed side of the patient.

Individual Nurse Call System shall be installed for the following areas:

- Patients rooms (Separate system for each Nurse Station)
- Intensive Care Unit
- Coronary Care Unit
- Patients Wards

##### **PATIENTS ROOMS**

The system shall have patient bed side display control unit which shall consist of the following:

- i. Wired remote hand set at the patient bed side with a green indicating lamp which shall glow continuously indicating that the system is in working condition and this green lamp shall also help the patient to locate the remote hand set during night.
- ii. Push button for medical assistance required by the patient which when pressed shall put off the green light and a red light which shall be located near the call acknowledge push button shall start flashing light. Also, there will be an audible beep to indicate that a call has been made.
- iii. Calls acknowledge push button which shall be operated by the nurse from the patient bed side control console to call Ack mode. At this time, patient's bed side panels beeps twice & the red light turns amber.
- iv. Staff call button at the patient console shall be provided for calling of additional help by the nurse without leaving the patient unattended.
- v. There shall be an indicating light at the entrance of the patient room, towards the corridor to enable the nurse/ doctor to identify the patient requiring assistance without going back to the nurse station for confirmation.
- vi. In the patients toilet there shall also be an emergency call point and a indicating light at the entrance of the toilet towards the room.

##### **CENTRAL DISPLAY AT THE NURSE STATION**

At each nursing station the Central Display Unit shall indicate all the patient; bed numbers under the care of that nursing station in the form of one green light for each bed indicating that the system is functional. When a patient shall press the "Nurse Call" button at the bed side from his/ her room, the respective green light at the central display shall go off and the associated red light shall start flashing at the Nursing Station display, at the entrance of patient's room and at the toilet entrance. Audio alarm shall also start to attract attention of the Nursing Staff. This audio alarm shall have a volume control for adjustment of the sound level for the day (high level) and the night (low level) operation.

The system tests itself continuously and if any console is not working, it is indicated on the Nurse's Panel.

The system shall be digital and all console shall be aesthetically pleasing and shall blend with the interiors. All operations at the bed side shall be isolated low DC voltage and with very low current consumptions for the safety of the patient.

The nursing station console shall have the following features:

- Modular construction, table mount, main body to be made of non-corrosive metal or synthetic high grade polymeric materials.
- Versatile message display functions using 2 line LCD display with at least 16 digits per line.
- Program protection function in case of power failure
- Battery backup for protection of memory program
- Built in real time clock chip
- Audio visual indication for each patient call
- Provision for acknowledgement of patients call
- Auto revert to alarm condition on non-attending of patient within a fixed time

#### BEDSIDE INDICATION AND CALL MODULE

This shall consist of a recess wall mountable module having three colour indications, input jack for connecting hand module, reset button.

#### HAND MODULE

The hand module shall have an extension cord for being used by the patient lying on the bed. This module shall have a provision for call and reset/ cancel.

#### TOILET CALL MODULE

Toilet call modules shall comprise of recess mountable modules having provisions for emergency call from the toilets and provision for reset.

#### CORRIDOR INDICATION MODULE

Corridor indication module shall be three colour. (Red, Amber & Green) indication recess mountable plates to indicate the status of the patients calls to be fixed outside each room door in the corridor.

## **CHAPTER J**

### **TECHNICAL SPECIFICATIONS FOR D.G.SETS**

#### **1.0 SPECIAL CONDITIONS OF CONTRACT FOR D.G.SETS**

##### **DRAWINGS**

The drawings, specifications and bill of quantities shall be considered, as a part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice-versa, shall be executed as if specification called for in both. The contract drawings indicate the extent and general arrangement of various equipment and their wiring, etc. and are essentially diagrammatic. The drawings indicate the point of termination for conduit runs and broadly suggest the routes to be followed. The work shall be done as indicated on the drawings. However, any minor change if found essential to co-ordinate the installation of this work with other traders shall be made without any additional cost to the owners. The data given herein and on the drawings is as could be secured but its complete accuracy is not guaranteed. The drawings and specifications are for the assistance and guidance of the contractor. The exact location, distances and levels etc. will be governed by the space conditions. The contractor shall examine all Architectural, structural, Plumbing and Sanitary, Air-conditioning and electrical drawings before starting the work and report to the architect any discrepancies, which in his opinion appear, on them, and get them clarified. He shall not be entitled to any extras, for omissions or defects in electrical drawings or when they conflict with other works.

##### **SHOP DRAWINGS**

The Contractor shall prepare and submit to the Engineer-in-charge for their approval detailed shop drawings within 30 days of signing of the contract or before 7 days of particular work or whichever is earlier. The shop drawings shall clearly indicate.

- a) The general arrangement and schematic diagram of main D.G Panel, PLC Panel, clearly stipulating the material, size of sheet steel, bus bar, inter connections detail, make and rating of switchgear and other equipment etc.
- b) Number, size and route of the Cable Tray, and fixing details.
- c) Total number of cable runs, size make, material and type of cables with clear routing, trenches / treys detail, installation mode, starting and termination point of each and individual cable etc.
- d) The shop drawings shall also show all setting out details and physical dimensions of all equipments components used in the system, location of manholes fixing, cutout details etc.

##### **QUALITY**

The Engineer-in-charge's decision with regard to the quality of the material and workmanship will be final and binding, any material rejected by the Engineer-in-charge shall be immediately removed by the Contractor from the site. The Engineer-in-charge or their representative shall at all reasonable times have free access to the works and / or to the workshops, factories or other places where materials are being prepared or constructed for the contract and also to any place where the material lying or from which they are being obtained, and the contractor shall give every facility necessary for inspection and examinations and test of the material and workmanship free of cost.

**COST OF SAMPLES AND TESTS**

The Contractor at his own cost shall supply all samples and the cost of making any test as per specifications shall be borne by the contractor. The Contractor shall submit four copies of all brochures, manufacturers' description data and similar literature. One copy will be returned to the Contractor after approval.

**COMPLETION DRAWINGS**

The Contractors shall submit to the Owner / Consultant, layout drawings drawn at approved scale in six sets and a reproductive (original) copy clearly showing.

- a) Location of distribution and PLC Panel
- b) All types of cables (L.T. / Control etc.) layout.
- c) Layout of DG Room and switchgears and associated equipments.
- d) Layout of Diesel Generator Sets.
- e) Location of Fuel Tank, Cooling Towers, Pumps and fuel and water piping layout.
- f) As built drawing with equipments operation and maintenance literature. - After the completion of the work and before issuance of certificate of virtual completion.

**INSPECTION AND TESTING**

Contractor shall employ a full time qualified Engineer who shall be available at all working hours at site for taking instructions and to look after the quality of the work. Instructions given to the Engineer of the contractor shall be construed as issued to the contractor.

Contractor shall maintain at site the following tools and instruments, but not limited to the list below in working conditions.

- a) Clip-on Ammeter and voltmeter
- b) 1000 V Meggar and 5 KV Meggar
- c) Steel tapes of various lengths
- d) Spirit Level
- e) Hydraulic Crimping Tool
- f) Earth Testing Meggar
- g) Pipe bending Tool, thread-cutting die, bench vice etc.
- h) Cable jointing kit

The contractor shall provide at least four permanent benchmark at site, which shall be preserved till the completion of works. These are essential for laying of cables at correct levels.

**CLEARANCE FROM LOCAL AUTHORITIES**

The Contractor shall get the entire installation tested inspected and approved by Local Authorities like Electrical inspectorate pollution control explosive clearance and any other agency required to take permission for commissioning of the installation. He will also undertake the Liaison work with local Electricity Supply Company for obtaining the Electrical Service Connection.

**SCOPE**



In general, the contractor shall supply, store, erect test and commission all the equipment required for electrical installation. The contractor shall furnish all the materials, labour, tools and equipment for electrical work, as shown in the accompanying drawings and in the bill of quantities and specifications hereinafter described.

### **CONTRACTOR**

The contractor shall be a licensed electrical contractor, possessing a valid electrical contractor's in the state, employing licensed supervisors and skilled workers having valid permits as per the regulation of Indian Electricity Rules and Local Electrical Inspector's requirements.

## **2.0 Preamble to BOQ for D.G. Set:**

1. All items of work under this Contract shall be executed strictly to fulfil the requirements laid down under the specifications. Type of equipment, material specifications, methods of installation and testing, and type of controls shall be in accordance with the Specifications, approved shop Drawings and the relevant Indian Standards, however, capacity of each component and their quantities shall be such as to fulfill the above mentioned requirement.
2. The rate for each item of work included in the Bill of Quantities shall, unless expressly stated otherwise, include cost of:
  - a. All materials, fixing materials, accessories, appliances, tools, plants, equipment, transport, labour and incidentals required in preparation for and in the full and entire execution, testing, balancing, commissioning and completion of the work called for in the item and as per Specifications and Drawings.
  - b. Wastage on materials and labour.
  - c. Loading, transporting, unloading, handling / double handling, hoisting to all levels, setting, fitting and fixing in position, protecting, disposal of debris and all other labour necessary in and for the full and entire execution and to fully complete the job in accordance with the contract documents, good practice and recognized principles.
  - d. Liabilities, obligations and risks arising out of Conditions of Contract.
  - e. All requirements of specifications, whether such requirements are mentioned in the item or not. The specifications and drawings where available, are to be read as complimentary to and part of the Schedule of Quantities and any work called for in one shall be taken as required for all.
  - f. In the event of conflict between Bill of Quantities and other documents including the specifications, the most stringent shall apply and the interpretation of the consultants shall be final and binding.
3. The unit rate for each equipment or materials shall include cost in Rupees for equipment and material including the excise duty, and also including forwarding, freight and insurance up to Contractor's store at site, storage, installation, testing balancing, commissioning and other works required.

The extension for (total) amounts against each item shall be based on the quantities indicated in this Schedule.

4. All equipment, quantities and technical data indicated in this Schedule are for the Contractors guidance only; these are based on the documents prepared by the Consultants. The contractor shall assess the required quantity of cables, cable trays, piping etc that are required for completion of the work. This schedule must be read in conjunction with these

documents. The Contractor shall be paid for the actual quantity of work executed by him in accordance with the approved shop drawings at the contract rates.

5. The quantities given in this schedule are provisional, the Owner reserves the right to increase or decrease the quantities of work or to totally omit any items of work and the Contractor shall not be entitled to claim any extras or damages on these grounds. These variations shall be permitted until such time Contractors shop drawings are approved.
6. This schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK.
7. No alteration whatsoever is to be made to the text or quantities of this Schedule unless such alteration is authorized in writing by the Consultants. Any such alterations, notes or additions shall unless authorized in writing be disregarded when tender documents are considered.
8. In the event of an error occurring in the amount column of the Schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the tenderer shall be regarded as firm and the extensions shall be amended on the basis of the rates.
9. Any errors in totalling in the amount column and in carrying forwarded totals shall be corrected. Any error, in description or in quantity or commission of items from this schedule shall not vitiate this contract but shall be corrected and deemed to be a variation required by the Consultants.

### 3.0 D.G. SET- 750 KVA/500KVA/200KVA

For all the DG sets of 750KVA,500KVA and 200KVA capacity CPWD **“General Specifications for Electrical Works PART-VII(DG SETS) 2013”** with its latest version if any shall be followed.

The Gen set shall be thoroughly tested on load before it is dispatched from factory.

Technical Data Sheet Diesel Generator (Alternator) 750KVA/500KVA/200KVA(As per BOQ)		Project: Construction of RIAHS at BHUBNESHWAR, ODISHA
		Date:
S.No.	Item	Data
1	Serial	
2	Type	
3	Make	
4	Voltage, Phase, Frequency	415V,3PHASE, 50Hz
5	Normal Continuous Rating	KVA as per BOQ
6	Starting KVA	<b>(PLEASE SPECIFY)</b>
7	Manufacturer	
8	MAXIMUM VALUE OF MOTORLOAD WHICH DOESNOT AFFECT STARTING	<b>(PLEASE SPECIFY-minm. 60% of the rating)</b>

9	Power Factor	0.8	
10	Class of insulation	H	
11	Efficiency & losses at 0.8 p.f. and	AS REQUIRED / PER IS.	
		Actual	
a)	1/4 <sup>th</sup> Full load		
b)	½ th Full load		
c)	¾ Full load		
d)	full load		
12	OVERLOAD CAPACITY	10%	
13	Build up time for voltage from no load to full load	20sec Maximum	
14	NO. of hours alternator can be run with no increase in temp under 10% over load	1hr Minimum	
Prepared by:		Name :	Date:
		Format no:	
		Page 1 of 2	

Technical Data Sheet Diesel Generator (Engine) 750KVA/500KVA/200KVA(As per BOQ)		Project: Construction of RIAHS at BHUBNESHWAR, ODISHA	
		Date:	
S.No.	Item	Data	
1	Serial		
2	Make		
3	Model		
4	Manufacturer		
5	BHP	@ ----- rpm	
6	Starting Torque		
7	Type of Cooling	Heat Exchanger	
8	Specific oil consumption	gm / BHP / HR & __ litres/hr.	
9	Lube oil consumption		
10	Efficiency & losses at 0.8 p.f.		
a)	1/4 <sup>th</sup> Full load		
b)	½ th Full load		
c)	¾ Full load		
d)	Full load		
11	Day oil tank	_____ LTR	
12	Lube oil tank	_____ LTR	
13	Temp. De-rating factor		
14	Altitude De-rating factor		
15	Noise level at 1 Mtrs.		
16	Vibration		
17	Emission Level		
18	Exhaust pipe diameter & Nos.	_____ mm dia.	
Prepared by:		Name :	Date:
		Format no:	
		Page 2 of 2	

## **CHAPTER K**

### **TECHNICAL SPECIFICATIONS FOR FIRE ALARM SYSTEM**

#### **1.1.0 GENERAL**

- A.** This chapter of the specifications includes furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.
- B.** The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification, or the stringent one of the two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.
- C.** Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported. The message shall instruct the occupants with emergency instructions. Emergency manual voice override shall be provided.
- D.** The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing for equivalent European standard EN54.
- E.** Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.
- F.** The FACPs shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.
- G.** The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.
- H.** The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

#### **1.2.0 SCOPE:**

- A.** A new network intelligent reporting, microprocessor controlled fire detection and shall be compatible with PA system emergency voice alarm communication network shall be installed in accordance with the specifications and drawings.
- B. Basic Performance:**
  - 1. Alarm and trouble signals from the FACP, NRT, and NLCD network nodes shall be digitally encoded by listed electronic devices onto a NFPA Style 9 looped multiplex communication system.

2. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 6 (Class A) Signaling Line Circuits (SLC).
3. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D). Connected by the SLC.
4. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z). Connected by the SLC.
5. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).
6. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
7. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
8. Digitized electronic signals shall employ check digits or multiple polling.
9. Transponder devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.
- 10.F.A. System shall be integrated with P.A system & Car Calling system so that it can be used for Emergency evacuation under fire condition.

### **1.3.0 SUBMITTALS**

#### **A. General:**

All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Two copies of all submittals shall be submitted to the Architect/Engineer for review.

#### **B. Shop Drawings:**

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show equipment layout and main control panel, module layout, configurations and terminations.

#### **C. Manuals:**

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets.

Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.

Provide a clear and concise description of operation, which gives the information required to properly operate the equipment and system.

Approvals will be based on complete submissions of manuals together with shop drawings.

**D. Software Modifications**

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 2 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

**E. Certifications:**

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.

**1.4.0 DEFECT LIABILITY PERIOD:**

- A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of one year from the date of acceptance.

**1.5.0 POST CONTRACT MAINTENANCE SCHEDULE:**

Maintenance and testing shall be as required by the Local Statutory Authority. A preventive maintenance schedule shall be provided by the contractor describing the plan for preventive maintenance of all devices and subassemblies requiring regular maintenance. The schedule shall include:

- Systematic examination, adjustment and cleaning of all detectors, manual fire alarmstations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.
- Each circuit in the fire alarm network shall be tested semi annually.
- Each smoke detector shall be tested in accordance with the requirements of Indian Standards/ NFPA.

**1.6.0 APPLICABLE PUBLICATIONS:**

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

- A. The fire alarm system shall comply with requirements of NFPA for protected premises signaling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.
- B. Underwriters Laboratories Inc. (UL) - USA: / EN - 54
- C. Local and State Building Codes.
- D. All requirements of the Authority Having Jurisdiction (AHJ).

**1.7.0 APPROVALS:**

- A.** The system must have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories Inc
FM	Factory Manual
ULC	Underwriters Laboratories Canada
CPWD	Central Public Work Department
BIS	Bureau of Indian Standards
EN 54 or Equivalent European Standards	

- B.** The fire alarm control panel, network interface and all transponders shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels, which may require return to the manufacturer for system upgrades, and are not acceptable.

**2.0 PRODUCTS****2.1 EQUIPMENT AND MATERIAL, GENERAL:**

- A.** All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- B.** All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
- C.** All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

**2.2 CONDUIT AND WIRE:****A. M.S. Conduit:**

- Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
- Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
- Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
- Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices



and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter any FACP or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.
6. The following specifications of Maharashtra Schedule of Rates shall be followed:-
  - a) WGMA/BW

### 2.2.1 Scope

#### **Concealing of Rigid steel Conduits:**

##### **In walls / flooring:**

Concealing of Rigid steel conduits and erecting in wall, flooring by making chases / grooves/ entries as per approved Method of Construction along with continuous earth wire and all required material including earth clips hardware such as 'U' nails, binding wire, fish wire; accessories such as MS junction / inspection boxes, check-nuts, flexible PVC pipe, drawing fish wires and making all piping rigid, refinishing the surface with cement mortar, removing debris from site.

##### Material:

##### **Rigid Steel Conduits:**

Rigid steel HG conduit minimum 20mm dia and 16 gauge, ERW grade duly processed for antirust treatment and painted with black enamel paint, accessories for rigid steel conduits such as check nuts, long bends, deep junction boxers for flooring, regular junction boxes for walls; of required ways all of the same make.

##### **Earth continuity wire:**

GI wire of 2.5 sq. mm GI earth clips 22 gauge, 100 mm width, for fixing earth wire along the conduits.

##### **Junction boxes / Draw – in boxes:**

Junction box shall be 5 sided with removable to plate and of suitable size to accommodate No. of entries; fabricated from 16 SWG CRCA sheet steel earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knock out holes in required numbers and dia for entry of conduit of conduit pipes and arrangement to fix cover plates on it.

##### **Hardware:**

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20 gauge, GI fish wire, etc.

##### **Method of Construction:**

##### **Concealing of Rigid Steel conduits:**

##### **General:**

Work shall be done in co-ordination with civil work to suit final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No. 1/1, for Steel conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc; for which the distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations.

Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. ¼ (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25 metre; in such manner so as to facilitate drawing of wires. All bending of conduits shall be done approved manner without changing the cross-section.

**Concealing of Rigid Steel Conduits in walls/ flooring:**

Chases shall be made in walls of adequate width with cutter and chiseling through it. Necessary finishing of the wall surface shall be done. Work in flooring shall not disturb RCC work, Conduits of adequate size shall be erected with use of appropriate accessories, and hardware like 'U' nails, etc. draw-in / inspection boxes shall be fixed with check-nut, flush with surrounding surface and earthed.

**Testing:****Earth continuity:**

Earth continuity shall be ensured at termination point of Earth wire, between the ends of metal conduit.

**Mode of Measurement:**

Measurement shall be carried out on the basis per running meter length of conduit.

**b) WGMA/CC-****Scope:****Bunch of wires:**

Providing specified wires and drawing them through provided conduits/ trunking and / or as directed with coated ferrules, harnessing the bunch of wires with necessary material when used in panel boards, duly connecting / terminating with lugs, and testing for safety and beneficial use.

**Material:****Wires: in conduits/ trunking/ panel boards****Mains/ Sub- Main/ Circuit mains (comprising phase and neutral wires):**

PVC insulated wire of specified size, minimum FR Grade insulation copper conductor of electrolytic tough pitch (ETP) grade having insulation of 1.1 kV grade, ISI marked of required colour coding as per Table No. 1/5.

**Wires: Open**

PVC insulated and PVC sheathed wire of specified size, minimum FR Grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked of required colour coding as per Table No. 1/5.

**Earth Continuity wire:**

PVC insulated wire minimum FR Grade insulation, copper conductor of electrolytic grade, having insulation of 1.1 kV grade of green/ green yellow colour, ISI marked of required colour coding as per Table No. 1/5.

**Lugs:**

Copper lugs of appropriate size & type.

**Other material:**

Rubber grommet, bush, harnessing material, flexible conduit etc.

#### **Method of Construction:**

##### **Bunch of wires:**

##### **Drawing of wires: General**

Specified wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) of two different phases, shall not be drawn in single pipe. Wires shall be terminated in the terminals of accessories only, with appropriate type of size and lugs.

##### **Drawing of wires: through PVC conduits.**

Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs/ sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2.

##### **Drawing of wires: through Rigid Steel conduits**

Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs/ sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/1.

##### **Open wire bunch:**

Open wires shall be erected with due care so as to avoid chances of any mechanical manner in panel boards or where ever necessary. For covering lead wires flexible conduit shall be used with gland as per necessity.

##### **Testing:**

##### **Insulation resistance test:**

All wiring shall be tested with 500V Megger between phases, phase – neutral and to Earth. IR value shall not be less than 1 M-ohm.

##### **Earth continuity:**

Earth continuity shall be ensured between termination points of Earth wire.

##### **Polarity Test:**

Test shall be carried out for ensuring the correct polarity in switch and plug.

##### **Mode of Measurement:**

Measurement shall be carried out on the basis per running meter length of single wire or bunch as specified.

**Table 1/1**

#### **Maximum Number of single core 1.1 KV cables that can be drawn in Rigid steel Conduits**

Size of cable mm <sup>2</sup>		Size of Conduit mm													
Nominal Cross Sectional area	No. and dia of wires	16		20		25		32		40		50		63	
		S	B	S	B	S	B	S	B	S	B	S	B	S	B
1.0	1/1.12 Cu	5	4	7	5	13	10	20	14						
1.5	1/1.4	4	3	7	5	12	10	20	14						
2.5	1/1.8	3	2	0	5	10	8	18	12						

	3 / 1.06 Cu														
4.0	1 / 2.24 7/ 0.85 Cu	3	2	4	3	7	8	12	10						
6	1 / 2.80 7 / 1.06 Cu	2		3	2	6	5	10	8						
10	11/3.55 Al 7 / 1.40 Cu			2 2		5 4	4 3	8 6	7 5						
16	7 / 1.70					2		4	3	7	6				
25	7 / 2.24							3	2	5	4	8	6	9	7
35	7 / 2.50							2		4	3	7	5	8	6
50	7 / 3.0 Al 19 / 1.80									2		5	4	6	5

Note 1: Cu – applicable to only copper cable; Al – applicable to only Aluminium Cable.

Note 2: The table shows maximum capacity of conduits for the simultaneous drawing of cables. The columns headed 'S' apply to straight runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from straight by an angle more than 15°. The columns headed 'B' apply to bent runs of conduit, which deflect from the straight by an angle of more than 15°.

Note 3 : In case of inspection type draw in box has been provided and if the cable is first drawn through one straight conduit, then through the draw in box and then through the second straight conduit such system may be considered as that of straight conduit even if the conduit deflects through the straight by more than 15°.

**Table 1/2**

**Maximum Number of single core 1.1 KV cables that can be drawn in Rigid Non-Metallic Conduits**

Size of cable sq. mm <sup>2</sup>		Size of conduit mm					
Nominal cross sectional area	No. and dia of wires	16	20	25	32	40	50
1.0	1/1.12Cu	5	7	13	20		
1.5	1/1.4	4	6	10	14		
2.5	1/1.8 3/1.06 Cu	3	5	10	14		
4.0	1 / 2. 24, 7/0.85 Cu	2	3	6	10	14	
6	1 / 2.80 7/1.06 Cu		2	5	9	11	
10	11 / 3.55 Al 7/1.40 Cu			4	7	9	
16	7/1.70			2	4	5	12
25	7/2.24				2	2	6
35	7/2.50					2	5
50	7/3.0 Al 19/1.80					2 2	5 3

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable.

**Table No. 1/4**

**Colour Coding for Conduits in Wall entry**

Conduit For	Colour
Light/ Power Circuit	Black
Security wiring	Blue
Fire Alarm wiring	Red
Low voltage circuits	Brown
UPS circuits	Green

**Table 1/5****Colour code of Wires**

Type	Colour
Phase	Red, yellow, Blue
Neutral	Black
Earthing	Green

**B. Wire:**

All fire alarm system wiring must be new, unless specified herein.

Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 1.5 sq.mm. for initiating device circuits and signaling line circuits for notification appliance circuits.

All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

Wiring used for the signaling line circuit (SLC) shall be twisted and shielded and installed in conduit unless specifically accepted by the fire alarm equipment manufacturer.

All field wiring shall be completely supervised.

**2.3 FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:**

**2.3.1** The Fire Alarm Control Panel shall be as per Section 7.33 of IS: 2189.

**2.3.2** Each network FACP shall contain a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices.

Each FACP on the network shall perform the following functions:

1. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
2. It shall supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.
3. It shall detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
4. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
5. When a any of the following condition is detected and reported by one of the system initiating devices or appliances:
  - i. Fire Alarm Conduits
  - ii. Trouble Confirmation
  - iii. Supervisory Card
  - iv. Security Alarm
  - v. Pre Alarm

Then the following functions shall immediately occur:

- a. The FACP alarm LED on the FACP shall flash.
- b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
- c. The 640-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
- d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

### **2.3.3 General FACP Configuration & Operation**

- a. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit 640 character Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
- b. All programming or editing of the existing programming in the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
- c. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions.

This shall be obtained by having transponders operate as local control panels upon loss of network communication.

d. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.

e. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.

f. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

**The FACP shall be able to provide the following software and hardware features:**

1. Pre- Signal and Positive Alarm Sequence: The system shall provide means to cause pre-alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-Second time period for acknowledge an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.

2. Smoke Detector Pre-Alarm indication at control panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-Alarm indication shall be available at the control.

i) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

ii) Action: if programmed for action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition, Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.

3. The system shall be integrated with P.A. System Car Calling system for Emergency evacuation under fire.

4. Each FACP node shall be capable of providing the following features:

- a) Block Acknowledge for Trouble Conditions.
- b) Rate Charger Control
- c) Control-By-Time (Delay, Pulse, time of day, etc.)
- d) Automatic Day/Night Sensitivity Adjust (high/low)
- e) Device Blink Control (turn of detector LED strobe)
- f) Environmental Drift Compensation (selectable ON or OFF)
- g) Smoke Detector Pre-alarm Indication at Control Panel
- h) NFPA 72 Smoke Detector Sensitivity Test

- i) System Status Reports
- j) Alarm Verification, by device, with tally
- k) Multiple Printer Interface
- l) Multiple CRT Display Interface
- m) Non-Fire Alarm Module Reporting
- n) Automatic NFPA 72 Detector Test
- o) Programmable Trouble Reminder
- p) Upload/Download System Database to BMS
- q) One-Man Walk Test
- r) Smoke Detector Maintenance Alert
- s) Security Monitor Points
- t) Alpha-numeric Pager Interface
- u) On-line or Off-line programming

The configuration features & peripherals of FACP shall be given below:-

Doc1	Standard Data Sheet
Item	Floor Fire Alarm Panel
Purpose	Automatic fire detection and alarm
Interconnection	Peer to peer networked floor Panels
Type	Solid state micro-processor based analogue addressable
Loop capacity	6 Loop card slots
	Loop cards as per floor requirement
Compatibility	Photo electric smoke sensors Loop isolators Loop sounders Loop manual call points Loop input monitoring cards RS 485 cards for networking & RS 232 cards for printer & CRT Convention devices
No of devices	Each loop shall be able to cater to minimum 127 devices upto Zone 50
Operation Voltage	15 V to 28 V DC, 3 amps
Input Voltage	230 V AC, 1 Ph 50HZ, 0.75 amps.
Stand by battery charging	28 V DC, 1.5 A
Wiring	2 core 1.5 mm <sup>2</sup> , copper, PVC insulated, twisted, screened wires in concealed conduits wherever available & in other places by surface cable for notification loop, sounder loop, RS 232 & RS485 communication
Loop wire monitoring	Open circuit Short circuit Earth Leakage Device removed Wrong Device



Communication	To remote repeater panel through proprietary protocol over RS 485 link
Outputs	2 X programmable sounders on panel 1 X Fire Contact 1 X Fault Contact
Printer	24 character built in printer
Communication port	RS 485 RS 232
Selectable Features	Common sounders coincidence alarm RMC Fire
	RMC Fault
	Zone walk test
	Control Output
	Output delay Alarm counter Alarm Counter Alarm verification Sounder silence
Dialing Time	4second per loop for 127 devices, 3 second per loop for MCPs
Software	Firmware Field configuration programmable
Memory	EPROM non volatile for 600 event memory storage
Configuration	Power supply module
	CPU
	memory extension module
	memory buffer module
	printer interface module
	LCD ineterface module
	relay driver module
	1 no. 80 column external printer
	1 no. menu driven membrance switch keyboard
	1 set control switches
	1 set operator push buttons
	Loop cards
	Remote terminal unit connection port
	LCD display & driver module
Connectivity	To proprietary protocol compatible to analogue addressable detectors of type
LCD display	4 X 160 character alpha numeric LCD auto back-lit with occurrence of event or manual override
Display Format	Alarm/pre-alarm/fault/isolation
	Alarm & event acknowledge
	Commands/report/programming
	Time/day/date
Power supply	SMPS
Back up power supply	As per clause 7.5 of IS 2189
Power pack	SMF lead acid / Nicd 24 V DC 30 AH
Test features	Panel self test
	LCD test

	Fault test
	Detector test
	Battery fault
	Internal hooter test
	External hooter test
Control facility	Scroll/next
	Alarm silence
	Fault silence
	Lamp evacuate
	System reset
	LCD back Lighting
	Trouble Silence
Indications	System normal
	Priority 1 Alarm
	Priority 2 Alarm
	Fault
	Alarm Silence
	Power ON
	Battery ON
Event report	Type
	Address
	Location
	Time/day/date
	Date
	Time
Zone recording	In order of occurrence regardless of alarm priority
	Print Interrupt of occurrence of fresh event & on its record resume print
Testing facility	Possible with digital and analogue input and output digital simulation from panel through software
	Under maintenance mode testing possible with balance system in normal operation
Fire pattern	No alarm issue for short duration
	Quick response for fast smoke build up
	Early detection and suitable modification for of alarm level for dirt accumulation
	Programmed output actuation
	Access protection through 4 levels of pass words
	Hardware security lock
	Detector sensitivity adjustment and display of set value
	Disable/isolate detectors/ interface units
	Single button operation front panels keys
Software facility	Individual detector
	Sensitivity setting
	Trending
	Adjustable dual alarm thresholds
	Pre alert warning
	Cross zoning
	Alarm verifications
	Input/ output assignment

	Event history indexing
Local Sounder	Yes
Panel Sounder output	1 no. rated for 1 Amp.
Surge withstand	As per IEEE 472 for mains, input/ output/loops, 7 kv discharge on panel electronics except LCD display
Ambient	From (-) 5 deg. C to (+) 45 deg C Max.
Humidity	15% to 95% non condensing
Mounting	Wall/ floor
Enclosure	1.6mm sheet steel, dust and vermin proof to IP 55
Enclosure treatment & painting	Degreased, de-rusted, pickled, rinsed, phosphattized, putty finished. Double primer and final epoxy painted FIRE RED shade
Front doors	Hinged and lockable with transparent visor for viewing LEDs etc.
Cable Entry	From both top & bottom, through 2 mm thick removable gland plate

## 2.4 Network Repeater Panel (NRP)

A network control annunciator shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all possible points on the network.

Network display devices which are only capable of displaying a subset of network points shall not be suitable substitutes.

The NRP shall include a minimum of 640 characters, backlit by a long life, solid state LCD display. It shall also include a keypad. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a back box designed for this use.

The NRP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NRP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

For time keeping purposes the NRP shall include a time of day clock.

The configuration, features & peripherals of the Repeater panel shall be given below:-

Doc 2	STANDARD DATA SHEET
Item	Network Repeater Panel
Purpose	Repeat indication
Compatibility	With networked analogue addressable floor fire alarm panel through proprietary communication protocol
Type	Solid state micro-processor based
Communication	By 2 core RS 485 twisted pair screened with networked floor fire alarm analogue addressable panels
Distance maximum	Up to 2 Km from nearest networked floor addressable fire alarm panel. Connection to system by tee off / spur / daisy chained
Power Supply	From power supply unit or from nearest floor addressable fire alarm panel.
Operating Voltage	15 V to 28 V DC
Monitoring	Panel power disconnection
	Floor / Loop / Zone indication LEDs (50 nos)
	Select keys for point addresses in display zone
	Fire
	Fault
	Disabled
	Accept / Reset / Silence / Sound alarm
	Control key for current Fire / Fault / Disabled status
Power consumption	100 mA mains fail state
	250 mA nominal
	350 mA max. draw
LCD display	Back lit, Alphanumeric, 4 line 160 character display
Data interface	RS 485 serial bus driver board
Mounting	Suitable for both surface & recess mounting
Enclosure	1.8 mm sheet steel, dust and vermin proof
	Hinged lockable double door
Ambient	From(-) 5° C to (+) 45° C Max
Humidity	15 % to 95 % non condensing
Paint	Degreased, de - rusted, pickled, rinsed, phosphatized epoxy painted in FIRE RED paint
Local sounder	Yes

## 2.5 Network Control Station (As required)

The NCS shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.

The PC for NCS (Network Control Station) shall be provided by the client/other Vendor.

The NCS shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400MHz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200 watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.

The NCS shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.

The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)

The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.

The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu:

- a) An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles.
- b) A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable.
- c) A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed.
- d) A Disabled Device window that shall contain all disabled devices in the system.

The NCS shall have the option, from a Windows pull down menu, to connect to a third party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.

The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in.

The NCS shall include help screens, available to aid the user without leaving the selected application screen and shall have a table top hardware configuration.

The NCS shall include an industry-standard EIA-232 port for a UL864 listed printer.

The NCS shall meet FCC regulations (Part-15, subpart-J) regardless of its connection means to the network and shall be UL-Listed for fire protection (UL864) and burglary (UL1076).

## **2.6 Water flow Indicators:**

Water flow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.

Water flow Switches shall have an alarm transmission delay time, which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.

All water flow switches shall come from a single manufacturer and series.

Water flow switches shall be provided and connected under this section but installed by the mechanical contractor.

Where possible, locate water flow switches a minimum of one (1) foot from a fitting, which changes the direction of the flow and a minimum of three (3) feet from a valve.

## **2.7 Sprinkler and Standpipe Valve Supervisory Switches:**

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 25 mm conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

## **2.8 Non-Alarm Input Operation**

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

Combo Zone: - A special type code shall be available to allow water flow and supervisory devices to share a common addressable module. Water flow devices shall be wired in parallel, supervisory devices in series.

## **2.9 SYSTEM COMPONENTS - ADDRESSABLE DEVICES**

### **2.9.1 Addressable Devices - General**

Addressable devices shall use simple to install and maintain decade, decimal Address Switches. Devices shall be capable of being set to an address in a range from 001 to the maximum address provided by SLC loop.

Addressable devices, which use a binary address setting method, such as a Dip switch, are not an allowable substitute.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP Signaling line circuit.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7 or EN 54.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DB minimum, a relay base and an isolator base designed for Class A applications.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (Photoelectric, Thermal& Photo-thermal).

Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

### **2.9.2 Programmable Electronic Exit Point Directional Sounders**

Electronic sounders shall operate on 24 VDC nominal. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device. It shall be capable to broadcast preprogrammed Voice Message also and shall be flush or surface mounted as shown on plans. It shall produce broad-band directional sound to guide occupants to safe exists even in complete darkness.

Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria: The maximum pulse duration shall be 2/10 of one second.

Strobe intensity shall meet the requirements of UL 1971.

The flash rate shall meet the requirements of UL 1971.

### **2.9.3 Addressable Pull Box (manual station)**

Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.

#### **2.9.4 Intelligent Multi-Co-Operative Sensing Photoelectric Smoke Detector (As required)**

- a. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall be in position to work in advance multi Co-Operative Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density.
- b. Photo- electric Fire Alarm detector having photo electric smoke sensor and thermal sensor incorporated and shall send individual smoke sensitivity and temperature operation to panel having following technical specifications: -
  - Operating Temperature - 0 to 50°C
  - Humidity - 10 to 95%
  - Smoke sensor sensitivity - 0.2% to 3.7% per foot of smoke Obstruction
  - Smoke sensor Air velocity - 0-610 m/min

#### **2.9.5 Intelligent Thermal Detectors (As required)**

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a fixed rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

#### **2.9.6 Intelligent Multi Criteria (Photo- Thermal) Acclimating Detector**

The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

The detector shall have Isolator modules to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the campus.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.



### **2.9.7 Two-Wire Detector Monitor Module**

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

### **2.9.8 Addressable Control Module**

Addressable control modules shall be provided to supervise and control the operation of Lifts, sprinkler, switch gears etc., one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.

The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.

The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30V DC.

### **2.9.9 Addressable Relay Module**

Addressable Relay Modules shall be available for HVAC (AHUs & Ventilation Fans) control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

## **2.10 EXECUTION**

### **2.10.1 INSTALLATION:**

- a. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- b. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- c. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- d. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

**2.10.2 TYPICAL OPERATION:**

- Actuation of any manual station, smoke detector, heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:
- Activate all programmed speaker circuits.
- Actuate hooter units until the panel is reset.
- Light the associated indicators corresponding to active speaker circuits.
- Release all magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.
- Where required, return all elevators to the primary or alternate floor of egress.
- A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
- Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.
- Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as appropriate.
- Activation of any sprinkler system low-pressure switch, on valve tamper switch, shall cause a system supervisory alarm indication.

**2.10.3 HVAC/Smoke Control System Operation:**

- On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan.
- The OFF LED shall be Yellow, the ON LED shall be green, and the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
- Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
- All HVAC switches (i.e., limit switches, vane switches, etc.) which shall be provided and installed by the HVAC contractor, but the detail of the switches required shall be provided by the vendor for fire alarm system as per the equipment layout in the building.
- It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic annunciators if the project requires such.

**2.10.4 TEST**

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

- a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- c. Verify activation of all flow switches.
- d. Open initiating device circuits and verify that the trouble signal actuates.
- e. Open signaling line circuits and verify that the trouble signal actuates.
- f. Open and short notification appliance circuits and verify that trouble signal actuates.
- g. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
- h. Ground initiating device circuits and verify response of trouble signals.
- i. Ground signaling line circuits and verify response of trouble signals.
- j. Ground notification appliance circuits and verifies response of trouble signals.
- k. Check alert tone and prerecorded voice message to all alarm notification devices.
- l. Check installation, supervision & operation of all intelligent smoke detectors using walk test.
- m. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- n. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

#### **2.11 FINAL INSPECTION:**

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

#### **2.12 INSTRUCTION & SEQUENCE OF OPERATION:**

Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

## **CHAPTER L**

### **TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT TELEVISION SYSTEM & PA SYSTEM**

#### **1.0 GENERAL**

All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.

All systems and components shall have been thoroughly tested and proven in actual use.

#### **2.0 INDOOR CCTV DOME CAMERA SYSTEM (COLOUR)**

The COLOR CCD camera shall meet or succeed the following design and performance specifications:

- a. The CCD camera shall be a 1/3" interline transfer imager meeting CCIR signal format specifications.
- b. The camera shall have factory fitted 3mm lens.
- c. The camera shall be 2:1 interlace, with AC line lock, which is adjustable via remote control.
- d. The image sensor shall have a total pixel array of 811(H) x 508(V) with an effective pixel array of 768(H) x 494(V).
- e. The camera shall provide a resolution of 520 TV lines.
- f. The camera shall provide for automatic electronic iris and a shutter speed range of 1/60 to 1/30,000.
- g. The camera/lens package shall provide for a sensitivity of 1.0lux at F1.4, signal level of 20 IRE, gain high.
- h. The camera shall have a signal to noise ratio of >46dB.
- i. The camera shall have a factory fitted dome housing, which should compliment with the interiors of the building.
- j. The camera shall have PT mechanism and allow panning of 360° C degree and tilting 120 ° C (degree).

#### **3.0 DIGITAL VIDEO RECORDER**

- a. The digital recorder shall be 16 channel (with built-in multiplexer) hard disk digital recorder. The digital recorder shall have the capability to record 5 recording resolutions, Fine/ Normal / Basic/ Economy/ Network. The digital recorder shall have the capability to set the following resolutions for the recordings:
  - a. 704x576/ch,
  - b. 704x288/ch,
  - c. 352x288/ch
- b. The digital recorder shall have 16 Video Input terminals (BNC x 16), 1 Video main monitor Output (BNCx1), 1 Monitor 2 output (BNCx1), S-Video output and 1 VGA monitor.
- c. The digital recorder shall have a one-touch operation for Play, Stop, Record and Still. The digital recorder shall have high-speed digital fast-forward and review.
- d. The recorder shall have 4 audio inputs and 1 audio output (RCA x 4 in, RCA x 1out).

- e. The digital recorder shall have a built-in CD-R/RW drive for backing up data to CD-R/RW and a built-in USB terminal for backing up data to a USB memory.
- f. The digital recorder shall have a built-in LAN terminal (100Base-TX/ 10Base-T) for remote viewing by running the utility software (included in the product package) on a specified network.
- g. The digital recorder shall have motion sensor for each of 16 channels.
- h. The sensitivity level can be set to a value between 1 and 9. The lower is the value, the higher is the sensitivity.

The digital recorder shall offer the following search modes:

- EVENT SEARCH
- TIMELINE SEARCH
- T/D SEARCH
- BOOKMARK SEARCH

The digital recorder shall have SSP(RS485) communication for the controller operation and the camera operation.

The digital recorder shall have switching between PAL and NTSC video systems.

The digital recorder shall be no larger than 432 x 98 x 349 mm (W x H x D) and weigh approximately 7.5 Kg (with two HDD units).

The digital recorder shall be CE listed, ISO9001, and ISO14001 certified.

#### Minimum Performance Specifications

Hard disk capacity	Max HDD capacity (technically) per bay: 540 GB
Compression Method	MPEG4 (video)
Signal format	PAL / NTSC colour signal standard (switchable)
Video Input	16 (BNC x 16)
Main Monitor output	1 (BNC x 1)
Monitor 2 output	1 (BNC x 1)
S-video output	1
VGA output	1(VGA X 1)
Audio input	4 (BNC x 4)
Audio output	1 (BNC x 1)
USB terminal	For Compact Flash reader (Front Panel)
LAN terminal	100BASE-TX / 10BASE-T (RJ-45)
Menu Language	English / French / German / Spanish/ Italian/ Russian/ Chinese/ Polish/ Czech/ Swedish/ Rumanian/ Bulgarian/ Serbian/ Japanese
Picture Resolution	NTSC: 704 x 480, 704 x 240, 352 x 240 PAL: 704 x 576, 704 x 288, 352 x 288
Picture Quality	5 levels (Fine/ Normal/ Basic/ Economy/ Network)
Screen display	1-screen display / 4-screen display / 9-screen display / 16-screen display
Number of cameras	16
Playback	Playback/ still/ search/ Cue/ Review/ Frame advance/ Slow
Backup to USB2.0 memory & CD-RW	JPEG & AVI
<b>Search Mode</b>	

Event Search	Search by event
Timeline Search	Search by calender
Time / Date Search	Search by time and date
BOOKMARK Search	Search by bookmark
<b>Control Signal</b>	
RS-485	Push Lock x 4 terminals
Telemetry control protocol	SSP, PELCO-D, KALATEL, VICON, SENSORMATIC, ELMO
Alarm in	16 inputs
Alarm out	4 outputs
Remote control	IR remote control can control up to 99 units.
<b>Electrical</b>	
Power Source	Input:100V to 127V AC, 4A or 200V to 240V AC, 2A
Power consumption	Max. 90W (HDDx2 and CD-RW)
Operating conditions	Temperature: 5°C to 40°C, [41°F to 104°F], Humidity: 80% or less
<b>Physical</b>	
Dimensions (W x H x D)	432 x 98 x 349 mm ( 17.0 x 3.9 x 13.7 inch)
Weight	7.5kg (264.6 oz) with two HDD units + built-in CD-RW)

#### 4.0 21" COLOR MONITOR

- The 32" COLOR monitor shall be comprised of a high resolution CRT, and solid state electronics housed in a rugged metal case.
- The 32" COLOR monitor shall meet or exceed the following design and performance specifications:
- The monitor shall provide a 32" picture display, 90 degrees deflection.
- The monitor shall meet CCIR standards.
- The monitor shall feature a display with integral implosion protection.
- The monitor shall provide a minimum of 1000 TV lines resolution at the centre and 800 TV lines at corners.
- The monitor shall feature automatic degaussing circuitry and fast warm up period.
- The monitor shall operate on 230 VAC, 50Hz. Input power and use a maximum of 48 watts.
- The monitor shall provide horizontal within 15% and vertical linearity within 10%.
- The monitor shall accept 0.5 to 2.0 V p-p composite video.
- The monitor shall use internally derived synchronization.
- The monitor shall feature brightness, vertical hold, horizontal hold, contrast and power ON/OFF controls on the front panel.
- The monitor shall provide a video gain of 30 dB.
- The monitor shall provide a terminating slide switch and two BNC connectors, one looping, on the rear.
- The monitor shall be provided with a 6', 3 wire grounded AC power cord.
- The monitor shall be constructed of a black matte, textured coat finished steel cabinet with black plastic faceplate.

- The monitor shall have an operating temperature range of 50 deg. F to 131 deg. F and an operating humidity range of 10% to 95% relative, non-condensing.
- The monitor shall be rack mountable in a standard EIA rack

#### **5.0 SPEAKER CUM HOOTER**

- a. A moveable jumper provided should have a choice for high (98 db A) or low (94 db A) outputs.
- b. Speaker cum hooter will be dual transformer speaker capable of operating at 25 and 70.7 Vrms and will have a frequency range of 400 to 4000Hz.
- c. The synchronized speaker should be supplied with "ALERT" (wall orientation) as the standard marking. It should be for indoor and outdoor installation.

#### **6.0 PUBLIC ADDRESS SYSTEM CUM VOICE EVACUATION SYSTEM**

- a. The public address system with microphone and amplifier of adequate capacity with 2 Nos. manual selector switches for selecting between: (a) alarm or public address system (b) Alert tones or Evacuation tones to all the channels.
- b. The amplifier shall work on A.C. or 24 VDC power supply separate from that of the fire alarm panel. Master control for adjustment of volumes shall be provided. The amplifier unit shall have complete protection against over loads, short circuits and wrong battery polarity. The amplifier shall have hum and noise level better than 60db.
- c. Speakers with line impedance transformers (at speaker end) shall be connected to amplifier. This will be integrated with panel and shall be capable of announcing pre-recorded messages.
- d. A Message Unit shall be provided having up to 30 seconds of pre-recorded emergency messaging.
- e. The message contained in the message unit shall be recordable in the field.
- f. The Public address system shall be provided with a separate full battery back-up and suitable chart.

## **CHAPTER M**

### **TECHNICAL SPECIFICATION FOR HVAC**

#### **1.1 BASIC SYSTEM DESIGN**

##### **1.1 SCOPE**

A central air conditioning system has been designed for air conditioning of REGIONAL INSTITUTE OF ALLIED HEALTH SCIENCES (RIAHS) AT BHUBANESHWAR, ODISHA

The system is designed to cater air conditioning requirement with the Centralized chilled water system. The areas to be air-conditioned include Hospital Block and Academic Block. The toilets are mechanically ventilated.

##### **1.2 BASIS OF DESIGN**

Outside conditions

- a. Summer: 37.8°C DB; 27.8°C WB
- b. Monsoon: 32.2°C DB; 30.0°C WB
- c. Winter: 13.3°C DB; 8.9°C WB
- d. Latitude: 20.15°N

Total Tonnage for both the buildings Total Installed capacity of chillers (Considering diversity @ 85 %) = 238.50 TR = 180 TR (1WORKING + 1 STANDBY)

#### **2.0 SYSTEM DESIGN**

- i. It is proposed to provide a central Air-conditioning system to maintain the specified inside design conditions during summer, monsoon & winter.
- ii. The total peak air conditioning load works out to **240 TR** for all the floors. To cater to this load, it is proposed to install **2** Nos. Screw type air-cooled chilling machines (1W + 1 S) each having **180 TR** actual capacities.
- iii. Water chilling machines shall work in conjunction with 2 Nos. chilled water pumps (1W plus 1S). The AC plant room is located at Terrace floor.
- iv. Chilled water produced shall be pumped to various Air-handling units and Fan coil units. Chilled water shall be pumped through insulated chilled water pipes installed in basement / ceiling spaces and in vertical risers installed in pipe shafts. At each Air-handling unit balancing valves are provided for balancing. All pipes within plant room shall be supported from floor.
- v. Double skin Air handling units consisting of centrifugal fan, cooling coil and filter section shall be provided for each area. Chilled water supply and return headers shall be tapped and connected to cooling coils. There would be automatic controls provided for AHUs to control inside conditions in summer and monsoon.
- vi. The conditioned air from the AHUs would be supplied through insulated ducts. The air would be diffused through extruded aluminum Grilles and diffusers. The return air would be taken back from the conditioned space to the AHUs through return air ducts or through ceiling spaces.
- vii. The stale air from the common toilets would be exhausted by means of mechanical exhaust system.



- viii. Motorized smoke and fire dampers shall be provided in accordance with ASHRAE/NFPA within supply air ducts and return air ducts/spaces to prevent spread of smoke / fire to adjacent areas.

### **2.1 indoor air quality:**

Due consideration has been given for good indoor air quality.

Outdoor air ventilation rates have been maintained as per ASHRAE standard 62.1.2004 (Ventilation for acceptable indoor air quality).

All utility areas like AC plant room, pump room etc., will be mechanically ventilated. It is proposed to use centrifugal type blower for basement car parking ventilation.

All fire escape staircases and lift shafts shall be provided with pressurization system consisting of fans installed on terrace. These fans shall be actuated by smoke sensors in case of detection of fire on any affected floor.

## **3.2 AIR COOLED WATER SCREW CHILLING UNITS**

### **3.2.1 GENERAL**

The contractor shall furnish and install where indicated on plans air cooled Rotary Screw water chilling units. Each unit shall be guaranteed by chilling unit manufacturer to produce a capacity of not less than specified tons of refrigeration at specified leaving water temperature with the temperature of ambient air entering the condenser not exceeding 110 deg.F.(44 deg.C). The construction and rating of the chillers shall be in accordance with latest ARI standard 590 and shall comply with ANS. B 9.1 safety code, National Electrical code and ASME code. Necessary 3 ph.50 Hz, 220/415 volts, A.C. Power supply shall be made available for all units.

### **3.2.2 BASIC UNIT**

Each unit shall consist in general of multiple semi hermetic screw/scroll compressors, air cooled condenser coils, DX type water chiller, condenser fans, outer weather proof casing, automatic control panel and accessories.

### **3.2.3 COMPRESSOR (SCREW)**

Each unit shall have multiple rotary, double bolted hermetic screw compressor

The rotary screw shall be manufactured from forged steel with precision cast male and female profiles which are asymmetrical. The profile of screws shall permit safe operation up to a speed of 3000 RPM for 50 Hz operation. The compressor shall unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve positioned over both the male and female rotors.

The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the rotors and the housing.

The rotors shall be mounted on antifriction bearings designed to reduce friction and power input. There shall be multiple cylindrical bearings to handle the radial and axial loads.

There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.

There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and coasting for shut down. An oil sump header shall be provided in the casing.

The units shall be complete with automatic capacity control mechanism, by use of slide valve to permit modulation between 20% to 100% of capacity range.

### **3.2.5 COMPRESSOR MOTOR**

The driving motor shall be Hermetic squirrel cage type protected against damage by means of built in protection devices.

### **3.2.6 CONDENSER**

#### **Condenser coil**

The condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes. The coil shall be circuited for sub-cooling. The coils shall be minimum 3 rows deep with at least 12 fins per inch.

#### **Condenser fans**

The units shall be furnished with necessary number of direct driven propeller type fans arranged for horizontal or vertical discharge. Condenser fan motor shall have class 'B' motor insulation, inherent protection device and shall be permanently lubricated type with resilient mounting. Each fan shall have a safety guard and shall have a low noise level.

### **3.2.7 COOLER**

- The cooler shall be direct expansion shell and tube type, with steel shell and seamless copper tubes. The refrigerant head shall be removable type. The tubes shall be supported in the shell by adequate stiff supports to eliminate vibrations and noise. The tube ends shall be fixed firmly into the tube sheets to prevent leakage of refrigerant gas.
- The cooler shall be tested and stamped against leaks in accordance with ASME code for the refrigerant being used and otherwise tested and constructed in accordance with ASME or equivalent approved code requirements.
  - The cooler shall have a minimum of 2 independent direct expansion refrigerant circuits.
  - The cooler shall be factory insulated with 19 mm thick closed cell polyvinyl chloride and further protected by means of heater cables.

### **3.2.8 CONTROLS**

- All the controls shall be factory wired and located in a weather proof enclosure. These shall include fuses, selector switch, oil safety switch, high and low pressure cutouts, interlocks for crankcase heaters and inherent motor protection devices, fan control thermostat, recycling pump-down circuit, high discharge temperature cutout indicator lamps shall be provided for the compressor units.
- Necessary starters for compressor motors and condenser fan motors shall be included and provided within the unit. The compressor & the condenser fans shall be electrically interlocked such that the compressor can run only when at least one of the condenser fans are running.

### **3.2.9 WATER CHILLING MACHINE CONTROL SYSTEM**

The water chilling unit shall be complete with microprocessor based type control system, which shall have the following features:-

- i. Electric expansion valve for economic operation of the system
- ii. Self diagnostic capability to locate faults and give early warning.
- iii. Leaving chilled water temperature control and reset capability, with provision to accept over ride commands from a central BMS system.

iv. Automatic sequencing of various functions for starting, running and stopping of the various components of the unit based on demand.

v. A programmable microprocessor complete with key pad and LED display window to perform the above functions.

vi. The control package shall also consist of, but not limited to, the following components:

- Low control voltage to unit.
- Field power and control circuit terminal blocks.
- ON/OFF switch.
- Replaceable relay board.
- Leaving chilled water set point board.
- Diagnostic digital display module.
- Microprocessor board.

Temperature reset board.

vii. The control system shall have an extended module for control and monitoring from a central BMS including the reset of chilled water temperature, ON/OFF / Fault etc.

### **3.2.10 REFRIGERANT CIRCUIT**

The refrigerant piping between compressors, chiller and condenser shall be of heavy gauge copper with brazed joints. The circuit shall include sight glass, moisture indicator, solenoid valves, electronic expansion valves, filter driers and necessary shut off valves with charging connections.

### **3.2.11 UNIT CASING**

All the above components shall be housed in an outer casing fabricated from galvanized steel, zinc phosphate with multiple coats of baked enamel paint to make the whole casing weather proof for outdoor installation. Removable panels shall be provided for access to all working parts.

### **3.2.12 AHRI/ EUROVENT CERTIFICATION**

The chilling unit shall be AHRI certified as per AHRI 550 / 590 – 2003 STANDARD. All suppliers shall furnish computer printouts along with their technical bids, giving details of capacity output at design conditions as given in tender.

### **3.2.13 MISCELLANEOUS**

Each system shall be provided with the following:

- Necessary charge of refrigerant gas and lubricating oil.
- Spring vibration isolators below the unit rated by the isolator manufacturers to absorb 0% of unit vibration and as approved by the engineer.
- Dial type thermometers and pressure gauges for the inlet and outlet of the chilled water lines.
- Flexible connectors between chilled water lines and cooler inlet and outlet.
- Water flow switch at the outlet of chilling unit
- Butterfly valve at the outlet and balancing valve at the inlet of the chillers

### **3.3 PUMPS**

#### **3.3.1 SCOPE**

This section of specification covers the supply, installation, testing, commissioning of water pumps along with accessories conforming to these specifications and in accordance with requirement of drawings, 'Technical Schedule of Equipments' and of the 'Schedule of Quantities'

#### **3.3.2 CODES AND STANDARDS**

The design, materials of construction, manufacture, inspection, performance and testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipments will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. The equipments supplied shall comply with the latest applicable Indian, American, British or American Standards

#### **3.3.3 TYPE**

All chilled, condensing water pumps shall be of capacity and size in accordance with the requirements indicated in the drawings and 'Schedule of Quantities' Pumps shall conform to relevant IS standards/codes.

#### **3.3.4 ACCESSORIES AND FITTINGS**

Pump shall be complete with

- (a) Lubrication fittings.
- (b) Gland drain (25mm min) piping upto nearest floor drain point.
- (c) Test and air vent cocks.
- (d) Water seal piping connections
- (e) Suction, discharge pressure gauge (not less than 150 mm diameter) of appropriate range, with globe valves.
- (f) Suction and discharge shut off valves.
- (g) Discharge check valve
- (h) Y type strainer at suction of each pump
- (i) Flexible couplings (at suction & discharge) with control rods.
- (j) However quantities of item (e) to (i) are separately quantified under 'Schedule of Quantities' and as such, cost of these valves should not be included in the cost of pump. Also GI gland drain piping (Item b) upto nearest drain point will be paid under piping item, as such cost of same should not be included in the cost of pump.

#### **3.3.5. INSTALLATION & TESTS**

The pump sets shall be mounted on cement concrete foundation, which shall be provided by other agencies. However, grouting nuts, bolts, channels, shims etc shall be provided by the HVAC contractor.

#### **3.3.6 MECHANICAL BALANCING**

The impeller shall be statically and dynamically balanced.

#### **3.3.7 VISUAL INSPECTION**

8.1 Pumps shall be offered for Visual inspection (if specifically asked for) before dispatch. The components of the pumps shall not be painted before inspection.

### **3.3.8 MATERIAL TEST CERTIFICATE**

Materials of the various pump components shall be tested in accordance with the relevant standard and Test Certificates shall be furnished along with the Pumps.

### **3.3.9 FIELD TESTING**

After installation, the pumps shall be subjected to testing at site also. If the performance does not meet the requirements regarding capacity, power consumption, vibration and noise etc. as specified, then the equipments shall be rectified or replaced by the CONTRACTOR, at no extra cost to the CLIENT.

### **3.3.10 TENDER DRAWINGS**

The following drawings shall be submitted by the tenderers along with their Bids: -

- Preliminary outline dimensional drawing of pump. (Suction and discharge Connections and foundation details shall also be indicated).
- Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

### **3.3.11 NAME PLATE**

Each pump shall be provided with a name plate indicating the following details:-

- a) Design capacity
- b) Total head
- c) Speed
- d) Motor rating
- e) Model number
- f) Manufacturer's serial number
- g) Weight of equipments
- h) Tag number

### **3.3.12 PAINTING**

13.1 All ferrous surfaces shall be painted with one coat of red oxide primer paint followed by two coats of synthetic enamel paint (approved shade).

### **3.3.13 INSULATION**

The Pump casings for chilled water along with its accessories and fittings shall be insulated as specified in section on insulation. The cost of this insulation should be included in the cost of the pump. Pumps shall be insulated only after they have been tested and test results have been approved by the engineer.

**Note:-** All the hardware required for the installation and equipments required for testing & commissioning shall be supplied by the Contractor.

### **3.3.14 SECONDARY PUMPS VFDs SALIENT FEATURES**

VFDs shall have built in AC chokes for line side protection and harmonic reduction, VFDs shall be provided with I/O expander cards for expanding the input / output requirements. they

shall have BMS option cards for integration with IBMS and also shall have pump logic controller for synchronizing the VFDs for pump application.

VFDs shall have pump functions like sleep frequency, wake frequency, dry pump protection, PID controller/built in PLC for performing the pumping functions.

VFDs shall be with 4 line alpha numeric display.

VFDs shall be housed inside sheet steel cubicle panel with associated switchgears like SFU / MCCB/MPCB, contactors, overload relays, indicating lamps, push buttons, selector switches, control transformers, cooling fans along with filters.

The power and control circuit shall be separated to meet the EMI guidelines for the use of VFDs inside the hospital premises.

VFD panel shall be placed near the secondary pumps motor to keep the cable length below 30 m.

Motors used for VFD shall be inverted duty and shall have VPI treatment, insulated bearing housings, EFF 1 class only.

#### **4.0 COOLING TOWERS**

- 4.1 Cooling towers shall be factory assembled units, rigidly constructed of galvanised sheet steel, stainless steel, aluminium or moulded fibre glass suitably reinforced with galvanised steel angle iron. Units shall be complete with fan/s, spray nozzles, water distribution system, eliminators, pan section and casing.
- 4.2 Water level control shall be automatic with a quick-fill bypass valve and drain valve fitted to the sump.
- 4.3 Unless otherwise specified in the Supplementary Specification the unit shall be of the counter-flow blow-through arrangement type with centrifugal fans.
- 4.4 All steel sections shall be manufactured from galvanised steel with edges protected against corrosion.
- 4.5 Access to all internal parts shall be provided by means of easily removable panel or watertight doors fitted with quick opening catches. Suitable handles or holding bars shall be fitted to removable panels and doors.
- 4.6 Fan wheels and housings shall be of hot dip galvanised steel or corrosion protected to the Department's approval.
- 4.7 All moving parts shall be protected with removable screens and panels, hot dip galvanised after manufacture.
- 4.8 Effective eliminator sections, corrosion proof shall be provided to prevent water carry-over.
- 4.9 The pan section shall be manufactured of heavy gauge hot dip galvanised steel. Standard pan accessories shall include access doors, easily removable corrosion proof strainer for the pump suction, drain valve, overflow and large bore adjustable make-up ball valve. The perforations of the strainer shall be smaller than the bore of the spray nozzles.
- 4.10 Automatic water treatment for corrosion protection with bleed control shall be fitted as standard equipment.
- 4.11 Recirculation spray water shall be uniformly distributed over the heat transfer surfaces ensuring complete wetting of the wet deck areas at all times. Spray nozzles shall be of

the non-clogging type. Nozzles and branch piping shall be easily removable for cleaning and flushing purposes.

- 4.12 Cooling towers with ducted discharge shall be provided with access panels in the ducting, large enough to ensure proper access to nozzles and headers and to enable removal of eliminator sections for repairs or replacement.
- 4.13 A pressure gauge shall be fitted to the nozzle inlet piping from the pump.
- 4.14 Units for outdoor use shall be completely weatherproof including all electric components.
- 4.15 Units shall be assembled with compatible galvanised or polymer and cadmium coated fasteners.
- 4.16 Where specified in the Supplementary Specification protection against pan freezing shall be built in.
- 4.17 Where specified modulating damper control matching heat rejection and system load shall be provided.

## **5.0 UNITARY AIR HANDLING UNITS**

### **5.1 SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and of the 'Schedule of Quantities'.

### **5.2 TYPE**

The air-handling units shall be double skin ceiling mounted, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and Schedule of Equipment.

### **5.3 CAPACITY**

The air moving and coil capacities shall be as shown on the drawings and indicated in 'Schedule of Quantities'.

### **5.4. UNIT CONSTRUCTION**

The ductable unit shall be ceiling mounted type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. The entire frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self-supporting frame work for various sections.

25mm thick double skin panels shall be made of 0.63 mm pre-plasticized GSS sheet on outside and 0.63 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 38 Kg./m<sup>3</sup> density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 25mm thick thermo Cole or 12mm thick closed cell Nitrile rubber.

## **6.0. FAN AND MOTOR**

The fan shall be DIDW centrifugal backward curved fan having single-phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA certification.

The fan motor shall be single-phase squirrel cage suitable for 415V +/- 10%, 50 Hz, 3-phase AC supply as specified in "Schedule of Quantities". Fan and motor may be directly coupled or may be belt driven.

## **7.0 FAN COIL UNITS – SPECIFICATIONS**

### **SCOPE**

This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the requirement of the drawings and 'Schedule of Quantities'.

### **7.1 TYPE**

The fan coil unit shall be horizontal type to be mounted within ceiling space. The units shall have horizontal discharge and complete with chilled water coil, one or more centrifugal fans and motors, cleanable fabric filters, double skin insulated condensate drain pan. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

### **7.2 Capacity**

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

### **7.3 Cabinets**

Cabinets shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

### **7.4 Interior Chassis**

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

### **7.5 Fan Section**

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds

A GI plenum shall connect fan outlet to the coil.

### **7.6 Cooling Coil**

The coil shall be of seamless copper tube of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/ hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a



level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper

#### **7.7 Drain Pans**

Primary drain pan shall be of double skin construction fabricated from 18 gauge stainless steel with all corners enclosed. An additional inner bottom panel of 18 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves.

The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

#### **7.8 Motor**

Motor shall be  $220 \pm 6\%$  volts, 50 cycle, single phase, six poles, shaded pole type, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

#### **7.9 Air Filter**

The filter shall be cleanable type 12mm thick AL. wire mesh and mounted behind the pan in a filter plenum of GI sheet.

### **8.0 INLINE & PROPELLER FANS – SPECIFICATIONS**

#### **8.1 SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

#### **8.2 TYPE**

Centrifugal and inline fans shall be of type as indicated in drawings and 'Schedule of Quantities'

#### **8.3 INLINE FANS**

Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

#### **8.4 PROPELLER FANS**

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for  $415 \pm 6\%$  volts, 50 cycle 3-phase power supply and for smaller fans shall be suitable for  $220 \pm 6\%$  volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawing Schedule of Quant

Propeller fans shall be provided with following accessories: -

Wire guard and bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor.

Single-phase preventors for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

#### **8.5 PERFORMANCE DATA**

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

#### **8.6 TESTING**

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

### **9.0 AXIAL FLOW FANS – SPECIFICATIONS**

#### **SCOPE**

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in 'Schedule of Quantities' and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following: -

(a) Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type). Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).

## Gravity louvers

### 9.1 APPLICABLE SPECIFICATIONS STANDARDS AND CODES.

Documents listed below should be read along with the technical data given in the 'Schedule of Quantities' and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.

- (a) I.S.S.: 3588 – 1986; specifications for electric axial flow fans.
- (b) ANSI/ASHRAE: standard 51
- (c) ANSI/AMCA: standard 210 for preparing performance curves, charts and testing of fans
- (d) IS-2312 – Propeller type A.C ventilation fans
- (e) BS – 848 – Methods of performance test for fans

### 9.2 DESIGN & MANUFACTURING

#### Fan and Components

**9.3** The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have optimum efficiency at operating conditions and shall have performance characteristics to match the approved performance curves.

The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quite, stable and vibration free operation at the prescribed conditions of flow, static and speed.

The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.

#### Impeller & Blades

The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

#### Drive

The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0–class F and suitable for 415 10% V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in 'Schedule of Quantities'. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

### 9.4 TECHNICAL SPECIFICATIONS

The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

### 9.5 GENERAL REQUIREMENTS

- Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.
- **NOISE LEVEL:** The tendered shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard.

## 9.6 PAINTING

All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

## 9.7 PACKING

The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

## 9.8 INSPECTION & TESTING

All fans shall be subjected to inspection and testing requirements as given below. The contractor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of Client may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves

Airflow capacity  
Static head developed  
BHP requirement  
Vibration and noise level

## 10.0 PIPING AND FITTINGS – SPECIFICATIONS

### 10.1 SCOPE

The scope of this section comprises the supply and laying of pipes required for chilled water; condenser water & drain water conforming to these specifications and in accordance with the requirement of the 'Technical Schedule of Equipments' and 'Schedule of Quantities'

### 10.2 WATER PIPING

Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below

<b><u>Chilled Water Pipes</u></b> <u>UPTO150MM</u>  200MM & ABOVE	MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992 Welded Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589 (LATEST)
<b><u>Condensate Water Pipes</u></b> <u>UPTO150MM</u>  200MM & ABOVE	MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992 Welded Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589 (LATEST)

All welding shall be done by qualified welders and shall strictly conform to Standard Code of practice for manual metal arc, welding of Mild Steel. First butt weld of each welder shall be fully radiographed by HVAC contractor under guidance of Client/Consultant for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All jobs welding shall be done by the electric arc welding process in accordance with the following:

All joints shall have 45-degree bevel type, pipe mill-beveled or machine-beveled by the contractor. All scale and oxides shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

### **10.3 BALANCING VALVES**

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings.

15-50 mm Size: Gunmetal ASTM B-6 2 Screwed ends conforming to BS 5154

65mm and above: Cast iron, flanged ends with stainless steel trim.

The valves shall have PTFE/SS disc with special erosion/corrosion proof sealing. The valves shall have temper proof adjustable and lockage arrangement for required water quantity after commissioning. The valves shall be complete with pressure test cock and drain cocks.

To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs to provide the following functions:-

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)

To printout saved data in computerized measurement protocol (CMP) consisting of:-

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV

- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

#### 10.4 BUTTERFLY VALVES

**Body:** Cast Iron

**Seat:** Resilient lining moulded black nitrile rubber

**Disc:** SG Iron conforming to IS: 1865 SG 400/12 & BS 2789 GR 420/12 Nylon Coated The handle shall have arrangement for locking in any position.. Valve shall be suitable for 16 Kg/Cm<sup>2</sup> working pressure.

#### 10.5 BALL VALVES

Ball valves without Y strainers and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

#### 10.6 NON RETURN VALVES

Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications

#### 10.7 Size Construction Ends

50 to 150 mm Body cast iron, gun metal plate Flanged

200 to 450 mm Body cast iron, plate carbon steel with

13% chrome overlay Flanged

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be suitable for not less than 10 Kg per sq. cm. gage working pressure.

#### 10.8 STRAINERS

a. Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm<sup>2</sup> and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet / outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and included in BOQ. The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall

avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

### **11.0 Expansion Tanks**

Close expansion tank should be provided with water capacity to suffice the capacity of volume of water contraction & expansion during operation & rest state of the HVAC system. Tank should be a closed vessel with rubber bladder/diaphragm to maintain the operating pressure inside the pipelines. Standby and working booster pump should be provided with selector switch for pump starting, pressure differential transmitter, pressure gauge & non return valve at discharge outlet of the pump Contractor to investigate the expansion tank size.

### **12. Fresh/Exhaust Air Damper**

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals. All outside air intake return air and exhaust air dampers are in proper position. All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

### **13. Earthing**

The electrical work will be carried out as per IE rules. The Employer will provide incoming cable with earthing for each Out door unit. The further distribution of control cabling and earthing of GI shall be carried out by the contractor.

In conventional field assembled plants lighting wired from the air conditioning control panel shall be provided for the filter chamber, coil chamber and fan chamber and shall comprise of bulkhead fittings permanently fixed to the walls or ceiling and earthed directly to the main earthing bar of the switchboard by means of a 4mm<sup>2</sup> bare copper earth continuity conductor, in addition to being earthed by means of the continuity of the conduit as specified in the Standard Electrical Specification.

### **14. PROPELLER FANS**

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by

spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced.

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for  $415 \pm 6\%$  volts, 50 cycle 3-phase power supply and for smaller fans shall be suitable for  $220 \pm 6\%$  volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and Schedule of Quantities.

Propeller fans shall be provided with following accessories: -

Wire guard and bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor.

Single-phase preventors for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

## **15.0 AUTOMATIC CONTROLS AND INSTRUMENTS – SPECIFICATIONS**

### **1. SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and 'Schedule of Quantities'

### **2. PRODUCTS**

#### **15.1 Two / Three Way Valve**

Two way or Three way motorized / modulating valve for each air handling units shall be provided in chilled water line at each air handling units as shown on the Drawings and included in Schedule of Quantities. Each valve shall be actuated by a space or duct mounted thermostat. Constant space condition shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall revert to fully by pass position when fan is shut off. Motor shall be proportional modulating motor. Motor shall be suitable for 24 volts supply and shall have a cover mounted 220/24 volts transformer factory-installed. The unit shall be suitable for outdoor installation in the open space. Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.



15.2 **Flow switches** shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.

## 16.0 DAMPERS

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings.

Damper frames shall be constructed of 16 gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required.

## 17.0 DRAIN PIPING

The drain piping shall be medium class galvanized iron as per IS:1239 (as per latest amendment).

The fittings shall be of as per IS:1239 Part-II with screwed connections.

The gate valves shall be of gun metal as described earlier.

Pipe crosses shall be provided at bends, to permit easy cleaning of drain line. The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

Drain lines shall be provided at all the lowest points in the system, as well as at equipments where leakage of water is likely to occur, or to remove condensate and water from pump glands. The drain pipe work shall be carried out with threaded joints only. No welded joint shall be permissible.

### Pipework Insulation :

Chilled water (20mm) and all drain pipes Insulation shall be as follows. The material will be TF quality Expanded polystyrene of 20kg/m<sup>3</sup> density minimum.

10 to 40 mm pipe size	-	25 mm
50 to 100 mm pipe size	-	50 mm
Above 100 mm pipe size	-	75 mm

## **CHAPTER N**

### **TECHNICAL SPECIFICATION FOR IBMS**

#### **INTEGRATED BUILDING MANAGEMENT SYSTEM**

##### **1.0 SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY**

The system will consist of a flat, open architecture that utilizes the Bacnet/LonTalk protocol as the common communication protocol between all controlled and controlling devices, and LNS architecture for the definition of the device database. No other device database structure will be permitted. When necessary or desired, bacnet/LonTalk packets shall be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Any such encapsulation of the LonTalk protocol into IP datagram's shall conform to existing bacnet/LonMark guidelines for such encapsulation. Systems that utilize non standard routing methods or hierarchal systems consisting of master or global controllers that poll and/or control less intelligent unitary controllers on a secondary bus will not be considered.

Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC , electrical, Fire & plumbing and electrical system etc.) and carry out followings functions:

- a. Individual input/output point scanning, processing and control.
- b. Centralized operation of the plant (remote control).
- c. Dynamic graphic details of plant and building.
- d. Energy Management through optimization of all connected electrical and mechanical plants.
- e. Alarm Detection and early recognition of faults.
- f. Time, event and holiday scheduling as well as temporary scheduling.
- g. Prevention of unauthorized or unwanted access.
- h. Communication interface and control.

The control system shall be designed such that mechanical equipment will be able to operate under stand-alone control. In general, the operation of any controllers on the network shall not rely on any other controller for its functional operation. System controllers that require a master computer will not be considered. Function specific modules may be used to supplement the functionality resident in each controller. As such, in the event of a network communication failure or the loss of any other controller on the LON, the control system shall continue to independently operate under local control of the resident program stored in nonvolatile memory as detailed herein. In such a case, each individual controller shall continue to perform basic functions until a network connection can be restored.

Each stand-alone intelligent outstation shall control a maximum of One AHU and shall be located adjacent to the Units.

The number of controllers for central plant room equipments shall be decided by the contractor with a maximum capacity limited to 18 points per controller. Overall, the system shall be provided with 15% spare capacity, with spare of at least 15% points on each controller. Also, in case of HVAC system, each controller shall control maximum one chiller and associated chilled water pump.

There shall be one control station located in Building Automation Room. The computer shall be sized to cover the graphic display memory and planning information. The display shall be in the form of dynamic colour graphics and text format with menu driven pop-up windows and help facility.

#### Reference Standards

1. Control system components shall be new and in conformance with the following applicable standards for products specified:
  - i. ANSI\EIA 709.1 (LonTalk Protocol)
  - ii. LonMark Certified (Version 3.1 Guidelines)
  - iii. UL 916 (Energy Management Equipment)
2. Utilize standard components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.
3. All products (PCU's, TDCU's and ID's) shall contain LonWorks networking elements to allow ease of integration of devices from multiple vendors.
4. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

## 2.0 CENTRAL STATIONS HARDWARE

The Control stations shall comprise of Personal computers (PC) providing high-level operator interface with the system. The terminals shall be capable of providing the operator with the facility for remote system interrogation, control, and retrieval / storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC  $\pm$  10%, 50 HZ + 3%.

#### a. Minimum Specifications for Workstations

FEATURES	DESCRIPTION
Processor	Intel I core 3.0 Ghz
Memory	512 MB, DDR 333 Mhz expandable to 2 GB
Cache (External)	512 KB Pipeline burst cache
ROM	256 Flash ROM, Can be upgraded from a diskette
Expansion Bus	3 PCI Slots, 4 ISA slots (3 slot shared)
Graphic Accelerator	ATI RagePro/AGP graphics accelerator, 4 MB SDRAM
Hard Disk	1 TB HDD
Power Supply	350 W switchable/50 Hz
Keyboard	104 keys window 98 keyboard, PS/2 Compatible

Operating System	Supports Windows XP, OS/2 Warp, Windows NT, DOS 6.22
Software	Office XP/Vista
Power Management	EPA compliant
Desktop Manager	Based on SNMP protocol
Antivirus Software	PC-Cilin or equivalent pre-loaded
Diagnostic Software	PAQ 95 or equivalent pre-loaded
Network	100 Mbps Network Interface Card with wake on lan/ethernet support
CD Writer	Built in 52X CD Writer with speakers

b) Key board : The central station shall be complete with detached 101-keys keyboard which includes full upper/lower case ASCII keyset, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.

c) Colour Monitor : The colour monitors shall be with a minimum 21 inch diagonal nonglare screen and minimum Super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 base colors. The monitor shall be with tilt and swivel facilities.

d) Mouse : For keyboard less operation, in addition to the enhanced keyboard, a mouse shall also be provided as an alternative user interface for day to day system operation. 2 Nos. mouse pads shall be provided for each mouse.

e) Printers: The contractor shall provide printers as specified for printing alarms, operator transactions and reports.

There shall be two printers with each Control Station. One printer shall be dedicated for alarm printing and the second printer for printing reports, trend log, summary, analyzer logging, recording alarms and providing system reports etc. Each of these shall be identical and interchangeable, and shall have the following characteristics:

i) All the printers shall be Dot matrix printers.

ii) 132 column/300 character per second print speed with minimum 24 pin head.

iii) Adjustable line spacing of six or eight lines per inch with compressed mode option and bidirectional printing and logic seeking.

f) The available PCI slots on the PC shall be used only for communication cards and shall not be utilized for mounting protocol converter cards. If protocol converter cards are used, they shall be external to PC and separately powered and backed-up by the UPS supply.

### 3.0 CENTRAL STATION SOFTWARE

#### 1. Command & Operating Software

- a. As a minimum, the menu driven command and operating software shall permit the operator to perform the following tasks with a minimum knowledge of the HVAC Control System provided and basic computing skills.

- i. Configure the network.
  - ii. Create control sequences.
  - iii. Graphical interface to systems.
- b. Provide additional third party software to permit the operator to manage hard drive files such as access, delete, copy, modify, etc. The package shall be object oriented and permit the user to manage directories upon boot-up. The file management software shall organize directories and sub-directories using files, file folder objects.
  - c. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
  - d. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
  - e. System Diagnostics. The system shall automatically monitor the operation of all HVAC control workstations, printers, modems, network connections, and nodes. The failure of these devices shall be annunciated to the operator.
  - f. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. Data shall be able to transferable to other software packages so as to create custom reports.
  - g. Web Browser Access: The DDC system shall provide total integration of the facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.

## 2. Graphical Object-Oriented Programming Software

- a. The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in LonWorks® programmable nodes. The graphical object-oriented programming function shall provide programming elements to be connected together to create a logic diagram. The graphical object-oriented programming function shall include elements for mathematical, logical, timing, setpoint, display and input/output functions to create logic diagrams that represent sequences of operation for LPNs.
- b. Program elements shall be able to be combined into a custom template that can then be used as a standard function.

- c. Program checkout and debug tools shall include display of real-time and/or simulated system variables and inter-object data on the programming screens. The user shall be able to assign fixed or variable values to inputs during the dynamic debugging of the control sequence.
  - d. The graphical programming tools shall provide the ability to print I/O lists, lists of standard network variables and lists of all parameters to be viewed by the HMI.
  - e. The programming software shall reside on each POT and OW server for programming and/or configuring each model of LPN on the project. The applications shall be downloaded and executed at the appropriate nodes. The software shall allow for updated applications via the network from the OW.
  - f. DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each LPN shall have available a full library of DDC algorithms, intrinsic control operators, arithmetic, trigonometric, logic, Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and relational operators for implementation of control sequences. 2-POSITION, FLOATING, STANDARD I/O AND COUNTER INPUTS, TIME BASED DATA, CURVE FIT FUNCTION, PSYCHOMETRIC FUNCTIONS, INTEGRATION.
  - g. All DDC setpoints, gains, and time constants associated with DDC programs shall be available to the operator for display and modification via the POT, DDU or OW interface.
3. Library of Applications: A library of control, application, and graphic objects shall be provided to enable the creation of applications and user interface screens. Provide the capability to cut & paste objects and libraries into applications for a node/system. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together, using a built-in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.
- 4. Provide integral trend-logging presentation in the programming screen.
  - 5. Print capability, with page break reference tags to allow down to 8 ½"x 11" size paper
  - 6. Off-line simulations (step function, continuous run function, simulation of external inputs)
  - 7. Dynamic presentation of logic in on-line state (all intermediate values)
  - 8. Text to logic screens
  - 9. Memory monitoring
  - 10. Power cycle restart function
  - 11. Run-time capability
  - 12. Calculator objects, (basic stuff), including if-then-else, log, ln, exp, and trig functions.
  - 13. Recognize standard network variable type data (nvi) and create network variables to put on the network (nvo)
  - 14. Programming Objects
    - a. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-

one, or one-to-many relationships. Linked objects shall maintain their connections to other objects, regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.

- b. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
- c. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system (step function and run mode, integral trend logging).
- d. The system shall support object duplication within the Owner's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

## 15. Object Libraries

- a. A standard library of object function blocks shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- b. The function blocks in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- c. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
- d. Application Specific Node Configuration software Tools: Provide application specific node configuration software tools that will permit the individual LASN to be configured and commissioned with appropriate parameters. This software will reside on the POT. Functionality shall include:
  1. Recognize all Standard Configuration Parameters (SCPTs)
  2. Provide capability for setting all Standard Configuration Parameters (SCPTs)
  3. Translation capability for user defined configuration parameters
  4. Monitoring capability for nvo's from the nodes
  5. Ability to set the values for nvi's to the nodes
- e. Network Management
  1. LonMaker for Windows network management software tool shall be used to assign domain, subnet, and node addresses to nodes; configure all routers and repeaters; define network data connections between LonWorks® device network variables, known as "binding;" and record binding data into node addressing tables, and create a database of all addressing and binding information for all nodes on the network.

2. Network management shall include the following services: browse all network variables on nodes; Attach, Detach, Manage, Add, Remove, and Replace nodes; plus transmission error off-line, on-line reporting.
  3. The network management database shall be resident in the operator workstation server, ensuring that anyone with proper user name/password authorization has access to the network management database at all times.
  4. The software shall have Client/server capability to allow multiple users ability to manipulate the database simultaneously.
- f. Human-Machine Interface - Operator Workstation Software
1. The HMI shall be a Web Server technology to allow multiple client access to an Ethernet connected server. The workstation shall operate also as a stand-alone workstation/server.
  2. The software shall enable an operator to interact with various devices including LonWorks® nodes, recorders, input/output (I/O) systems, intelligent transmitters, and other field devices.
3. It shall provide the following functions:
- Calendar.
  - Scheduling.
  - Trending.
  - Alarm monitoring and routing.
  - Time synchronization.
  - Time zone handling
  - Integration of LonWorks® controller data
  - Object linking and embedding for process control (OPC) for connectivity to third party OPC compliant software/devices
  - Color graphic display
  - On-line plots
  - Use Microsoft NT security
  - System documentation generation
  - Dynamic data exchange (DDE)
  - Dispatch of a single time schedule to all programmable nodes
4. System Configuration. At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access:
- i. Create, delete, upload, or modify control strategies.
  - ii. Add/delete objects to the system.
  - iii. Tune control loops through the adjustment of control loop parameters.
  - iv. Enable or disable systems
  - v. Generate text file reports to a networked printer.
  - vi. Select points to be alarmable and define the alarm state.



- vii. Configure alarms to be sent to Microsoft windows mail client
  - viii. Select points to be trended over a period of time and initiate the recording of values automatically.
  - ix. Provide different levels of security to every object in the HMI database
  - x. Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords
5. Event Alarm Notification and Actions
- i. The HMI software shall provide alarm recognition, storage, routing, management, and analysis.
  - ii. The HMI software shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
  - iii. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    - a. To alarm.
    - b. Return to normal.
    - c. To fault.
  - iv. Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
  - v. Provide timed (schedule) routing of alarms by class, object, group, or node.
  - vi. Provide alarm generation from “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
  - vii. Control equipment and network failures shall be treated as alarms and annunciated.
  - viii. Alarms shall be annunciated in any of the following manners as defined by the user:
    - a. Screen message text.
    - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
      - i. Day of week.
      - ii. Time of day.
      - iii. Recipient.
    - c. Pagers via paging services that initiate a page on receipt of email message.
      - i. Auto answer (at OWS) and auto dial (from node)
      - ii. Graphic with flashing alarm object(s).
      - iii. Printed message, routed directly to a dedicated alarm printer.
      - iv. Audio messages.
      - v. The following shall be recorded by the OWS HMI software for each alarm (at a minimum):

- d. Time and date.
- e. Location (building, floor, zone, office number, etc.).
- f. Equipment (air handler #, accessway, etc.).
- g. Acknowledge time, date, and user who issued acknowledgement.
- h. Number of occurrences
  - i. Alarm actions may be initiated by user defined programmable objects created for that purpose.
  - ii. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
  - iii. A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.
  - iv. Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.
  - v. Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.
  - vi. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. An alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms.
  - vii. The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

#### 6. Data Collection and Storage Requirements

- i. The OWS HMI shall have the ability to collect data for any property of any object and store this data for future use.
- ii. The data collection shall be performed by objects, resident in the node, and if desired OWS, shall have, at a minimum, the following configurable properties:
  - a. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
  - b. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
  - c. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
  - d. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
  - e. All log data shall be stored in a database in the OWS HIM and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
  - f. Systems that cannot provide log data in HTML formats at a minimum shall not be acceptable.

- g. The OW shall have the ability to archive its log data either locally (to itself), or remotely to a OWS server. Provide the ability to configure the following archiving properties, at a minimum:
  - i. Archive on time of day.
  - ii. Archive on user-defined number of data stores in the log (buffer size).
  - iii. Archive when log has reached its user-defined capacity of data stores.
  - iv. Provide ability to clear logs once archived.

## 7. Audit Log

Provide and maintain an Audit Log that tracks all activities performed on the OWS HMI. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to OWS HMI or to a server. For each log entry, provide the following data:

- i. Time and date.
- ii. User ID.
- iii. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

## 8. Database Backup And Storage

- i. The OW shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- ii. Shall have the ability to automatically complete full or partial backups; and have the ability to full or partial restore. Partial is defined as only items that have changed in the database.
- iii. Copies of the current database and, at the most recently saved database shall be stored in the OW. The age of the most recently saved database is dependent on the user-defined database save interval.

## 9. Graphical Real-Time Displays. The HMI, shall at a minimum, support the following graphical features and functions:

- i. Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.
- ii. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
- iii. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
- iv. Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered.
- v. Adjustments to analog objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value.
- vi. The OWS shall be able to support multiple graphic objects at the same time. If tiled, then each graphical object shall be fully scalable or aspect locked.

- vii. Trend Displays (variable versus time) - A trend display shall show the values of points plotted versus time similar to a strip chart recorder. Eight tags shall be trended per trend. The HMI software shall provide real-time and historical trending (for data which had been logged). This may be achieved by either color graphic page display or an Microsoft excel based display.
  - viii. Real-Time Trends - shall contain real-time data without consuming hard disk space.
  - ix. Historical Trends Logs - A historical trend log display presents data stored on the computer's hard disk.
  - x. X-Y Plots (variable versus variable) - An x-y plot shall dynamically represent the real-time or historical relationship one variable plotted against another variable.
  - xi. Automatic Generation - All trends and plots shall be self-generated and not require any programming by the user.
  - xii. The HMI software shall provide dialog boxes and menu picks for configuring trends and plots.
  - xiii. Any analog or binary data may be trended or plotted.
  - xiv. The software shall store pre-configured presentation of trends to facilitate operator call-up of trend log displays. It shall be possible to call up a trend log with pre-assigned data.
10. Graphics Builder - The HMI software shall provide a graphics builder.
- i. Display Documentation - The graphics builder shall provide show, simulate, review, and document animation functions to allow the user to identify, diagnose, change, and document animation points on each display.
  - ii. A library of vendor-supplied objects will be included. These objects, widgets, and symbols must be continuously scalable. These items shall be editable by the user.
  - iii. A library of animated graphic objects shall be included.
  - iv. Animation - The Graphics Builder will animate process graphics with real-time data from field devices.
  - v. Multi-State Color Animation shall be provided to change a graphic object's color from a palette of colors.
  - vi. Alarm Color - Color animation for normal, alarm, and alarm acknowledged states for both analog and binary point tags shall be provided. The user shall define the foreground and background colors for each state.
  - vii. Alarm Blink – Objects and text data shall blink based on alarm state and acknowledged state.
  - viii. Text and Numeric Animation - The software shall display the numeric value of an analog point, text of a text point, and the descriptors of a binary point. Display Linking - The software shall provide a display linking function. Clicking the object associated with the link changes the display to a new user-defined display.
  - ix. Pickable/Non-Pickable - The software shall enable active points to be selected with the mouse and accessed. It shall be possible to make a point non-pickable: the dynamic information shall be displayed, but the operator will not be able to access a detail display, change the value, etc. based on security settings of the software.
  - x. Ability to open external executable files from button click

- xi. Ability to open HTML web pages from button click
  - xii. Ability to view Microsoft Excel files from button click
11. On-Line Help. Provide a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.
  12. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.
    - i. System security shall be selectable for each operator.
    - ii. The system administrator shall have the ability to set passwords and security levels for all other operators.
    - iii. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
    - iv. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
    - v. All system security data shall be stored in an encrypted format.
    - vi. Each object in the HMI database must be able to have a security policy applied to it.
  13. System Diagnostics. The system shall automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciated to the operator.
  14. DDE Server - The HMI software shall be able to communicate and exchange data with any Third Party DDE compliant application.
  15. The same software will act as programming software.

#### **4.0 DIRECT DIGITAL CONTROLLER**

##### **4.1 DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT:**

- 1) DDC controllers shall be capable of fully "stand- alone" operation i.e. in the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own. The controllers shall be LonWorks based products.
- 2) The controllers shall consist of minimum single 16/32-bit microprocessors for reliable throughput, based with EEPROM based operating system (O.S.).
- 3) The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of number of points being controlled by them.
- 4) The controllers shall be UL listed and conforming to CE (Euro norms).
- 5) Controllers requiring nickle-cadmium/lithium battery to support the full operation of the RAM, shall have battery back-up upto 12 hours in the event of a localised mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.

In addition to the above battery reserve a further battery shall be provided to retain the RAM for a minimum of 2 days, after the expiration of the standard battery.

A low battery alarm shall be provided with each Controller and with an indication at the Control Station.

In case the memory is stored on EEPROM, the battery backup will not be required.

6) The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

7) The controllers shall have a resident real time for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network.

Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

8) The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 18 input/output (I/O) hardware points (with or without an expansion board). DDC's with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points.

9) If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met:

- i) In addition to the basic outstation, a minimum of two slots shall be provided for the insertion of plug-in function cards.
- ii) The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.
- iii) The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.

10) The DDC's shall have 15% spare capacity (digital/analog input/output) to give flexibility for future expansion.

11) All DDC controllers shall be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

Analog inputs/outputs of the following minimum types shall be supported:

- i) 4-20 mA.
- ii) 0-1 volts.
- iii) 0-10 volts.
- iv) 0-5 volts, and
- v) 2-10 volts.
- vi) Resistance Signals (either PTC or NTC)  
(PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

Digital input/output types to be supported shall be, but not limited to the following:

- i) Normally-open contacts.
- ii) Normally-closed contacts.

Modulating outputs shall be true proportional outputs and not floating control type.

12) Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.

- 13) All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.
- 14) Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, and Bus Error. All LED's shall be visible without opening the panel door.
- 15) It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localized mains failure.
- 16) Controllers requiring fan cooling are not acceptable.
- 17) There shall be the facility for accessing controller data information locally, via a portable plug-in keypad display which can be common to all controllers and normally removed to prevent unauthorized tampering. Alternatively each controller shall have a keypad and display integral with its casing for local interrogation and adjustment. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.
- 18) In case the Portable operator Terminals (POT) are required to programme the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.
- 19) The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.
- 20) It shall be possible to add new controllers to the system without taking any part of the system off-line.

#### 4.2 DIRECT DIGITAL CONTROLLERS CAPABILITIES:

1) The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

2) Operating system (O.S.) software for controllers shall be EPROM resident.

Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.

3) In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

4) In the event of memory loss of a Controller, or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded automatically and without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.

5) Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that

information may be transmitted either on change of incremental value or at specific time intervals.

6) Controllers must be able to perform the following energy management functions as a minimum.

- a) Time & Event programs
- b) Holiday Scheduling
- c) Maximum and Distributed power demand
- d) Optimum start and stop program
- e) Night purge
- f) Load reset
- g) Zero energy bands
- h) Duty cycle
- i) Enthalpy analysis and control
- j) Run Time Totalization
- k) Sequencing and Optimization
- l) Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Engineer-in-Charge.

7) The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience and current operating conditions.

8) Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.

Tenderers shall indicate their proposed system alarm handling capability & features.

9) Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

10) It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

11) Distributed power demand program shall be based on a sliding window instantaneous demand trend algorithm. The DDC interfaced to the demand meter shall calculate the demand, forecast the demand trend, compare it to the established demand limits, and initiate load shedding or re-establishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last.

#### 4.3 SYSTEM INTERFACE UNITS (SIU) / LAN ROUTERS / REPEATERS

##### A. General



1. Equip each router with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP).
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. Routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
4. Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
5. The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.
6. Provide a minimum of two Neuron 3120 or 3150 processors for use as the network router communication controller.

**B. Ethernet IP Router**

1. Equip each router with an Ethernet IP communication on one side and a LonTalk® transceiver Type 1 FTT or Type 2 - TP on the other side.
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.
4. On the LonTalk® side, the routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
5. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
6. The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

**5.0 PORTABLE OPERATORS TERMINAL (POT)**

**A. General Requirements.**

1. The DDUs shall permit the project operating staff to:
  - i. Display point values
  - ii. Display parameters
  - iii. Change time schedule elements
  - iv. List and acknowledge alarms
  - v. Monitor points in the system
  - vi. Command points (manual overrides) of points
  - vii. Override input points (put inputs in test)
  - viii. Read and check LonWorks variables on the network
  - ix. Password protected

- x. Node configuration for Fan Coil and Rooftop Unit TCUs
- 2. DDU with the following components:
  - i. Liquid Crystal Display
  - ii. Minimum 4x20 character
  - iii. Pushbuttons for scrolling display and enter
  - iv. Permanent mount or portable connection.

## 6.0 DATA COMMUNICATION

The communication between controllers shall be via a dedicated communication network as per LonWorks recommended standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

- 1) Every DDC must be capable of communicating with all DDC's.
- 2) Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retries shall constitute a communication or device failure.

## 7.0 FIELD DEVICES

### 7.1 ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

#### *General Requirements*

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

#### *Ancillary Items*

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

- (i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

- (ii) Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

- (iii) Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

#### *Additional features*

(i) Concealed Adjustment: All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.

(ii) Operating Voltage : All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

### **7.2 TEMPERATURE SENSOR**

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :

- 1) Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least  $\pm 0.33$  degrees F and sensitivity of at least 2 ohm/F.
- 2) Immersion sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm<sup>2</sup>.
- 3) The connection to the pipe shall be screwed ¾ inch NPT (M). An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.
- 4) The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
- 5) Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
- 6) Outdoor air temperature sensor shall be provided with a sun shield.
- 7) The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types :

- i. PT 100, PT 1000, PT 3000
- ii. NI 100, NI 1000
- iii. Balco 500.
- iv. Thermistor
- v. NTC1800

### **7.3 HUMIDITY SENSOR**

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

### **7.4 FLOW METER**

Water flow meters shall be either ultrasonic type or electromagnetic type. For electromagnetic flow meter, teflon lining with 316 SS electrodes must be provided. The housing shall have IP 55

protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.

The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to 'zero' the flowmeter without any external instruments, with the overall accuracy of at least  $\pm 1\%$  full scale.

#### **7.5 PRESSURE TRANSMITTER FOR WATER**

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of  $-10^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  with ambient ranging between  $0^{\circ}\text{C}$  to  $55^{\circ}\text{C}$ .

#### **7.6 DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK**

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

#### **7.7 DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS**

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1 A rating.

The switch shall be supplied suitable for wall mounting on ducts in any plane. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and have differentials adjustable over 10%-30% of the scale range.

The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

#### **7.8 AIR FLOW SWITCHES**

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 2 NO/NC potential free. Site adjustable scale shall also be provided.

#### **7.9 AIR PRESSURE SENSOR**

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

#### **7.10 WATER FLOW SWITCH**

These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 2NO/2NC potential free.

#### **7.11 TRANSDUCERS FOR ELECTRICAL SERVICES**

Electrical transducers shall be integrated electronic type and rack mounted on the field. These shall work on 230 V supply with the output being standard type i.e. 4-20 mA, 0- 10 Volts etc.

Power factor, Voltage, Current, Frequency and Kilowatt transducers shall have standard output signal for measurement for the specified variable.

Kilowatt-Hour metering(if any) shall be poly-phase, three- element with current transformer (CT) operated type. The metering shall feature high accuracy with no more than +/- 1% error over the expected load range. The coils shall be totally encapsulated against high impulse levels.

#### **7.12 LEVEL SWITCH**

The level switches shall have to meet the following requirement :

Type	:	Float Type/Capacitance type/Conductivity type
Mounting	:	To suit application.
Connection	:	Flanged ANSI 150 lbs RF Carbon steel
Float material	:	316 SS
Stem Material	:	316 SS
Output	:	2 NO, 2 NC potential free
Switch Enclosure	:	IP 55

#### **7.13 CONTROL VALVES (AIR HANDLING UNITS)**

Control valves for the Air Handling Unit's shall be globe type, two way suitable for Variable flow hydraulic system.

The Manufacturer's standards shall be applicable for these valves.

##### **Valves**

a.	Type	:	Two way mixing
b.	Stem / Trim	:	SS-316 or better
c.	Plug and seat	:	SS-316 or better
d.	Plug characteristics	:	Equal Percentage
e.	Service	:	Chilled water
f.	Stroke Length	:	Minimum 20 mm
g.	Compliance	:	IEC 534
h.	Packing	:	Teflon

**Actuator**

a.	Actuator	:	Electrical/Electronic/Magnetic.
b.	Actuator type	:	Proportionating(Modulating)
c.	Spring return function	:	Yes
d.	Travel limit switch	:	2 Nos. for open and close.
e.	Hand wheel	:	Required
f.	Input signal	:	0 – 10 V dc, 4 –20 mA
g.	Power Supply	:	240 V ac
h.	Thrust	:	To be selected by the vendor
i.	End Connections	:	Screwed upto 2" Beyond that ANSI 150, Lb RF
j.	Noise Level	:	Not exceeding 70 DB
k.	Weather Proof	:	NEMA1

**Note :**

Actuator should be directly coupled to the trim. Eccentric linkages not acceptable. Leakage not to exceed 0.1% of flow.

**7.14 CONTROL FOR FCU**

Control valves for the Air Handling Unit's shall be globe type, two way suitable for Variable flow hydronic system as indicated in BOQ.

**7.14.1 Two way motorized valves**

Two way motorized valves shall be provided in chilled water lines at each fan coil units. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing chilled water through the coil. The valve shall be provided with spring return function so that it revert to fully closed position when fan is shut off. Valve shall be two/three position with flare connections. Valve shall have the facility to replace motor \ actuator without removing the valve body. Actuator shall be suitable for 240 V, 50 Hz ac or 24V ac. Maximum close off pressure shall be selected to suite the CV requirement.

**7.14.2 Thermostats**

Thermostat shall be snap acting fixed differential type thermostat for air-conditioning application for actuating the two way valve at each fan coil unit with HI-MED-LO fan switch and system setting OFF-FAN-COOL. Switching off must break fan circuit. Thermostat shall be provided with necessary relays to operate valve of cooling coil.

**7.15 TWO WAY MOTORIZED BUTTERFLY VALVE****7.15.1 Valve**

a.	Type of valve	Butterfly Valve.
b.	Body Material	Carbon steel ASTM A 216
c.	Body seat ring (if applicable)	Gr WCB
d.	Vane	SS-316
e.	Packing	Teflon
f.	Mounting Stool	Required.
g.	Shaft	SS-316
h.	Seat	Nitrile rubber
J	Fasteners	SS-316

**7.15.2 Actuators**

Type	Electric
Duty.	On/Off (Maximum 50 operations per day)
Motor power supply	230 V AC or 415 V 3-phase
Travel limit switches	2 Nos
Torque limit switches.	2 Nos
Hand wheel	Required
Speed	Approx 150 mm/min

**NOTE**

- Actuator must open/ close with one changeover contact. Control panel, if required, must be supplied integral with the Actuator.
- No gear box is envisaged, however if gear box is provided, the travel limit switches must be connected directly to the valve stem.
- Cover tube for the valve stem must be provided

**8.0 ELECTRONIC METERING**

Electronic metering shall be provided on the main LT panel at incoming and outgoing feeders. These meters shall be free supply by the BAS contractor to the Electrical contractor whereby these shall be installed in the LT panel by the Electrical contractor. The electrical contractor shall also provide necessary CT, PT and 220 V power input for the meters. All further control wiring and networking of the meters shall be in scope of BAS contractor.

The specifications for the electronic meters to be supplied by BAS contractor is as follows:

Type	:	Static Power Meter
		Class 1.0 accuracy.
Instantaneous		
Measurements	:	<ol style="list-style-type: none"> <li>V (1-n), V (1-1) &amp; 1 per ph &amp; avg. V &amp; I unbalance</li> <li>PF per ph &amp; total, frequency</li> <li>Power &amp; BI-directional energy (active, apparent, reactive)</li> <li>Peak &amp; Predictive Demand (I, W, VA, VAR totals)</li> <li>V &amp; I harmonics (Individual &amp; Total)</li> <li>Time of use (internal calendar, multiple daily tariff, energy &amp; demand accumulators).</li> </ol>
Features	:	<ol style="list-style-type: none"> <li>Event Triggered</li> <li>Sequence of event</li> <li>Panel mountable</li> <li>Internal battery backup</li> <li>Transducerless connection via standard CT / PT</li> </ol>

## f. Y2K compliance

Display : Local LCD display panel user formattable display with scrollable screens.

Software interface shall be ensured by BAS contractor for the electronic meters. Systems requiring transducers for duplicating the data shall not be accepted.

All the instantaneous measurements shall be displayed on the control stations and the data shall be logged. It shall be possible to access minimum / maximum logging of any parameter with alarm annunciation for unusual measurements. The system shall also accept user defined "Set-Point" limit of any parameter.

## 9.0 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note : All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54 protection) and UL listed.

## 10.0 CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers Any modifications suggested by the Contractor shall be got approved by the Architect /Engineers before the actual laying of conduits is commenced.

### 10.1 CONDUITS / TRUNKER

Conduits and accessories shall conform to relevant Indian Standards. PVC conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made, with help of adhesive.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

### 10.2 CONNECTIONS

All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.



The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

### 10.3 BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

### 11.0 SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications:

- |    |                     |   |  |
|----|---------------------|---|--|
| a. | Wire                | : | Annealed Tinned Copper   |
| b. | Size                | : | 1.5 sq. mm, 7 strands  |
| c. | No. of conductors   | : | Two (One pair)   |
| d. | Shielding           | : | Overall beld foil Aluminium Polyester shield.  |
| e. | Jacket              | : | Chrome PVC   |
| f. | Nominal DCR         | : | 17.6 ohm/km for conductor<br>57.0 ohm/km for shield  |
| g. | Nominal OD          | : | 8.5 mm   |
| h. | Nominal capacitance | : | 130 pF/m between conductors<br>at 1 KHz 180 pF/m between one<br>conductor and other<br>conductors connected to shield. |
| i. | Colour              | : | Black and Red  |

### 11.1 COMMUNICATION CABLE

The communication cable shall be of the following specifications:

- |    |                      |   |  |
|----|----------------------|---|--|
| a. | Wire                 | : | Annealed Tinned Copper   |
| b. | Size                 | : | Minimum 24 AWG stranded  |
| c. | No. of conductors    | : | One pair (2 conductor)   |
| d. | Shielding            | : | Overall beld foil Aluminium polyester Shield.  |
| e. | Jacket               | : | Chrome PVC   |
| f. | Nominal DCR          | : | 78.7 ohm/km for conductor<br>55.8 ohm/km for shield  |
| g. | Nominal OD           | : | 5.64 mm  |
| h. | Nominal capacitance: | : | 131 pF/m between conductors at 1 KHz 243 pF/m between<br>one conductor and other conductors connected to shield. |
| i. | Colour               | : | Black and Red, Black and White)  |

DATA POINT SUMMARY								Immersion type Temp Sensor	Outside T/RH	Level switch	DP switch Water	DP switch Air/Blower	Duct type temperature/Rh Sensor	Water Flow Switch
Sr. No.	Description	Qty.	AI	DI	AO	DO	Remarks							
A	Chillers	2					Integration through BACnet/Modbus Protocol							
1	Chiller - ON / OFF					2	Potential Free Contact from BMS to Chiller Micro-Processor panel							
2	Chiller run status			2			Potential Free Contact to BMS from Chiller Micro-Processor panel							
3	Chiller Auto / Manual switch			2			Potential Free Contact to BMS from Chiller Micro-Processor panel							
4	Chillers Trip / Fault Status			2			Potential Free Contact to BMS from Chiller Micro-Processor panel							
5	CHW Supply/Return temp.		4				Immersion temperature sensor	4						
6	CDW Return temp.		2				Immersion temperature sensor	2						
7	Outside Air temperature cum RH Monitoring		1				OA Temp+RH Sensor		1					
8	Room Air temperature cum RH Monitoring		1				Room Temperature +RH Sensor							
9	Chilled Water & Condensate Water Flow Status			4			Signal from Flow Switch							4
B	CHW Pumps	2												
1	Pump ON / OFF					2	Potential Free Contact from BMS to Pump Starter panel							

2	Pump run status			2		Differential Switch across Pumps				2			
3	Pump Auto / Manual switch status			2		Potential Free Contact at Auto/Manual Switch							
4	CHW pump trip status.			2		Potential free from electrical panel							
<b>C</b>	<b>Condenser Water Pump</b>	<b>2</b>											
1	Pump ON / OFF				2	Potential Free Contact from BMS to Pump Starter panel							
2	Pump run status			2		Differential Switch across Pumps				2			
3	Pump Auto / Manual switch status			2		Potential Free Contact at Auto/Manual Switch							
4	CHW pump trip status.			2		Potential free from electrical panel							
<b>D</b>	<b>Secondary Water Pump</b>	<b>2</b>											
1	Pump ON / OFF				2	Potential Free Contact from BMS to Pump Starter panel							
2	Pump run status			2		Differential Switch across Pumps				2			
3	Pump Auto / Manual switch status			2		Potential Free Contact at Auto/Manual Switch							
4	CHW pump trip status.			2		Potential free from electrical panel							
5	Pump Speed Control through VFD				2	0-10 V DC or 4-20 ma output from BMS to VFD							
<b>E</b>	<b>Cooling Tower</b>	<b>2</b>											
1	Cooling Tower In/Out temperature.		4			Imm type temp sensor.	4						
2	Cooling Tower fan ON/OFF command.				2	Command from PC/DDC to the cooling tower MCC panel.							
3	Cooling Tower fan run status.			2		Signal from potential free							

							contact.								
4	Cooling Tower fan Auto/ Manual status.			2			Potential Free Contact at Auto/Manual Switch								
5	Cooling Tower isolation Motorised valves (In+Out) ON/OFF command & status.			4		4	Potential free contact from B/F valve Actuator to BMS & potential free cotact from BMS to B/F actuator for on/off.								
6	Sump level monitoring high / low			4			Signal from level switch			2					
	<b>Sub Total (A+B+C+D+E)</b>		<b>12</b>	<b>40</b>	<b>2</b>	<b>14</b>		<b>10</b>	<b>1</b>	<b>2</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>4</b>	
<b>F</b>	<b>Air Handling Units / FCUs</b>	<b>55</b>													
1	AHU / FCUs ON/OFF Command					55	Potential Free Contact from BMS to fan Starter panel								
2	AHU /FCUs Air Flow status			55			Differential Pressure Switch across Fans					55			
3	AHU /FCUs Auto / Manual status			55			Potential Free Contact at Auto/Manual Switch								
4	AHU /FCUs Return Air Temperature		55				Duct temperature Sensor						55		
5	Chilled Water Valve Command				55		Signal from duct type temperature sensor								
	<b>Sub Total (F)</b>		<b>55</b>	<b>110</b>	<b>55</b>	<b>55</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>55</b>	<b>55</b>	<b>0</b>	
<b>G</b>	<b>UG &amp; OH TANKS</b>														
1	Water tank overhead	16		32			Level Switch			16					
2	Water tank underground	4		8			Level Switch			4					
	<b>Sub Total (G)</b>		<b>0</b>	<b>40</b>	<b>0</b>	<b>0</b>		<b>0</b>	<b>0</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	
<b>Grand Total (A to G)</b>			<b>67</b>	<b>190</b>	<b>57</b>	<b>69</b>		<b>10</b>	<b>1</b>	<b>22</b>	<b>6</b>	<b>55</b>	<b>55</b>	<b>4</b>	
	<b>TOTAL</b>		<b>383</b>												

**LIST OF BUREAU OF INDIAN STANDARD CODES**

IS 1239 (Part– I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel Pipe Fittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 823-1964	Code of Procedure For Manual Metal Arc Welding of Mild Steel
IS 780-1984	Service Valves For Water Works Purpose
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration
IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves For Water Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration ( Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS 3103 – 1975 Reaffirmed 1994	Code of Practice For Industrial Ventilation
IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Erection Motor
IS 3142 – 1993	V Grooved Pulley

BS-EN-779 – 1993	Particulate Air Filters For General Ventilation
IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel
ASHRAE Hand Books	<p>American society of heating, refrigeration and air conditioning books</p> <ul style="list-style-type: none"> <li>- Applications 1999</li> <li>- Fundamentals 1997</li> <li>- System and equipments 1996</li> <li>- Indoor air quality 62 – 1999</li> </ul>

**CHAPTER O****LIFTS****A. BRIEF SPECIFICATION OF PASSENGER LIFTS PROPOSED FOR RIAHS at BHUBNESHWAR, ODISHA**

1.	Type	Passenger Lift
2.	Capacity / Load	13 Passenger/884 Kg.
3.	Speed	1 Meter / Sec.
4.	No. of Stops	As per BOQ
5.	Mode (Operation)	Duplex, (with or without attendant)
6.	Type of Drive	A.C. VVVF
7.	Signals & Other Features	a) Call register indicator at all Floors
		b) Digital car position indicator in car
		c) Battery operated alarm bell and Emergency light.
		e) Fireman's switch
		g) Over-riding Facility
		h) Adjustable guide shoes
		i) Music & hands free press & speak intercom
		j) Braille Buttons
		k) Stainless steel Hand rails on all 3 sides at 900 mm height
		l) Voice synthesizer
		m) Full height car operating panel
		n) Vendor's shall specify any additional feature if any
8.	Lift Well/shaft size	2500 mm x 1900mm (NBC) or as per manufacturer's Standards
9.	Car Size	2000 mm x 1100 mm (NBC) or as per manufacturer's Standards
10.	Door Operation	Automatic AC VVVF
11.	Door Frame	Stainless steel Hairline Finish

12.	Type of Door	Centre opening sliding door, one hour fire rated landing doors, Stainless steel Hairline finish.
13.	Car enclosure	Stainless steel Hairline finish. The ceiling panel shall be with 4 down lights (CFL Type) in stainless steel panel, Ceiling cabin fan.
14.	Car Floor	PVC Flooring or as per manufacturer's specifications
15.	Car height	2300mm (NBC) or as per manufacturer's Standards
16.	Door height	2100mm or as per manufacturer's Standards
17.	Car Entrance	900mm wide.
18.	Machine Room	Gearless Machine M/C Room at Terrace
19.	Power Supply	415 Volts $\pm$ 10%, 3 Phase 4 wire, 50 Hz A.C. supply.
20.	Safeties	a) Overload Safety device.
		b) Full length infrared curtain (min. 150 criss cross beam)
		c) Automatic Rescue device with maintenance free batteries
The contractor shall get approved the variations, if any from the Engineer-in-charge.		

**B. The detailed technical specifications for lifts and Elevators as under:-**

**A. GENERAL**

1. This section details the performance specification for the lift installation, associated control and auxiliary equipment.
2. The finish for lift cars, landing door/fixtures, architraves, transom panels, etc. are described generally in this Specification, unless it is separately shown on the drawings or described in the particular Specification. The stainless steel finished as specified shall have a thickness of not less than 2.0 mm. Construction and installation details for various applications shall be submitted to the Supervision Consultant for approval prior to commencement of work.
3. The Contractor shall take into account of the maximum loading of car internal finishes for each of the lifts (including false ceiling, wall panels, flooring, lighting fixtures and the like) when proposing the equipment for the Lift Installation. As a general guidance, the loading for internal finishes shall not be less than 30% (unless, otherwise specified) of the lift rated capacity. Exact provision shall be submitted for Supervision Consultant's approval prior to construction.
4. The type, quantity, capacity, speed of lifts shall be as described in the Technical Schedule and as shown on the Drawings.
5. To provide a complete electric operated glass Passenger and Service Lifts, including design, manufacture, installation at site, testing and commissioning of the same to the Employer's/Consultant's satisfaction. No consideration will be given to extra payment based upon difference in interpretation of the specification and drawings.



**B. SCOPE**

- A. Safety during operation and maintenance to personnel and equipment
- B. Service Reliability.
- C. Minimal fire risk.
- D. Ease of maintenance and convenience of operation.
- E. Automatic protection of all electrical equipment through selective relaying system
- F. Maximum interchangeability of equipment spares.
- G. Fail safe feature.
- H. Suitable for applicable environmental factor.
- I. This specification defines the basic guidelines of the system as necessary for lifts. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere. Compliance with these specifications and or approval of any of Contractor's documents shall in no case relieve the Contractors of his contractual obligations.
- J. All works to be performed and supplies shall be affected as a part of contract requires specific approvals/review of Owner or his authorized representative. Major activities requiring approvals/review shall include but not limited to the following.
- K. Lift shaft section, Elevation and plan as per the drawing attached.
- L. Quality assurance procedures.
- M. Testing and commissioning procedures in field.
- N. Engineering activities to be performed by Contractor shall include but not limited to the following as relevant to the scope of work included in the project specification.
  - a) Control and protection scheme.
  - b) Making of shop drawings with bill of materials.
  - c) Sizing and calculation of Motors, breaking capacity, rope, cable trays/raceways etc.
  - d) Cable schedule based on the control schematic drawings.
  - e) Installation/operation and Maintenance Manual.
  - f) Lighting and ventilation of Lift Cabin.
  - g) Interconnection drawings.
  - h) Factory inspection and testing procedures.
  - i) Field testing and testing procedure.
  - j) Preparation of as-built drawings.
  - k) Any other work/activity which is not listed however is necessary for the completion of lift installation.
  - l) A complete check list (works/work site).

**C. TESTS**

## 1.0 Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programmed.

## 2.0 Commissioning Tests

- A. The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted with specified load.
- B. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- C. Pre-commissioning test shall be carried out as per relevant IS and/or as specified elsewhere in the tender.
- D. The Contractor shall be responsible for obtaining clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by Owner on production of requisite documents.

## D. PACKAGING

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of the wagons etc.

## E. PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

## F. CODES AND STANDARDS

The work shall be carried out in accordance with the C.P.W.D General Specification for Electrical work (Part-III) lift 1981, along with B.I.S., National electric code, Indian electricity act & rules which govern the requirements of the lift installation including amendments up to date of the following standards and regulations.

i)	IS: 1860:1980	Code of Practice for Installation/erection and maintenance of Electric Passenger & Goods Lifts.
ii)	IS: 3534:1976	Outline Dimensions of Electric Lifts.

iii)	IS: 4722	Rotating electrical machines.
iv)	IS: 325	Three phase induction motors.
v)	IS:900	Installation and maintenance of induction motors.
vi)	IS:4029	Guide for testing of three phase induction motors.
vii)	IS:8623 & 4237	Switch gear and control gears.
viii)	IS:4064	Air break switches
ix)	IS:2208 & 9224	HRC cartridge fuses.
x)	IS:10118	Selection, installation and maintenance of switch gear and control gear.
xi)	IS:2959	Contactors.
xii)	IS:1354&1554 Part-I, II	PVC insulated cables.
xiii)	IS:10810	Test procedures for cables.
xiv)	IS:6875	Control switches & push buttons.
xv)	IS:732	Wiring installation.
xvi)	IS:6121	Cable glands
xvii)	IS:9537	Rigid steel conduit
xviii)	IS:3043	Earthing
xix)	IS:2365-1977	Specification for steel wire suspension rotor for lifts, elevators hoists.
xx)	IS:1030-1982	Specification for carbon steel castings for general engineering purpose.
xxi)	IS:7759-1975	Specification for lift door locking.
xxii)	USA standard institute (Code No. AI.7.1)	Safety code elevators, dumb waiters and moving walks.
xxiii)	Material specifications	BIS or approved equal.
xxiv)	IS:4202	Lift code & national electrical code for lifts.
xxv)	IS:4666:1980	Specification for Electric Passenger and goods lifts.
xxvi)	As per Bombay lift Act, 1939 amended up to date.	

#### G. SITE CONDITIONS

Lift shall be designed considering the followings

Ambient Temperature - 45 °C.

Relative humidity	-	100%
Mean Seal level	-	655m
Wind Velocity	-	170 km/Hr. max.

It is the responsibility of the Contractor to survey the site and acquaint himself to prevailing site conditions before quoting.

#### **H. DRAWINGS**

Before the commencement of work, the lift contractor on receipt of building drawings shall prepare and submit all necessary shop drawings showing the general arrangement of the lifts for their approval before the installation of the lifts. These drawings will become part of the contract.

#### **I. PAINTING**

All exposed metal work furnished under these specifications, except as otherwise specified shall be properly spray painted over an anti-corrosive primer coat and another two coats after installation.

#### **J. WORKS INCLUDED IN THE SCOPE OF SPECIALISED CONTRACTOR FOR LIFT WORK:**

- A. To provide scaffolding in the hoist way required for erection of lift
- B. To carry out minor civil work, such as modification and making good the pocket/cutout in wall/ceiling/floor for car, counter weight, rail bracket, hall buttons, indicators and laying of sills in positions or any other work required for smooth operation commissioning of lifts.
- C. To provide and fix the steel item such as machine beams, beam, bearing plate in the machine room, lift shaft for installation of machinery. Separators wherever required and buffer support channels and vertical iron ladder in lift.
- D. All electrical work will be done by lift supplier including providing and installing of voltage stabilizer and their cost should be included in his bid.
- E. Providing of lifting hook in the machine room/in lift shaft for hoisting of equipment during erection and to facilitate maintenance in future including their fixing etc.
- F. Providing and fixing of necessary sill supporting projection sheet steel fascia plates on all landings as per requirements.

#### **K. All other works not included in the scope of specialised contractor for lift work shall be provided by the main contractor with no extra cost and not limited to the following:**

- A. A hoist way properly framed and finished including pit of required depth with drain including water proofing, as per approved lift supplier drawing. The hoist way wall shall be neat plastered to avoid dust accumulation.
- B. Properly lighted and ventilated machine room and hoist way shall also have lights & lights plugs on alternate floor including one power plug point at mid landing including access doors, ladder and guards as required walls & ceiling shall be properly finished to avoid accumulation of dust.
- C. Trap doors shall not be provided in floor slab of M/c room. The Contractor shall lift the machinery from the last floor to M/c room through staircase.

**L. POWER SUPPLY**

The apparatus shall be suitable to operate on 415 volts 3 phase 4 wire, 50 Hz, Alternating current with a variation of  $\pm 10\%$  in volts and  $\pm 3\%$  in frequency respectively. The supply for illumination and signal equipment shall be 230V A.C.

**M. WARRANTY**

The bidder shall provide for two year warranty after commissioning against all manufacturing defects and shall provide for free replacement of all materials having manufacturing defects.

**N. PERMISSION TO INSTALL THE LIFTS AND LICENSE TO RUN THE LIFTS FROM RELEVANT AUTHORITIES.**

It shall be the responsibility of the successful tenderer to obtain the necessary permission, if required, to install the lifts from the relevant local authorities and subsequently to have the installation inspected by the relevant local authorities and arrange to obtain the license to run the lifts. All relevant papers connected to obtaining the permission and final inspection will be signed by the Owner. The requisite fees for this purpose shall be payable on the production of actual receipt on this account.

**O. ERECTION**

The lift contractor shall commence the erection of the lift equipment immediately after receipt of the complete equipment from their works and complete the work to the satisfaction of the Engineer-in-Charge within the stipulated time. The lift installation shall be handed over in perfect working order on completion of the work.

**P. DATA'S**

The contractor shall furnish technical particulars of the equipment devices type, make and catalogue number for the approval by the owner through Architect / Consultant.

- a) Motor sizing calculation.
- b) Brake selection calculation.
- c) Single line / Schematic diagram of electronic control panel.
- d) Layout of lift machine room showing electric control panel, elevator equipment etc.
- e) Cable size calculation along with cable and equipment layout.
- f) Rope size calculation.
- g) Earthing layout.
- h) Inspection manual for equipment and accessories covered in the scope of supply.
- i) Technical literature of operation & control.

**Q. TESTS**

The following tests shall be carried out as per relevant IS requirement.

- a) Insulation and earth test for all electrical apparatus.
- b) Continuous operation of the lift under full load conditions for one hour at the end of which time the temperature of the motor and the operating coils will be tested. This shall be as per ISI specifications.

The car is to be loaded until the weight on the rope is twice the combined weight of the car and the specified load. This load must be carried on for about 30 minutes without any sign of weakness, temporary or permanent elongation of the suspension ropes strands.

## **R. TESTING**

Testing at manufacturers works of the various equipments and components as required by European Standards shall be done by the successful tenderer before dispatching the material to site. The tenderer shall furnish the certificates of the same.

If the authorized representative of Owner / Architect wishes to participate in the Inspection & Testing are to be witnessed the Contractor shall inform to the Owner will in advance before carrying out such tests.

Various tests required to be done as per European Standards at site of the installation shall be carried out in the presence of the purchaser's representative.

## **S. CONTROL SYSTEM**

- A. Lifts shall be arranged in one of the following control patterns as stipulated in the Equipment Schedule of the Particular Specification. The control shall be with/without attendant.
- B. All lifts shall be of selective collective control, unless otherwise specified.
  - 1 Duplex Control
    - i) All calls shall be registered in the system and answered in sequence regardless of the order in which they are registered.
    - ii) When the car is in motion in a given direction, it shall travel to the furthermost call and stop at any intermediate floor for which a car call or landing call for the corresponding direction of travel has been, Landing calls in the direction opposite to the car travelling direction shall be by-passed. These calls shall be stored in the system and to be answered when the car returns in the opposite direction.
    - iii) When the car has responded to the last call in its direction of travel, the car shall change its direction of travel to respond to calls in the opposite direction of the previous trip.
    - iv) When all calls have been answered the car shall stay with doors in a closed position at the floor lastly served.

## **T. SYSTEM FEATURES**

This section specifies the details of system features, exact requirements shall be as stipulated in Equipment Summary on the drawing.

### **i. Attendant Operation**

Key switches for change of operation mode (including automatic, manual, off, fire bypass, attendant and etc.) shall be provided in a lockable recess panel on the car operation panel. After gaining control on the lift, the attendant can direct the car to stop at any storey. The attendant can also by-pass the landing calls (but not cancel them), or reverse the direction of travelling.

### **ii. Shutdown Operation**

When a lift fails to operate normally for some reasons but not a fault, the lift controller shall make two more attempts to start operation. If these two attempts fail, then the

defective car shall be disconnected automatically from service. This lift shall also be automatically put back to service if one of the attempts is successful.

### **iii. Automatic By-pass**

Load weighing devices located either on car top or under the car cage shall be provided for all lifts. Whenever the load exceeds 90% contract load of the lifts, the lifts shall ignore all landing calls and only respond to car calls. The sensitivity shall be 30 kg for passenger lifts and 5% of contract load for freight or goods lifts. All equipment and labour shall be provided to carry out adjustment on the device activating setting to the satisfaction of the Supervision Consultant.

### **iv. Overload Device**

- A. The load weighing devices as detailed above shall also operate when the load in the car exceeds the rated capacity.
- B. The operation of the devices shall activate buzzers sound and flashing 'overload' signals. At the same time the car doors shall be prevented from closing. When the excess load has been removed from the car, the buzzer alarm shall be muted automatically and the car shall function normally. The sensitivity shall be 30 kg for passenger lifts and 5% of the contract load for freight or goods lifts.

### **v. Anti-nuisance Device**

Facility shall be provided to cancel all car calls in case:

- A. The calls are not registered in a same direction as the travelling direction.
  - Many car calls registered in a short time.
- B. The number of calls does not correspond to the load in the car as determined by the car load weighing devices (for lifts with speed at 2.0 m/s and above). These devices for fire lift shall be bypassed automatically whenever the fireman's switch is operated.

### **vi. Direction Reversal**

If a car without registered car calls arrives at a floor where both up and down landing calls are registered, it shall initially respond to the lift landing call in the direction that the car was travelling. If, after the stop at the landing, there are no car or landing calls registered to require immediate travel in the same direction as before stopping at that landing, the car shall, without closing its doors, respond to the landing call in the opposite direction after a preset interval, adjustable from 1 to 5 seconds. If for any reason the doors are prevented from closing so that the car is unable to respond to a call, the call shall be transferred to another car.

### **vii. Advanced Car Arrival Feature**

Advanced hall lantern operation in terms of indication and gong shall be provided to minimize the door open holding time in response to landing calls, so as to enable the passengers to reach the entrance of the assigned car before it arrives.

### **viii. Empty Car Waiting Feature**

When there is a car waiting or loading at main floor, any empty car on returning to the main floor shall perform no 'Advanced Car Arrival Feature' as described above. The car shall wait quietly with the doors shut until the departure of the waiting or loading car. However, after a preset time if for whatever reason the car is prevented from leaving the main floor, the waiting empty call shall respond to the call with indication and gong

operation.

**ix. Door Closing Detector By-Pass**

If the doors are obstructed from closing for a predetermined time, say 15 seconds, by operation of door re-opening detector or the electronic detection system, such device shall become inoperative with the sounding of a loud buzzer in the car. The doors shall close at a safe reduced speed. However, the doors shall re-open whenever door-open button on car operation panel is pressed again.

**x. Leveling**

The lift shall be provided with a floor leveling device which shall automatically bring the lift car to a stop within +/- 10mm of level with any floor for which a stop has been initiated, regardless of the load or direction of travel. An automatic re-leveling device shall be provided which shall be arranged to automatically return the lift to the floor within the unlocking zone should the lift move up or down from floor level due to unloading or loading. This device shall be operative at all floors served, whether the landing and car doors are opened and closed.

**xi. Speech Synthesizer**

- A. An English speech synthesizer complete with microprocessor vocabulary chips, loudspeaker control and accessories shall be provided, unless otherwise specified. The speech synthesizer shall be used for broadcasting to car passengers the following messages.
  - a) Storey arrival
  - b) Up/Down travel
  - c) Obstructed doors
  - d) Lift full
  - e) Other announcements as required by the Supervision Consultant
- B. The voice of the speech synthesizer shall be of female and the sequence and frequency of the messages shall be subject to Supervision Consultants' approval.

**U. CAR DOORS AND LANDING DOORS**

- A. All car doors shall extend to the full height and width of the landing openings unless otherwise specified. A similar imperforate door shall be provided for every landing opening in the lift hoist way enclosures. The top track of the landing and car doors shall not obstruct the entrance to the lift cars.
- B. Any projections on or recesses in the exposed parts of the car doors or landing doors shall not exceed 10 mm to avoid finger trapping between sliding parts of the door and any fixed part of the car or landing entrance.
- C. Sliding car and landing doors shall be guided on door tracks and sills for the full travel of the doors. The distance between the cars and the landing sills shall not exceed 25 mm.
- D. Emergency landing door unlocking device and key.
  - i) Every landing door shall be provided with an emergency landing door unlocking device. When operated by an authorized person with the aid of a key to fit the unlocking triangle, the landing door shall be unlocked irrespective of the



position of the lift car for rescue purpose. When there is no 'Unlocking' action, the key shall only be able to stay in the 'locked' position.

- ii) In the case of coupled car and landing doors, the landing doors shall be automatically closed by means of weight or springs when the car is outside the unlocking zone.
  - iii) When there is a long section of lift well without a landing door, an emergency door shall be provided at a distance apart not exceeding 11 m for evacuating the passengers. The emergency door and locks shall be provided under the Building Trade.
  - iv) Each emergency door shall be provided with an electrical safety device to ensure that the lift cannot be set or kept in motion unless the door is fully closed. It is the responsibility of the Contractor to supply and install the electrical safety device including all necessary cabling works. The Contractor shall liaise with the Building Trade on all installation details prior submitting proposals to the Supervision Consultant for approval.
- E. Test Certificates – All landing doors shall be approved type for not less than one hour duration of fire rating. The Works is inclusive of the responsibility to schedule the testing of all lift landing doors with Supervision Consultant's design incorporated prior to the installation.

## **V. DOOR SAFETY**

- a. All doors locking devices and door switches together with any associated actuating rods, levers or contacts, shall be so situated or protected as to be reasonably inaccessible from the landing of the car. The lift car shall not move and shall not remain in motion unless all landing doors and car doors are in the closed and locked position except during slow speed leveling or re-leveling of car in the unlocking zone. It shall not be possible to open a car door from inside the car unless the car is within the leveling zone.
- b. If the car and landing doors fail to open within an adjustable time period (present initially at 20 seconds) after the car is stopped at a landing where a car call is registered, the door opening signal shall be cancelled and the lift shall answer other car calls. Any attempts of the lift controllers in opening the doors shall also be cancelled and the doors shall be kept in closed position. Alarm messages shall be reported to the Remote Supervisory System for hard copy record on printer (if any). If there are no other car calls registered, the lifts shall return to the main landings without stopping for landing calls.

## **W. Car Door Safety Device**

### **A. Multi-Beam Photo-Electric Lights**

- i) Light beams shall be directed across the lift car opening between heights of 800 mm to 1800 mm above finished floor level which shall operate in conjunction with electronic timer devices. An adjustable timer from 0.5 to 10 seconds shall be provided to hold the doors open for the period as specified below. The tabulated duration are initial adjustment standards only and shall be fine tuned to suit specific traffic movement capabilities and the arrangement of car and landing stations.
- ii) The first passenger stop duration are those measured from door fully opened to door start-to-close? The second and succeeding stop duration shall be from

restoration of the light beam to door start-to-close from its fully reopened position.

Passenger Conditions	Stop for	
	Car Call	Landing Call
First passenger	2.0 sec.	2.0 sec.
Succeeding passenger	1.0 sec.	1.0 sec.

- iii) A switch shall be provided in the service cabinet of the main car operating panels to by-pass the photoelectric devices in case they become defective. The lift shall continue to operate with only its protective leading edge device and a separate adjustable 2-10 second door open control timer set at 7 seconds. The 'Door Open' button shall remain active.

#### **B. Safety Edges**

- i) A safety edge shall be provided on both sides of the car door. This protective device shall be fitted to the leading edge of the car door panel, which moves across the clear entrance, to stop, reverse and fully re-open the leading edge of the doors in the event that the protective device is obstructed while closing. The protective device shall extend not more than 25mm above the sill (measured to the extended position of the protective device) to a minimum height of 1.8m above the sill.

#### **X. Landing Door Safety Device**

- 1 Landing doors shall be provided with an effective locking device so that it shall not normally be possible to open the door from the landing side unless the lift car is in that particular landing and unlocking zone. Provision shall be made for the opening of a landing door by an authorized person by means of master landing door access key, irrespective of the position of the car.
- 2 Landing door shall be provided with an electro-mechanical interlock which will prevent the lift from being started or kept in motion unless all landing doors are closed, and the interlock contacts are made.

#### **Y. CAR FIXTURES AND LANDING FIXTURES**

##### **A. General**

The following specification shall apply if there are no drawings or descriptions in the Particular Specification showing/detailing the requirements of car fixtures and landing fixtures.

##### **B. Car Position Indicator**

Digital car position indicator shall be located over the main landing door and the car door (or at the top of the car operating panel). The car position display shall be in colour approved by the Supervision Consultant with two 16-segment characters for complete alpha-numeric capability and protected by a polycarbonate lens. The characters shall not be less than 50mm high. Flash indication shall be provided on the indicators when lifts pass through the blind openings. Should there be other proposals for the indicating systems; the Contractor shall state them clearly as alternatives at the time of tendering. The detailed design of the indicator shall be confirmed with the Supervision Consultant and to be submitted for approval prior to manufacture.

**C. Call Buttons**

- i. Call buttons shall be provided at the car operation panel and at every served floor, adjacent to or in between the landing entrance.
- ii. For passenger lifts, micro-movement call buttons with a stainless steel face-plate of hairline finish and not less than 2.0mm thick shall be provided.
- iii. For goods lifts, push operated type vandal proof buttons shall be provided.
- iv. The momentary pressure of the call button shall register a call. The buttons shall flush with the face-plate, and illuminated when activated.
- v. One additional set landing call button adjacent to the lift designated for the handicapped shall also be provided. The landing call buttons shall be subject to Supervision Consultant's approval prior to manufacture.

**D. Landing Indicators**

- i. Directional indicators and an audible signal shall be provided on every served floor beside/above each lift entrance. The audible signal shall be in form of a chime which sounds softly in conjunction with the flickering of the predictive arrival directional indicator.
- ii. Flash indication should be provided on the indicators when lifts passes the blind openings.
- iii. Details of landing fixture including the chime and its sound shall be submitted for the Supervision Consultant's approval prior to manufacture.

**E. Architrave down Light**

18 watt CFL lights shall be supplied and installed on the underside of the hall lanterns. The spotlights on a particular floor shall be lit up to signify the arrival of the corresponding lifts. These spotlights shall be switched off after the corresponding lifts have left that particular floor. For parking cars, the spotlights on the parking floor shall be turned off after a preset period adjustable from 15 to 150 seconds. Should a call from the parking floor is registered; spotlight of the assigned parking car shall be switched on again together with the opening of the landing doors to attend the call.

**F. In-Use Indication**

For lifts with simple automatic control, a set of "IN USE" light and a red indicator shall be provided at every landing. The red indicator will be illuminated at the landing to show the car calls which will go off when the lift is emptied.

**G. Intercom**

For goods lifts, intercom shall be provided at each landing to allow direct communication with the lift car. The connection shall be established when the intercom call button is pressed. Provision shall also be made to allow "press to talk" and "release to listen" when the background is noisy.

**H. Signage**

A signage shall be provided and prominently displayed at each landing of goods lifts: "FOR GOODS ONLY- NO PASSENGER"

**I. CAR OPERATION PANEL**

- i. Unless otherwise specified or shown on the Drawings, car operation panels shall be of total integration design and shall be flush-mounted. The panels shall consist of the following:
  - a. Illuminated call buttons labeled in number to correspond with the landings served. All buttons shall be flush mounted.
  - b. Alarm push buttons with protection from accidental operation.
  - c. 'DOOR OPEN' and 'DOOR CLOSE' (with arrow indicators) buttons (For lifts with vertical bi-parting doors, the door shall remain open until the "Door Close" button is pressed).
  - d. Audio and visual signals in connection with the overload devices.
  - e. 'Up' and 'Down' directional indicator.
  - f. Inching buttons (for goods lifts only)
  - g. Attendant control cabinet for light switches, alarm reset switches, fan switches and cleaner's 'stop-switches' etc.
  - h. Intercom speaker for simultaneous intercommunication amongst lift car, lift machine room, central supervisory system, and, in case of goods lifts, the landing floors.
- ii. For lifts with centre opening doors, two identical car operation panels, one on each side of the front return panel shall be provided.
- iii. To cater for the disabled, a third car operation panel of a horizontal design shall be provided.

**J. CAR CAGE****a. General**

The following specification shall apply unless there are separate drawings or descriptions in the Particular Specification showing/detailing the requirements of lift car interior.

**b. Lift Car Interior**

The lift car interior shall generally complete with the following provisions:

- i. Ventilation fans complete with stainless steel No. 4 Satin Finish air grilles of size to limit the linear velocity of the air supply to be less than 1.5 m/s. Air change rate per hour shall be at least 20 times of the lift car volume. The effective area of the ventilation apertures in the lower part of the car shall be at least 1% of the available car area.
- ii. 18w emergency CFL down-lights.
- iii. Mounting frames for lift certificates lift number plates, lift loading plates, notice boards and 'No Smoking' signage in stainless steel hairline Finish.
- iv. Hairline stainless steel handrail on rear and two side walls.
- v. Exact car interior finishes being as detailed on the Drawings or described in the Particular Specification.

**c. Emergency Exit**

Imperforate emergency exit of minimum size 500 x 350 mm shall be provided for all lift cars in the car roof as per the requirement of EN81 and ASMA A17 and Local India-west Bengal Authority. Such exit panels shall be:

- i. Operable only from outside;
- ii. Clear of any apparatus mounted above the roof of the lift car:
- iii. Held close with a key operated lock, which can be re-closed and relocked without a key:
- iv. Provided with an electric safety device to prevent operation of the lift when the panel is open:
- v. Able to operate the alarm bell when the above-mentioned key operated locks cease to function.

#### **d. Car Platform**

- i. Car platforms shall be of framed construction. The relationship between the rated capacity of the lift and the maximum available car platform area shall be in accordance with the schedules in the Particular Specification. The minimum car platform area for the specified rated capacity shall comply with EN81 and ASMA A17 and Local India-Delhi Authority.
- ii. For goods lifts, the design of the supporting and suspension systems shall be adequately sized to sustain the highest roll-over load of a laden manual operated trolley/forklift entering/leaving the car platform. The total weight of the laden trolley/forklift shall be equal to the rated load of respective elevators and be carried by two axles. The maximum load to be carried by an axle shall be 80% of the laden trolley/forklift weight and the maximum eccentricity of loading shall be based on the laden trolley weight being off centre laterally  $\frac{1}{4}$  of the clear platform entering/leaving onto the entrance edge of the platform.

#### **e. Car Top Control Station**

- i. A control station shall be provided on the top of every lift car, and comprise the following switches clearly marked as:
  - 'STOP' switch;
  - 'NORMAL/INSPECTON' switch; and
  - Directional inspection buttons protected against accidental operation.
- ii. When the car top control panel is in operation:
  - It shall be impossible to control the car from any other position.
  - The car shall travel at a speed not exceeding 0.63 m/s.
  - The car shall be stopped if one of the safety devices operates.
  - The car shall move whilst the movement button is continuously pressed.
  - Where lift equipment is housed in a compartment separate from the machine room or lift hoist way, a switch shall be provided in that compartment which, when being placed in the 'STOP' position, shall cause the lift to stop and prevent it from being started until being placed in the 'RUN' position. Such switch shall also be provided in each lift pit.

**f. Car Frames**

- i. Every lift car body shall be carried in a steel car frame assembly which shall have sufficient mechanical strength to resist the forces applied by the safety gear or impact of the car on the buffers. The deflection of the steel members carrying the platform shall not exceed 1/1000 of their span under static conditions when the rated load is evenly distributed on the platform.
- ii. At least four renewable guide shoes or shows with renewable linings or sets of guide rollers shall be provided, two at the top and two at the bottom of the car frame assembly.

**g. Notices & Signage's**

- i. A stainless steel load plate indicating the rated load of the lift shall be fitted inside each lift car.
- ii. The following notice board shall be supplied and securely mounted in each car denoting:
  - The name of the Company, telephone number and emergency instruction.
  - "No Smoking", which shall be manufactured from stainless steel sheet of red letter.
  - A metal container housing the necessary tools, together with clear instructions for moving the lift car and releasing passengers in emergency shall be provided in the machine room in a conspicuous position.
  - "IN CASE OF FIRE DO NOT USE LIFT".
  - "FOR GOODS ONLY- NO PASSENGER" which shall be in red lettering for all goods lifts
- iii. Details of all the notice signage shall be submitted to the Supervision Consultant for approval before fabrication.
- iv. Name or Logo of lift manufacturer shall not be displayed inside the lift car interior.

**h. GUIDES AND GUIDE FIXING**

- i. The car and the counterweight shall be each guided by at least two rigid steel guides throughout their travel. The strength of the guides, their attachments and joints shall be sufficient to withstand the forces imposed due to the operation of the safety gear and deflection due to uneven loading of the car. This deflection shall be limited so as not to affect the normal operation of the lift.
- ii. The guides shall have machined guide surfaces.
- iii. Steel guide brackets shall be provided at suitable intervals of not more than 2.5m for passenger lifts and 2.0m for goods lifts to fix the guides to the walls enclosing the lift way. The method of drilling and mechanical anchoring to concrete or welding on steel support shall be used as the standard practice for fixing guides rail brackets. No boxing out shall be adopted.
- iv. Wood or fiber blocks or plugs shall be strictly forbidden for securing any guide brackets.

- v. The fixing of the guides to the brackets and to the building shall permit compensation, either automatically or by simple adjustment, of effects due to normal setting of the building or shrinkage of concrete.

#### **i. HOISTWAY SAFETY**

##### **i. Buffers**

- a. Buffers shall be provided at the bottom limit of travel for cars and counterweights. The type of buffer to be used shall be in accordance with the following table:

<u>Rated lift speed</u>	<u>Type of buffer</u>
£ 1.0 m/s	spring with buffered return
> 1.0 m/s	oil

- b. Spring (Energy Accumulation Type) Buffer with Buffered Return –

Buffers shall be designed and constructed to absorb within the limits of their stroke, the whole kinetic energy of car carrying its rated load when the speed of impact is at the maximum governor tripping speed.

- c. Oil (Energy Dissipation Type) Buffer –

The stroke shall be such that the car or counterweight shall be brought to rest with an average deceleration of not more than  $9.81 \text{ m/s}^2$  on striking the buffer at 115% of rated speed.

Reduced buffer stroke may be used when the retardation of the lifts at the ends of its travel is monitored by a device conforming to the requirements of EN81 and ASMA A17 and Local India-Delhi Authority. However, the reduced buffer stroke shall not be less than the values as stated below:

<u>Rated speed m/s</u>	<u>% Reduction in stroke</u>
£ 4	50
> 4	33 – 1/3

- d. The buffers installed shall be mounted on steel channels which extend between the guide rails or on the concrete plinth.
- e. The Contractor shall provide all necessary buffer extensions, modification of concrete plinth for buffers, supporting brackets, working platforms etc. in the lift pit wherever necessary.
- f. All counterweights shall be of CAST IRON and shall travel between rigid guides of steel frame capable of withstanding buffer impacts. Suitable metallic counter weights guard of required length shall be provided at the bottom of hoist way.

#### **j. Lift Pit Stop Switch**

A switch of Ingress Protection IP 55 minimum as defined in IEC 144 shall be provided in each lift pit to stop the lift and prevent it from any further movement until placed it back to 'RUN' position.

#### **k. Cat Ladder**

A cat ladder shall be provided by the Building Trade between the bottom landing and the lift pit floor.

#### **l. Terminal stopping and final limit switches**

- i. Terminal stopping and final limit switches shall be provided either on car cage or in the hoist way for each lift and shall be positively operated by the movement of the car.
- ii. The final limit switches shall be set to function as close as possible to the terminal landings. They shall operate before the car or counterweight comes into contact with the buffer and shall continue to operate whilst the buffers are compressed.
- iii. Terminal Slow Down Switches

These shall be provided and installed to slow down the lift car when approaching the top and bottom landings. The slow down switches shall act independently from the normal car operating device.

- iv. Over-travel Limit Switches

These shall be provided and installed to stop the car within the top and bottom clearances, independent of the normal car operating device. The bottom over-travel limit switch shall become operative when the bottom of the car touches the buffer.

When the over-travel limit switches are operative, it shall be impossible to operate the car until the car has been hand-wound to a position within the normal travel limits.

#### **m. Guarding**

- i. Rigid metal screen shall be provided to guard the counterweight. The screen shall extend from 300 mm above lift pit floor to at least 2500 mm above the lift pit floor.
- ii. For common lift hoist ways where two or more lifts are installed, rigid metal screens shall be provided to separate each lift from an adjacent lift or counterweight. The height of the metal screens shall be as follows:
  - When the horizontal distance between the edges (roof) of two adjacent cars or counterweights is 300 mm or more, the screens shall be extended from the lift pit floor to a minimum height of 2500mm and across the whole depth of the lift hoist ways.
  - When the distance as described in sub-clause is less than 300mm, the screens shall be provided from lift pits to full height of the lift hoist ways and across the whole depth of the lift hoist ways.
- iii. All other dangerous parts, such as governors and the like, shall also be properly guarded. The components of the guarding shall be designed to be inherently safe and to the approval of the Supervision Consultant.

#### **n. Safety Gear**

- i. Every lift car shall be provided with a safety-gear capable of operating only in the downward direction and stopping fully loaded car, at the tripping speed of the over speed governor, even if the suspension devices break, by gripping the guides, and holding the car there.
- ii. For lifts with speed below 48 mpm, instantaneous safety-gear shall be provided. It shall be installed at the bottom of the case frame and consisted of a pair of toothed eccentric rollers or similar devices and connected by rods. It shall be actuated by the pull of the governor rope when the car exceeds the



set tripping speed. Once actuated, the device should develop rapidly increasing pressures on the guide rails from the momentum of the lift car.

- iii. It shall only be possible to release the car safety-gear by raising the car without the use of any special tools.
- iv. The application of safety-gear shall sound the alarm bell(s).
- v. The application of the safety-gear shall not cause the car platform to slope at more than 1 in 25 to the horizontal.
- vi. It shall not be possible for vibration of the car frame to cause a safety-gear to operate.
- vii. Counterweight Safety Gear

Counterweight safety devices shall be provided for all lifts.

#### **o. Speed Governor**

- i. The speed governor shall be of the centrifugal type. Bearing shall be of the sealed lubricant type requiring a minimum maintenance.
- ii. The governor tripping speed shall have adjustable setting. On reaching the tripping speed, an electrical contact shall be operated first to cut off the motor power circuit followed by the engagement of the governor jaw to grip the governor ropes, thereby operating the safety gear device.
- iii. The over speed governor shall operate the safety gear should the speed of the lift car rise above normal in accordance with EN81 and ASMA A17 and Local India-Delhi Authority
- iv. The over speed governors shall be given by flexible wire ropes with the following requirements:
  - The breaking load of ropes shall be related to the force required to operate the safety gear by a safety factor of at least 8.
  - The nominal rope diameter shall be at least 7 mm.
  - The ratio between the pitch diameter of the over speed governor pulleys and the nominal rope diameter shall be at least 30.
- v. The over speed governors shall be sealed after setting the tripping speed.
- vi. The breaking or slackening of the governor rope shall cause the motor to stop by an electric safety device.

### **K. EMERGENCY OPERATION**

#### **a. Lift Homing**

- i. Under power failure and fire alarm conditions, lifts shall be grouped together in the pattern to the Supervision Consultant's approval and operated as detailed below.
- ii. Power Failure Operation
  - a) In case of power failure, standby power in the capacity for one lift per group will be supplied from the emergency back-up generator unit. Power failure and/or generator power available signals in the form of dry contacts shall be provided by others.

- b) On receipt of such signals, an automatic selection circuit incorporated in the lift control system shall be provided to send each car of the group in sequence, without answering any car call or landing call, to designated landing and cars shall remain there inoperative.
- i) However, fire lifts shall be arranged to home to the designated homing floor and then perform its lifts service as with normal power. Manual control key switches for selection for continuation of lift operation shall be provided in lift supervisory panel such that a lift of each group can be selected to remain in operation on emergency power (Or, alternatively commanding through the computer station of central supervisory system if provided).
- ii) Whenever an operation command is received and the lift car cannot start within a predetermined time limit, the operation command will be cancelled and given to next designated lift.
- iii. Fire Alarm Operation
  - a) One fire alarm signal in the form of dry contacts will be provided by others for fire alarm operation. When the signal is detected, the lifts shall perform the following operations:
    - After a rising lift car stops at the nearest floor, it shall go directly to the designated homing floor with the door closed. A descending lift car shall not stop on the way. A lift with an open door shall instantly close the door, proceed directly to the designated homing floor.
    - On normal power, all lifts shall simultaneously return to the designated main landing and remain there inoperative until the fire alarm signal is cancelled and lift operation is reset manually at lift car operation panel.
    - On emergency power, all lifts shall return to the designated main landing one by one and remain there inoperative until fire alarm signal is cancelled and lift operation is reset manually at lift car operation panel.
  - b) Manual override control key switches shall be inoperative during the fire alarm period.
  - c) If any of the passenger lifts is designated as the fire lift, the operation of the fireman switch shall cause this lift to operate according to the fire lift operation as described elsewhere.

**b. Battery Supply Unit**

- i. One (1) battery supply unit comprising rechargeable batteries and constant voltage float chargers shall be provided for each lift to cater for:
  - a) lift car lighting
  - b) lift car ventilation
  - c) alarm systems
  - d) intercom system
- ii. The units shall be located in the respective lift machine rooms and shall be the nickel cadmium or nickel alkaline type of sufficient ampere-hour capacity to operate the car emergency lighting fittings, car ventilation fans and the

emergency bells for each car for at least 6 hours in the event of power failure to an individual lift or a group of lifts. The recovery rate of the emergency supplies after 6 hours continuous use shall be not less than 50 per cent in 8 hours and 80 per cent in 16 hours.

- iii. The batteries shall be housed in a self-contained free standing cabinet fabricated from sheet steel of thickness not less than 1.6 mm (16 SWG) vermin-proof and ventilated, anti-alkaline treated internally and finished similar to the lift control panels. The chargers shall be of constant voltage float type employing electronic components and devices. The charger shall comprise HRC fuses or MCCBs for protection of the incoming and each outgoing circuit. Over-discharge protection, first grade MISC ammeter to read DC charging and, load current and DC voltmeter marked to indicate both the float and boost charge voltage, 'Mains On' indicating lamp, non-locking load test switch, disconnect switch and suitable test load with the voltmeter scale clearly marked in red showing the terminal voltage when feeding the test load, battery charger failure alarm, battery cut-off alarm, battery earth-leakage detectors, approved type engraved instruction labels for manner and duration of tests, other labels, wiring and all other necessary items are considered desirable. Proprietary design and make inverter shall be incorporated, if required, for the operation of the lift car lighting and ventilation fans.
- iv. The battery supply units shall conform to the current edition of EN81 and ASMA A17 and Local India-Delhi Authority.

**c. Automatic Rescue Device**

- i. Automatic Rescue Device (ARD) shall be an automatic device which, when operated in the event of power failure will release passengers trapped in the lift. The device shall be only applicable for lifts which are not provided with standby generator supply.

The device basically comprises the following:

- a) A set of standby battery
  - b) Battery charger
  - c) 3 phase inverter
  - d) Power supply to brake and door motor
- ii. In the event of power failure, the ARD shall be activated automatically to release the brake of the lift, drive the lift up or down depending on the load of the lift to the nearest landing and then energises the door motor to open the lift door. The lift door shall remain open until resumption of power supply in which case the lift will be automatically reset to normal. If the power failure occurs when the lift is at the landing, the device shall operate to open the lift door only.

Except for the safety circuit, any other failure which results in the stalling of the lift will immediately activate the ARD to operate the lift.

- iii. The battery must be nickel cadmium stand-by type or approved equivalent. The voltage shall be not more than 36 volts. The capacity of the battery is such that when fully charged it is capable of operating the lift from one landing to another for a minimum of 20 trips without further charging.

- iv. The approved charger must be constant voltage/current limiting type which shall keep the battery at full charge condition at all times and shall be able to boost charge the battery to full charged condition after any emergency discharge. The charge must be able to automatically lower the charging rate to the recommend trickle value of the battery manufacturer when the battery is fully charged.
- v. Separate source shall be available to operate the brake and door motor without any modification. Similarly the brake coil and door motor must not be overheated after 20 times of continuous operation of ARD.
- vi. Every existing safety feature of the lift shall be retained and the ARD will not become operative when any of the safety components is activated to stop the lift. When the ARD is in operation and if there is short circuit or open circuit in the output of the inverter, the brake shall immediately operate to stop the lift. If the fault is removed, the ARD shall automatically reset to operate the lift.
- vii. The rescue time of the device from the time of power failure to the time the door opened at the next landing should not exceed 7 minutes.

**d. Hand winding Apparatus**

Provisions shall be made on each hoisting machine such that the lift car can be raised or lowered during emergency by manual operation. The direction of winding corresponding to the raising and lowering of the lift car shall be clearly indicated. The hand winding apparatus, where detachable, shall be mounted in an accessible position in the lift machine room and one unit shall be provided for each lift machine room. A notice shall be prominently displayed stating that hand winding should only be undertaken by authorized persons and the notice should also detail step by step procedure to operate the lift in an emergency.

**L. CONTROL OF NOISE AND VIBRATION**

**a. General**

- 1. The whole of the lift assembly, including the opening and closing of the car and landing doors shall be quiet in operation and shall be free of rattling or squeaking noises. Lift doors operation shall be smooth to avoid the transmission of impact noise to the surrounding structure.
- 2. Noise levels resulting from the operation of the lifts, including direct sound transmission, breakout noise and re-radiation of structure borne noise, shall not exceed 55 dbA at 1.5 m from the lift shaft. Vibration resulting from operation of lifts shall not be perceptible in any occupied areas.

**b. Lift Cars Construction**

All elements of the lift cars construction shall be sufficiently rigid to avoid generation of noise by panel excitation as a result of movement. The total noise level in a moving lift car shall not exceed 55 dbA with the ventilation system operating. The contribution from the ventilation fan to the in-car noise level shall not exceed 50 dbA.

**c. Lift Machinery**

- i. The lift motors shall be fitted with vibration isolation mounting having a static deflection of at least 10 mm. Provision shall be made for the control of vibration transfer via electrical conduits and other flanking paths. The vibration isolation measures employed shall be sufficient to ensure that structure borne

noise resulting from the operation of the lift machinery is not audible in any occupied area.

- ii. Lift machinery noise levels under normal operating conditions shall not exceed 70 dBA at 1 m from the equipment in free-field.

**d. Arrival Chimes for Lifts**

- i. Noise from arrival chimes shall not exceed :
  - a) Main landings – 75 dBA
  - b) Other landings – 60 dBA
- ii. The above levels shall be measured at 3 m from the arrival chimes using a noise meter set to 'fast' response. Chimes with adjustable loudness shall be provided.

**M. CONTROLLER**

- a. Controllers shall be constructed in accordance with BS 587 and shall be mounted in ventilated steel cubicles with front hinged doors and removable rear hinged panels, in which all contactors, solenoids, relays and motor starting equipment shall be fitted.
- b. The controllers shall comply with the general requirements as stated in EN81/BS 5655, and in particular, the following features shall be included:
  - i. Non-combustible materials shall be used in the construction of the control equipment.
  - ii. The components shall be easily inspected, maintained, adjusted and replaced. Accessible cable terminal suitably marked with cable markers shall be provided for incoming and outgoing cables.
  - iii. Control circuits shall be connected between phase and neutral which are supplied through a double wound isolating transformer.
  - iv. The control circuits shall be protected by suitable rated over-current circuit breakers or HRC fuses independently of the main circuit's protection.
  - v. The brake solenoids and any retiring cams shall operate on direct current.
- c. A phase protection device shall be provided in the control cubicle of each lift to prevent the lift car moving in the event of phase reversal and loss of phase due to any reason whatsoever. This device, when actuated, shall illuminate a visual indicator on the control cubicle as well as central supervisory system until the fault has been rectified.

**N. ELECTRIC TRACTION LIFT**

- a. Drive System
  - i. Variable Voltage and Variable Frequency (VVVF) Drive System
    - a) The drive system shall be full solid state microprocessor-based comprising converters, inverters with digital regulators etc. to drive the respective AC induction traction motor using pulse width modulation (PWM) control.
    - b) The drive shall provide quiet and smooth operation with high degree of leveling accuracy, high efficiency (low power consumption) and good power factor under all load condition and direction of travel.

- c) Isolation and/of filtration device/circuits shall be provided to effect noise control and also to minimize the harmonic distortion to the AC power supply source such as the distortion is restricted to less than 5% of the operation current waveform.
- b. Solid State Drive System
  - i. A full solid state drive unit of appropriate design shall be provided for each DC lift to affect voltage control by means of supplying a uniformly varying DC voltage to each lift motor.
  - ii. Conversion from 3 phase AC voltage to variable DC voltage shall be accomplished by means of back-to-back power converters using thyristors or by means of two parallel bridges of three pairs of silicon controlled (SCR) or other acceptable means. Close loop control system shall be employed to provide positive, smooth response at all speeds and loads.
  - iii. The solid state drive units shall be suitable for operation on 400V +/- 10%, 50Hz AC supply and shall each be rated to suit the running and accelerating conditions of the associated lift motor. The drive units shall be suitable for operation in ambient temperature up to 50 degree Celsius and relative humidity of 100%.
  - iv. Each drive unit shall comprise solid state plug-in type modules, main contactors, reed switches, indicating lamps, filters, wiring and other necessary components all housed in a compact free-standing steel cabinet with perforated doors complete with necessary ventilation fans. The construction of the cabinets shall be similar to that specified elsewhere for equipment panels.
  - v. Protective devices shall be provided for each drive unit to shutdown the lifts concerned upon sensing of a phase reversal or single phasing.
  - vi. Each drive unit shall be provided with the necessary isolating transformer, suppression and filtration devices etc. to reduce the harmonic distortion to the levels as well as to reduce the noise to acceptable level.
  - vii. Should distortion levels be considered excessive, power filtration device and power factor correction equipment etc. shall be supplied and installed as determined by the Supervision Consultant.
- c. Driving Machinery
  - i. Machines shall be arranged either by the side or at the top of the lift shafts. They shall be mounted on steel beams or channels furnished in place with any necessary bearing plates. All steel beams or channels shall be securely fastened to R.C. supports/walls.
  - a) DC Machine:
    - A specially designed slow speed DC shunts motor for traction use.
    - Motor shaft directly coupled to driving sheave with or without the use of gearing.
    - The motor, electro-mechanical brake and sheaves are all mounted on a common steel bedplate.

b) AC Machine:

The machine shall be single-wrap traction type of approved design comprising:

- A specially designed AC three phase squirrel cage induction motor suitable for traction and intended use.
  - The motor shaft coupled to driving sheave with or without the use of gearing.
  - The motor, electro-mechanical brake, reduction gear if any, steel sheave shaft and traction sheave to be all mounted in proper alignment on a common steel bedplate.
  - Taco generator for velocity feedback.
- ii. The lifting motors shall be AC induction type or DC motor (whichever is applicable) to BS 4999 and BS 5000: Part 99 with an insulation level of Class F and shall be designed to operate for an unlimited period according to the expected duty of the lifts. The motors shall be supplied and controlled by static elements.
- iii. Means shall be provided to limit the starting current to not more than 2.5 times full load current with a tolerance of plus 10% of the limit.
- iv. AC motors shall be capable of continuous operation under actual service conditions at any frequency between 48 and 52 Hz and any voltage variation between +/-10% of the nominal value. They shall be capable of delivering the rated torque when running at 70% nominal voltage for a period of 10 seconds without injurious overheating and under these conditions slip shall not exceed 10% percent.
- v. Motors shall be provided with single phase anti-condensation heaters wherever necessary. The heaters shall energize when the motor reenergizes and vice versa. Heater terminal should be in separate terminal boxes with approved warning labels but may be located within the motor terminal box provided they are isolated from other connections, shrouded and clearly marked.
- vi. Bearings shall be of sleeve ring type with oil ring bearings. Gear cases shall be provided with journal and thrust bearings suitable for the application.
- vii. For geared lift machines, smooth wheel shall be fitted to the shaft of the hoist machines to raise the lift cars up and down by manual operation. The direction of car movement shall be clearly indicated on the machine.
- viii. If the wheels are removable, they shall be located in easily accessible positions in the machine rooms.
- ix. For gearless lift machines, emergency electrical switches with directional push buttons to protect against accidental operation shall be installed in the machine room.
- x. Whenever the emergency electrical switches are operated, the cars shall be moved up or down with speed not exceeding 0.63 m/s by constant pressure on the directional push buttons.

- xi. The emergency electrical switch and the push buttons shall be so placed that the machine can readily be observed during operation.
- xii. A prominent notice shall be provided stating that hand winding shall only be undertaken by authorized person and detailing step-by-step procedures to be taken to move the lift in case of emergency.
- xiii. Electro-mechanical brakes shall be provided to stop lift machines when the cars are travelling at rated speed with 125% of the rated load. The brake shall only be released by a manual operated device.
- xiv. Motors shall be rated at 180 starts per hour or better in general. For lifts with speeds between 0.5 m/s and 1.0 m/s, 150 starts per hour or better shall be required. For lifts with speeds below 0.5 m/s, 90 starts per hour or better shall be required.

d. Suspension System

Cars and counterweights shall be suspended by steel wire ropes which shall comply with the following requirements:

- i. The nominal diameter of the rope shall be at least 9 mm and 7 mm for governor ropes.
- ii. The tensile strength of the wires shall be:
  - 1570 N/mm<sup>2</sup> or 1770 N/mm<sup>2</sup> for ropes of single tensile
  - 1370 N/mm<sup>2</sup> for outer wires and 1770 N/mm<sup>2</sup> for inner wires of ropes of dual tensile.
- iii. The minimum number of ropes shall be three, which shall be independent.
- iv. The ratio between the pitch diameter of sheaves or pulley and the nominal diameter of the ropes shall be at least 40, regardless of the number of strand.
- v. The factor of safety for the ropes shall be not less than 10.
- vi. The strength of rope terminations shall be at least 80% of that of the rope.
- vii. The specific pressure of the ropes in the traction sheave grooves shall conform to the requirements as detailed in EN81 and ASMA A17 and Local India-Delhi Authority.
- viii. Other characteristics shall be in accordance with BS 329 "Steel wire ropes for electric lift".

An automatic device shall be provided to equalize the tensions of the suspension ropes.

For goods lifts, the design of the supporting and suspension systems shall be adequately sized to sustain the highest roll-over load of a laden manual operated trolley/forklift entering/leaving the car platform. The total weight of the laden trolley/forklift shall be equal to the rated load of respective elevators and be carried by two axles. The maximum load to be carried by on axle shall be 80% of the laden trolley/forklift weight and the maximum eccentricity of loading shall be based on the laden trolley weight being off center laterally ¼ of the clear platform entering/leaving onto the entrance



edge of the platform.

Compensating ropes shall be provided for lift travels over 30 m:

<u>Rated lift speed (m/s)</u>	<u>Compensation means</u>
< 2.5	Quiet operating chains
<sup>3</sup> 2.5 and < 2.5	Steel wire rope with an idle tension pulley in lift pit
<sup>3</sup> 2.5	Ditto but with a lock down arrangement of idle tension pulley to prevent counterweight jumping on application of car safety gear

e. Counterweight

- i. The counterweights shall be of cast iron construction and secured within a steel frame, and shall be equal to the weight of the complete car plus 40% to 45% (approximately) of the contract load.
- ii. At least four renewable guides' shoes shall be provided on the counterweights.
- iii. If pulleys are provided on the counterweights, then safety devices shall be incorporated to avoid:

**O. The suspension of ropes, if slack, leaving the grooves.**

- a. The introduction of objects between ropes and grooves.

Such safety devices shall not hinder inspection or maintenance of the pulleys.

A suitable guard shall be fixed in the lift pit around the path of the counterweight. Such guard shall extend from a height of not more than 300 mm above the floor of the lift pit to a height of not less than 2500 mm.

## **CHAPTER P**

### **TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING**

#### **1.01 FIRE FIGHTING WORKS:**

##### **FIRE PROTECTIONS**

##### **1. SCOPE OF WORK**

The scope of work covers the supply, installation, testing & commissioning of Fire Fighting Wet Riser Hydrant & Sprinkler system proposed for the proposed complex. It will be the responsibility of the Contractor to get all approval and completion certificate from the Local Fire Department without which the work will not be taken over by the owner. Fee payable to the local bodies for such activities shall also be borne by the owner on production of receipts for money paid and the all other expenses barring the fee will be borne by the contractor.

##### **2. TENDER DRAWINGS**

For guidance of the bidder, drawings as listed in Annexure are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer and get the same approved by Local Fire Authority/other statutory bodies. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer/ Local Fire Authority.

##### **3. SHOP DRAWINGS**

The contractor shall prepare and furnish all shop drawings in quadruplicate at no extra cost for approval by the Engineer before commencing fabrication/ manufacture of the equipment. Such shop drawings shall be based on the Architect drawings and requirements laid down in the specifications and as per site conditions. The manufacture of equipment shall be commenced only after the shop drawings are approved in writing by the Engineer. Such drawings shall be co-ordinate with all disciplines of work.

##### **4. COMPLETION AS BUILT DRAWINGS**

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer. General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories "As installed". These drawings shall in particular give the following:

- a. General layout of pump house
- b. Panels and other equipment location and sizes etc.
- c. Complete schematic as installed.
- d. Location of Hydrants, Earth pipes, route of earthing conductors etc.
- e. Route of all cables and pipes run along with detail sizes and mode of installation.

##### **5. DOCUMENTS**

The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

- i. Warranty for equipment installed.
- ii. Test certificates

- iii. History sheets of the equipments
- iv. Catalogues
- v. Operation and maintenance manuals
- vi. List of recommended spares and consumables
- vii. Reconciliation statement
- viii. All approvals and sanctions

#### **6. SANCTION/ APPROVALS FROM STATUTORY AUTHORITIES/ LOCAL FIRE AUTHORITY**

The contractor shall be fully responsible and shall carry out following activities:-

- a. Submission of working drawing
- b. Obtaining the approval of drawings
- c. Arranging inspection of site by officials of the Authority
- d. Obtaining the final no objection/ completion certificate after submitting documents.
- e. Any other statutory approvals required.

#### **7.MANUFACTURING**

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

#### **8. MAKE OF MATERIALS**

Only approved make of material shall be used. The contractor shall get the samples of all the items approved from the consultant or project incharge engineer before commencing the supply.

#### **9. MANUFACTURER INSTRUCTION**

Any specific instruction furnished by manufacture covering the points not mentioned in technical specifications of the tender shall be brought to the notice of project incharge engineer in writing for further instructions in this regard at the time of tendering.

#### **10. MATERIAL TESTING**

The project incharge engineer shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

#### **11. INSPECTION AND TESTING**

- a. All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/ directed by engineer.
- b. Contractor shall perform all such tests as may be necessary to meet requirements of Local Authorities, Municipal or other statutory laws/ bye-laws in force. No extra shall be paid for these.
- c. The project incharge engineer may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.
- d. Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

**12. TRAINING OF DEPARTMENT PERSONNEL**

- a. The contractor shall train the owner's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).
- b. The period of training shall be adequate and mutually agreed upon by the engineer and contractor.
- c. The owner's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- d. Nothing extra shall be paid to the contractor for training owner's personnel.

**13. PERFORMANCE GUARANTEE**

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the owner against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the owner.

- a. Any defective material or equipment supplied by the contractor.
- b. Any material or equipment supplied by the owner which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

**1.02 PIPING FOR WET RISER SYSTEM****1. SCOPE**

This section covers the details of requirement of piping used in wet riser system, including the associated auxiliary equipment.

**2. GENERAL**

The wet riser system shall remain pressurized at all times during operation, and as such the piping work shall be carried out to withstand the same.

**3. PIPES AND FITTINGS**

Pipes for Wet Riser system shall be of black steel conforming to IS: 1239 (Heavy Class). Fittings for black steel pipes shall be malleable iron suitable for welding or tapered screwed threads.

**4. JOINTING**

Joint for black steel pipes and fittings shall be metal to screw grid up to 50 mm dia and above 65 mm dia welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. Hold tight will be use for threaded pipes joint.

All the welding shall be radiographically tested. Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

**5. DIA OF FLANGE AND HOLE CONFORMING IS:**

Size of pipe →	80 mm	100 mm	150 mm	200 mm	300 mm
Dia of flange →	200 mm	220 mm	285 mm	340 mm	445 mm
Dia of bolt →	16 mm	16 mm	16 mm	16 mm	16 mm
No. of hole →	4	4	8	8	12

**6. PIPE PROTECTION**

- a. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.
- b. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous pypkote or Hessian cloth and finished with one coat of hot bitumen paint.

**7. PIPE SUPPORTS**

All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structurals e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red lead and two coats of black enamel paint. Where inserts are not provided the contractor shall provide anchor fasteners.

Pipe Support Spacing	Horizontal	Vertical
Pipe up to 50 mm	2 Mtr.	3 Mtr.
Pipe 65 – 100 mm	1.75 Mtr.	3 Mtr.
Pipe above 100 mm	1.50 Mtr.	3 Mtr.

**8. ORIFICE FLANGES**

Contractor shall provide orifice flanges fabricated from 6 mm thick stainless steel plates on the branch lines feeding different zones/ floors so as to allow required flow of water at 3.5 Kg/ sq.cm. Pressure. The contractor shall furnish design for these orifice flanges.

**9. AIR VESSEL AND AIR RELEASE VALVE**

Air vessel fabricated out of at least 8 mm thick steel to withstand the pressure, with dished ends and supporting legs shall be provided as approved scheme. This shall be of 250 mm dia and 1 m high. This shall be completed with necessary flange connection to the wet riser piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be of continuous welded construction and painted with red Colour. This shall be tested for twice the working pressure. Air release valve shall be provided on top of each wet riser.

**10. VALVES, GAUGES AND ORIFICE PLATES**

Butter-fly or Sluice valves above 50 mm shall be of cast iron body and bronze/ gunmetal seat. They shall conform to type PN 16 of IS: 13095,780, valves up to 65mm shall be of gunmetal construction. Valve wheels shall be of right hand type and have an arrowhead engraved or cast thereon the direction for turning open and closing.

Non-return valves shall be of cast iron body and bronze/ gunmetal seat. They shall be swing conform to Class 1 of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

Pressure gauge of suitable range shall be installed on the discharge side of each pump. Vacuum gauge shall be provided on suction side for pumps with negative suction. The dial size shall be 250 mm. The gauges shall have brass cocks.

Orifice plates shall be of 6 mm thick stainless steel to reduce pressure on individual hydrants to operating pressure of 3.5-kg/ sq.cm. Design of the same shall be given by the contractor as per location and pressure condition of each hydrant.

**11. EXTERNAL YARD HYDRANTS**

External yard hydrants shall be of 'Stand Post' type conforming to IS: 908 and comprise stand post for single or double (as per specified in boq) outlet, duck foot bend, flange riser and single headed brass/ gunmetal or (as per specified in boq) valve conforming type A of IS: 5290.

The stand post column shall be of cast iron, cast in one piece, conforming to grade 20 of IS: 210 or M.S. pipe. The internal diameter at the top shall be at least 80 mm.

The outlet shall be angled towards ground, with instantaneous spring lock type gunmetal female coupling of 63 mm dia. For connecting to hose pipe.

## **12. INTERNAL HYDRANTS**

The internal hydrant outlet shall comprise double-headed double outlet or as per B.O.Q. gunmetal or SS landing valve' conforming to type A of IS: 5290. Separate valves one on each of the two heads shall form part of the landing valve construction.

A brass cap with chain is provided on one head of the outlet which will have an instantaneous pattern female coupling for connection to the hose pipe. The landing valve shall be fitted to a tee connection on the wet riser at the landing.

## **13. FIRST AID HOSE REEL EQUIPMENT**

First aid hose reel equipment shall comprise reel hose guide fixing bracket, hose tubing globe valve, stopcock and nozzle. This shall conform to IS: 884. The hose tubing shall conform to IS: 1532.

The hose tubing shall be 20 mm dia and 36 m long. The gunmetal / brass nozzle of 5mm and globe valve shall be of 25 mm size.

The fixing brackets shall be of swinging type. Operating instructions shall be engraved on the assembly.

## **14. HOSE PIPES, BRANCH PIPES AND NOZZLES**

Hose pipes:- Hose pipes shall be rubber lined woven jacketed 63 mm in diameter and 15 m long. They shall conform to controlled percolation type comply with IS:8423 or type A (reinforced rubber lined ) of IS: 636 . The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose pipe shall be complete with necessary coupling at the ends of match with the landing valve or with another run of hose pipe or with Branch pipe.

The coupling shall be of instantaneous spring lock type.

Branch pipe: - Branch pipe shall be of copper, gunmetal or aluminum alloy 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

Nozzle: - The nozzle shall be of copper or gunmetal, 20 mm in internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with the nozzle spanner.

End couplings, branch pipes, and nozzles shall conform to IS: 903. Each hydrant point will be provided with two hoses of 15 m each and one gunmetal branch pipe.

## **15. HOSE CABINET**

The hose cabinet to accommodate the hosepipes, branch pipe nozzle and the hydrant outlets shall be fabricated from 1.5 mm thick sheet steel. In case of internal hydrants, this shall accommodate the hose reel equipment also. This shall have lockable, center opening glazed doors.

The scope of work includes provision of masonry or steel frame structure, as specified for installation. The hose cabinet shall be painted red stove enameled.

#### **16. FIRE BRIGADE INLET CONNECTIONS/ DRAW OFF CONNECTION**

One set of 2/4 ways collector head Fire Brigade connection shall be provided at under ground tank, sprinkler system and individual wet risers as specified.

The inlet to the wet riser sprinkler header shall be with 150 mm dia butterfly or sluice valve and non-return valve. The scope shall include necessary reducers, tees bends and special fittings as required.

It should be provided with M.S. enclosure fabricated from 1.5 mm thick M.S. sheet, front glass locking arrangement supported on M.S. structural members, painting with two coats of postal red enamel.

### **1.03 ELECTRIC DRIVE, HORIZONTAL FIRE PUMPS**

#### **1. SCOPE OF WORK**

- a. Work under this section shall consist of furnishing all labour, materials, equipment and appliance necessary and required to completely install electrically operated pumps as required by the drawings and specified hereinafter or given in the schedule of quantities.
- b. Without restricting to the generality of the foregoing, the pumps and ancillary and accessories.
  1. Electrically operated pumps with motors, base plates and accessories.
  2. Alarm system with all accessories wiring and connections.
  3. Pressure gauges with isolation valves and piping bleed and block valves.
  4. M.S. pipes, valves, suction strainers, delivery headers and accessories.
  5. Foundations, vibration eliminator pads and foundation bolts.

#### **2. QUALITY CONTROL**

- a. These shall comply with the IS codes as specified.

#### **3. SUBMISSIONS**

- a. Product Manuals
- b. Hydraulic Details

#### **4. STORAGE**

- a. These shall be stored as delivered in original packing.

### **1.04 FIRE, SPRINKLER AND JOCKEY PUMPS**

#### **1. PUMPING SETS**

- a. Pumping sets shall be multi stage horizontal split casing centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings.
- b. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.
- c. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.
- d. Pumps shall be provided with approved type of mechanical seals.

- e. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- f. The pump shall meet the requirements of the Tariff Advisory Committee and N.B.C.and N.F.P.A. and the unit shall be design proven in fire protection services.

## **2. ELECTRIC DRIVE**

- a. Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.
- b. Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- c. Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.
- d. Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee. and N.B.C.and N.F.P.A.
- e. Motors shall be suitable for 415 volts, 3 phase 50 cycles a/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.
- f. Motors shall be designed for two-start system
- g. Motors shall be capable of handling the required starting torque of the pumps.
- h. Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- i. Speed of the motors shall be compatible with the speed of the pump.

## **3. AIR VESSEL**

- a. Provide one air vessel fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 1000 mm high and tested to 20 kg/ sq. cm pressure.
- b. The fire pumps shall operate on drop of pressure in the mains as given below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.  
cm automatically

## **4. VIBRATION ELIMINATORS**

- a. Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

## **5. INSTALLATION**

- a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- b. Pumps and motors shall be truly aligned by suitable instruments.



- c. All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.
- d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Consultant or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the owners.
- f. Each pump shall be provided with a pressure gauge as per requirement, isolation cock and connecting piping, bleed and block valve.
- g. Provide vibration eliminating pad and connectors for each pump.

The contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

#### **1.05 DIESEL DRIVE, HORIZONTAL FIRE PUMPS**

##### **1. SCOPE OF WORK**

- a. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install diesel driven pumps as required by the drawings, specified hereinafter or given in the schedule of quantities.
- b. Without restricting to the generality of the foregoing, the pumps and ancillary equipment shall include the following:
  - 1. Diesel driven pumps with motors, base plates and accessories.
  - 2. Alarm system with all accessories, wiring and connections.
  - 3. Pressure gauges with isolation valves and piping bleed and block valves.
  - 4. M.S. pipes, valves, suction strainers, delivery headers and accessories.
  - 5. Foundations, vibration eliminator pads and foundation bolts.

##### **2. QUALITY CONTROL**

- a. These shall comply with the IS codes as specified.

##### **3. SUBMISSIONS**

- a. Product Manuals
- b. Hydraulic Details

##### **4. STORAGE**

- a. These shall be stored as delivered in original packing.

#### **1.06 FIRE, SPRINKLER AND JOCKEY PUMPS**

##### **1. PUMPING SETS**

- a. Pumping sets shall be multi stage horizontal split casing centrifugal pump having single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease-lubricated bearings.

- b. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced dynamically and statically.
- c. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.
- d. Pumps shall be provided with approved type of mechanical seals.
- e. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- f. The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.

## 2. DIESEL ENGINE

- a. Diesel engine shall be of 6 cylinders with individual head assemblies. The engine shall be water-cooled and shall include heat exchanger and connecting piping, strainer, isolating and pressure reducing valves, bye-pass line complete in all respects.
- b. Engine shall be direct injection type with low noise and exhaust emission levels.
- c. The speed of the engine shall match the pump speed for direct drive.
- d. The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg. C and shall take full load within 15 seconds from the receipt of the signal to start.
- e. The Engine shall efficiently operate at 38 deg. C ambient temperature at 50 m above mean sea level.
- f. Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 m distance.
- g. The engine shall be self starting type up to 4 deg. C and shall be provided with one 24 V heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.
- h. Provided a battery recharger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator.
- i. Annunciation panel shall be suitable for working on 24 volts D.C. Arrangement for starting shall be automatic on receiving the signal but shutting off shall be manual.
- j. The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.
- k. Engine shall be suitable for running on high speed diesel oil.
- l. The system shall be provided with a control panel with push button starting arrangement also and wired to operate the engine on a differential pressure gauge.
- m. The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.
- n. Provide one fully mounted and supported day oil tank fabricated from 5mm thick M.S. sheet electrically welded with a capacity of 8 hours working load but not less than 600 lit. Provide level indicating gauge glass on the day oil tank and low fuel indication of the control panel.

- o. Provide one exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions.
- p. Provide all accessories fittings and fixtures necessary and required for a complete operating engine set.
- q. Contractor shall indicate special requirements, if any, for the ventilation of the pump room.

### 3. OPERATING CONDITIONS FOR FIRE & SPRINKLER PUMPS

		Cut in	Cut out
Operating pressure		9.0 Kg/ sq.cm	
Jockey pump		7.5 Kg/ sq.cm	9.0 Kg/sq.cm
Fire Electrical Pump	1	6.5 Kg/ sq.cm	automatically
Diesel Engine driven pump	3	5.50 Kg/ sq.cm	manual

Note: The diesel pump shall start automatically, on fall of pressure in the pipe line, in the absence of electric supply, but the stopping shall be manual.

1. Jockey pump shall start and stop through pressure switch automatically.
2. Jockey pump shall stop when main pump starts.
3. Main pump shall start automatically on fall of pressure but stopping shall be manual.

### 4. VIBRATION ELIMINATORS

- a. Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

### 5. INSTALLATION

- a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- b. Pumps and motors shall be truly aligned by suitable instruments.
- c. All pump connections shall be standard flanged type with appropriate number of bolts. In case of nonstandard flanges companion flanges shall be provided with the pumps.
- d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Architect or their authorized representative of inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the owners.
- f. Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.
- g. Provide vibration eliminating pad and connectors for each pump.

- h. The contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

### **1.07 POWER AND CONTROL PANEL AND OTHER CONTROL COMPONENTS**

#### **1. SCOPE**

This section covers the detailed requirements of the power and the control panel for the wet riser system, and also for the various control components in the system.

#### **2. POWER AND CONTROL PANEL CONSTRUCTIONAL REQUIREMENTS**

- a. **GENERAL FEATURES:-** The power and control panel shall be totally enclosed dust and vermin proof free standing floor mounted cubicle type, fabricated out of sheet steel not less than 2 mm thick. Where ever necessary, additional stiffening shall be provided by angle iron framework. General construction shall be of compartmentalization and sectionalisation such as mains incomer, electric fire pump, diesel fire pump, pressurization such as mains incomer, electric fire pump, diesel fire pump, Jockey pump and control, so that there is no mix up of power and control wiring and connections in the same sections as far as possible. The panel shall be front operated type with all connections accessible from the front. Front doors shall be hinged type. Back doors shall be hinged type or removable type for inspection. The door hinges shall be of concealed type, the doors shall be provided with quick fixing doors knobs with indication. The general arrangement of the panel shall be got approved before fabrication. The cubical construction shall be to IP 21 as per IS: 2147, painted with approved make and shade stove enamel paint, aluminum identification plate for each compartment danger plate surrounding of bus bar and live contact parts, wiring diagram etc. red, white or black enamel coated aluminum plate to be fixed on visible location.
- b. **CABLE ENTRIES AND GLAND PLATES:-**All cable entries shall be through double compression plates which are removable and stationarised. Necessary compression type glands shall also be provided. Where heavy cables are brought in and terminated, suitable clamps shall be incorporated to relieve the stress on the glands due to the weight of the cable. Cable entries may be from top or bottom depending on the equipment layout and cable scheme as approved.
- c. **BUS BAR AND CONNECTIONS:-**The bus bars shall be air insulated and of aluminum of high conductivity electrolytic quality (grade E 91 E to IS 5082) and of adequate cross section. Current density shall not exceed .8 sq.mm per amps. sq.cm. All connections to individual, circuits from the bus bars shall preferably be with solid connections. The bus bar and the connections shall be suitable covered with PVC sleeves or in an approved manner. Bus bars shall be suitably support using non hygroscopic insulated supports such that they may stand 50 KA RMS symmetrical current for one second. High tensile bolts and spring washers shall be provided at bus bar joints with red, yellow paint and neutral with black color paint.
- d. **EARTHING ARRANGEMENT:-** GI strip 50 mm x 5mm shall be run at the rear of the board, bonding all the sections suitably. 2 nos. earth terminals shall be provided at the ends of the GI strip for connection to earth system. Earth terminals shall be with a flexible loop and the hardware shall be of GI or passivated and plate iron.
- e. **TERMINAL BLOCKS AND SMALL WIRING:-**Terminal blocks shall be of heavy duty type and generally not less than 15 Amps 250 V grade up to 100 V, and 600 V grade for the rest of the functions. They shall be easily accessible for maintenance. All control wiring inside the panel shall be with PVC insulated copper conductor of 2.5 sq.mm size and 600 V grade conforming to IS: 694. Suitable color coding may be adopted. Wiring harness

shall be neatly formed and run preferably function wise, and as far as possible segregated voltage wise. Identification ferrules shall be used at both ends of the wires.

### **3. INSTRUMENTS AND LAMPS:**

All indication lamps and instruments shall be flush mounted type in front of the panel. The voltmeter and ammeter shall be of size 10 mm conforming to clause 1.5 of 1248 for accuracy.

Current transformers shall be provided with ammeters, wherever necessary.

Indicating lamps to indicate the availability of electric supply shall be provided at the incoming section. Necessary indicating lamps for alarm indications and battery charging shall be provided in the respective sections.

All indicating lamps and voltmeter shall be protected with HRC cartridge type fuses.

- a. Labels: - All internal components shall be provided with suitable identification labels. Aluminum sheet engraved labels shall be fixed at the panel for all switches, instruments, push buttons, indicating lamps, danger plate etc.
- b. Painting: - The entire panel shall be given a primer coat of red after degreasing and phosphating treatment and 2 coat of powder/ stove enameled paint of approved shade before assembly of various items.

### **4. EQUIPMENT REQUIREMENTS**

- a. General: - The power and control panel shall comprise individual section for the various equipment of the system and controls, in a combined cubical type design. Where particularly specified, totally independent panels for each equipment shall be provided in cubical design and the main equipment panel and the individual panels in such a case shall incorporate isolation arrangement of appropriate capacity. All MCCBs shall be to AC 23 duty to IS: 2516.
- b. Incomer section: - The incoming section shall comprise
  - i. Moulded case circuit breaker with Electronic release, ammeter, voltmeter, selector switch set of phase indication lamps.
  - ii. Aluminum bus bars
  - iii. TP & N outgoing Moulded case circuit breaker with Electronic release for electric fire pump
  - iv. TP & N outgoing Moulded case circuit breaker with Electronic release for Jockey pump.
  - v. TP & N outgoing Moulded case circuit breaker with Electronic release for battery charger unit control.
  - vi. TP & N outgoing Moulded case circuit breaker with Electronic release (spares)

Note: - Terminal blocks, inter-connections, labels etc. as necessary.

### **5. ELECTRIC FIRE PUMP SECTION: -**

This section shall incorporate the following facilities.

- i. TP & N Moulded case circuit breaker
- ii. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- iii. Starter unit, current transformer and ammeter

- iv. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.
- v. Pump lock out devices due to faults or abnormalities as specified.
- vi. Visual/ audio alarms, indications and communications facility as specified.
- vii. Necessary inter-connection control and power cable work, cable glands, lungs and internal wiring and connections.

#### **6. ENGINE SECTION: -**

The engine section shall incorporate the following facilities.

- i. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- ii. Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.
- iii. Engine shut down and block out devices due to faults or abnormalities as specified.
- iv. Visual/ audio alarm indication and enunciator facility as specified.
- v. Inter- connection control and power cable work, cable glands, lungs, all internal wiring and connection etc.

#### **7. AUXILIARY PUMP SECTION: -**

Each of the auxiliary pump section for priming pump shall incorporate the following:

- i. TP&N Moulded case circuit breaker
- ii. Control system components such as relays, timers, contractors etc. as are necessary for functional requirements.
- iii. Starter unit, current transformer and ammeter
- iv. Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.
- v. Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.
- vi. Low water level alarm for terrace tank, where provided.

#### **8. CONTROL SECTION: -**

This section shall incorporate the following:

- i. Control components integrating the various sections, so as to satisfy the functional requirements.
- ii. Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.
- iii. Visual/ audio alarms not covered in individual sections.
- iv. Lamps healthy test facility.
- v. Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.
- vi. Test facility to stimulate operation of hydrants.

## 9. OTHER CONTROL COMPONENTS

### a. Pressure Switches:

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at present pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

### b. Low water level indication and switch:

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level audiol alarm. This should indicate the level of water at different stages is the power and control panel.

### c. Power Supply for Controls:

In order ensure that the control systems remains operational at all times, the control system shall be designed for 24V DC operation, fed from 24 V dry maintenance free battery. This shall be independent of the starting battery for the engine i.e., battery shall remain trickle charged at the times from the common battery, charges at the control section.

## 10. MAINTENANCE MANUAL

- 10.1 On completion of the entire work and successful commissioning, contractor shall hand over four copies of maintenance manuals of all equipment installed by him.
- 10.2 Maintenance manuals shall include information relating to make, model Number, year of manufacture for all electrical and mechanical equipment with names of local suppliers or manufacturers' agents.

## MEASUREMENTS

- 11.1 Pumping sets, air vessel, switchboard cubicle, pressure switch, fire alarm shall be measured by number and shall include all items necessary and required and given in the specifications.
- 11.2 Earthing shall be measured as a lump sum item.
- 11.3 Earthing tape will be linear measurement.
- 11.4 Cabling shall be measured per linear meter from switchboard to each motor and shall include all items necessary and required and given in the specifications.

## 1.08 INSTALLATION AND TESTING

### 1. SCOPE

This section covers the requirements of installation of the various components of the wet riser system.

A survey of the site of the work shall be made by the contractor before preparation of the detailed drawings for submission to the department for approval. The installation shall be carried out strictly in accordance with the approved drawing.

The scope of installation work shall include the following, where or not expressly mentioned in the schedule of work.

- i. Cement concrete (1:2:4 mix) foundation for all pump sets

- ii. Vibration isolation arrangement for all pump sets
- iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes
- iv. Necessary supports and clamps for wet riser pump room
- v. Necessary supports and camps for wet riser plumbing the building
- vi. Supporting bracket/ frame work for the fuel oil tank of the engine
- vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.
- viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are not strong enough to support the pipes, thereby likely to cause different settlement.
- ix. Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.
- x. Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.
- xi. Valve chambers of approved design with external (yard) hydrant.
- xii. Ground level hydrants of approved design, where specified.
- xiii. Cutting and making good the damages for the installation work of the riser system
- xiv. All the required control piping, exhaust piping from engine to outside, oil piping for fuel oil and lubricating oil for the engine, drain piping from the pumps to the drain point in the pump room, overflow piping from priming tank to the sump. The piping work shall include all necessary fittings, valve and accessories for effective functional requirements.
- xv. Inter-connecting cable work with controls, control panel, batteries etc. including battery leads.
- xvi. Orifice plates at individual hydrants as required.

Where provision of MS pipe shall below ground become inescapable, it shall be protected from soil corrosion by two coats of bitumen painting and wrapped with bituminous Hessian cloth and finish with hot bitumen paint.

Each MS pipe shall be subjected to hydraulic pressure test before installation, in presence of the Engineer or his authorized representative.

External (yard) hydrants shall be located at least 2m away from the face of the buildings but not more than 15m and be accessible.

Where external hydrants below ground level are specifically indicated in tender specifications, there shall be enclosed in masonry trenches of size 75sqcm and 8cm above ground level. The hydrant shall be within 8cm from the top of the enclosure.

Necessary facility for draining the rise pipe shall be provided at ground floor level with 50mm size sluice valve.

Internal hydrant at each floor shall be located at about 1m above floor level.

Valve chambers shall be of 1sqm in size, with cover.



## **2. HOSES AND HOSE CABINET**

All hoses shall be numbered and a record submitted with completion plane. The number and length shall be easily recognizable on each hose pipe.

External hose boxes shall be installed such that the hose is not exposed to sun rays.

## **3. PAINTING**

Painting of the entire wet riser piping over the ground shall be done with anticorrosive primer and 2 coats of approved paint. The color shall be red to shade No. 536 of IS: 5, Paint shall conform to IS:2932.

The pumps and engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

## **4. TESTING OF THE SYSTEM**

After laying and jointing, the entire piping shall be tested to hydrostatic test pressure. The pipes shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a period of not less than 24 hours and then tested under pressure. The test pressure shall be 14 kg/cm<sup>2</sup>. The test pressure shall be applied by means of manually operated test pump or by a power driven test pump to be provided by the contractor. In either case precautions shall be taken to ensure that the required test pressure is not exceeded.

The open end of the piping shall be temporarily closed for testing.

Test shall be conducted on each pump set after completion of the installation with respect of delivery head, flow and B.H.P. The test shall be carried out by the contractor at his own cost.

All leaks and defects in different joints, noticed during the testing and before commissioning shall satisfy the satisfaction of engineer.

Testing of fittings/ equipments shall be carried out either at site or at works in the presence of a representative of the engineer. Test certificates shall also be furnished by the contractor.

The automatic operation of the system for the various functional requirements and alarms as laid down in his specification shall be satisfactory carried out on pressure of the engineer.

## **5. APPROVAL BY LOCAL BODIES**

It shall be the responsibility of the contractor to obtain the approval of drawings and to get the installation inspected and approved by the concerned authorities as may be necessary as per local by laws, any fee payable to the local bodies for such activities shall also be borne by the owner on production of receipts for money paid and the other expenses will be borne by the contractor.

## **6. PIPE WORK ASSOCIATED WITH DIESEL ENGINE**

Pipe works for fuel system, lube oil system and exhaust system shall be complete with all required supports, clamps, hangers etc. for a complete work.

Fuel feed is by gravity and the fuel tank shall be located at least 60cm above the fuel injection pump.

Fuel pipe of copper shall not be soldered but brazed or welded.

No valves or cocks shall be provided in the fuel feed line to engine from the fuel tank.

Precautions shall be taken to prevent any air locks in any part of the fuel system. No air relief cock shall be permitted and where inescapable, screwed plugs shall be provided for the purpose.

The installation of the fuel supply system shall be such that a completely primed condition is maintained, free from air lock.

Filters shall be provided in fuel oil and lube oil circuits allocations that are easily accessible for maintenance.

## **7. WET RISER PIPE WORK**

The suction line for each pump shall be independent.

No sluice valve shall be provided in situation line, where the pump is located above the water level in the sump foot valve and strainer shall however be provided.

Butterfly or Sluice valve shall be provided in situation line, where the pump is located below the water level in the sump, strainer at the suction end shall be provided.

Each external (yard) hydrant shall be controlled by a Butterfly or sluice valve at ground level.

Butterfly or Sluice valves shall be kept in open position and the scope of work includes provision of necessary leather strap and pad lock so as to prevent unauthorized closing of valve.

The installation work includes provision of all clamps, supports, anchors etc.

Clamps shall be provided on either side of the tee joints for internal hydrants. Necessary anchors/ thrust pads shall be provided as approved at locations of bends, tees etc. as required within the scope of work.

Under ground pipes of the wet riser system shall be laid 1m below ground level and at least 2m away from the face of the buildings. The run of piping shall be preferably along roads and footpaths and shall not be under buildings. Where specifically indicated to cross buildings, these shall be laid in masonry trenches with removable covers. With cut off valves at the entry and exit points.

## **1.09 TECHNICAL SPECIFICATIONS FOR SPRINKLER SYSTEM**

### **1.0 SPRINKLER HEADS**

a. Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly yoke and the deflector. The sprinklers shall be of approved make and type.

b. Types

i. Conventional Pattern

The sprinklers shall be designed to produce a spherical type of discharge with a portion of water being thrown upwards to the ceiling. The sprinklers shall be suitable for erection in upright position or pendant position.

ii. Spray Pattern

The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.

iii. Ceiling (flush) Pattern

These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.

## iv. Side Wall Sprinklers

These shall be designed for installation along with the walls of room close to the ceiling. The discharge pattern shall be similar to one quarter of sphere with a small proportion discharging on the wall behind the sprinklers.

## c. Constructions

- i. Bulb:- Bulb shall be made of corrosion free material strong enough to with stand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches a predetermined level.
- ii. Valve Assembly: - Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.
- iii. Yoke: - The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is to used in corrosive conditions.
- iv. Deflector: - The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.

## d. Colour Code

The following color code shall be adopted for classification of sprinkler according to nominal temperature ratings:

Sprinkler Temperature Rating	Color of the Bulb
57 deg. C	Orange
68 deg. C	Red
79 deg. C	Yellow
93 deg. C	Green
141 deg. C	Blue
182 deg. C	Violet/ Mauve
204/260 deg. C	Black

## e. Size of Sprinklers Orifices

The following sizes of sprinklers shall be selected for various classes or hazards.

Extra light hazard	10/15 mm nominal bore
Ordinary light hazard	15 mm nominal bore
Extra high hazard systems	30 sprinklers

## f. Stock of replacement sprinkler

The following spare sprinklers shall be supplied along with the system.

Extra high hazard systems	6 sprinklers
Ordinary hazard systems	24 sprinklers
Extra high hazard systems	36 sprinklers

g. Temperature Rating

For normal conditions in temperature climates rating of 68/74 deg. C shall be used. However the temperature rating shall be as closed as possible to, but not less than 30 deg. C above the highest anticipated temperature conditions.

## 2.0 PIPES AND FITTINGS

- Pipes for wet riser system shall be black steel conforming to IS: 1239 (Heavy Class).
- Fittings for black steel pipes shall be malleable iron suitable for welding or approved type cast iron fittings with tapered screwed threads.

### Jointing

Joint for black steel pipes and fittings shall be metal to metal tapered thread or welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints.

Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

### Pipe Protection

- All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.
- Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous Hessian cloth and finished with one coat of hot bitumen paint.

### Pipe Supports

All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structurals e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red and two coats of black enamel paint. Where inserts are not provided, the contractor shall provide anchor fasteners.

### Orifice Flanges

Contractor shall provide orifice flanges fabricated from 6mm thick stainless steel plates on the branch lines feeding different zones/ floors so as allow required flow of water at 3.5 kg/ sq.mm pressure. The contractor shall furnish design for these orifice flanges.

### Valves

Butterfly or Sluice valves of size 80mm and above shall be double-flanged cast iron conforming to IS: 780.

Check valve shall be of cast iron double flanged conforming to IS: 5312.

Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.

#### Air Valves

25mm dia screwed inlet cast iron single acting air valves on all high points in the system or as shown on drawings.

#### Drain Valves

50 mm dia black steel pipe conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

### 3.0 INSTALLATION CONTROL VALVE:-

Installation control valves shall comprise of the following.

- a. One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut
- b. One automatic alarm valve, fitted with handle and cover.
- c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.
- d. One combined waste and testing valve including 5 mtr of tubing and fittings
- e. Alarm stop valve
- f. Strainer
- g. Drain plug
- h. Padlock & strap
- i. Wall box for installation of valve

### 4.0 PRESSURE GAUGES:-

Burden type pressure gauges conforming to IS/ BS specifications shall provided at the following locations.

- a. Just above alarm valve
- b. Just below alarm valve, on the installation stop valve
- c. One pressure gauge on delivery side of each pump
- d. Required number of pressure gauges on pressure tank

### 5.0 INSTALLATION OF PIPING

- A. Below ground piping: -Under ground piping should be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. Wherever pipes pass through roads/ pavements shall be protected against corrosion with two coats of bituminous painting and wrapped with pykote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.
- B. ABOVE GROUND PIPING: -
  - a. All above ground piping shall be installed on suitable to pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.
    - i. 20 mm to 32 mm dia 2 mtr

- |      |                     |          |
|------|---------------------|----------|
| ii.  | 40 mm to 65 mm dia  | 2 mtr    |
| iii. | 65 mm to 100 mm dia | 1.75 mtr |
| iv.  | Above 150 mm dia    | 1.50 mtr |
- b. Piping shall be so installed that the system can be thoroughly drained. All the pipes shall be arranged to drain to the installation drain valve. In case of basement and other areas where the pipe work, is below the installation drain valve / auxiliary valves of the following sizes shall be provided.
- |      |  |
|------|--|
| i.   | 20 mm dia valve for pipes up to 50mm dia         |
| ii.  | 25 mm dia valve for 65 mm dia pipes              |
| iii. | 32 mm dia valves for pipes larger than 65 mm dia |
- c. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 50 mm of larger diameters.
- d. The piping shall be pressure tested by the hydrostatic method upto a pressure of 1.5 times the working pressure the piping shall be slowly charged with water so that all the air is expelled from the piping by providing a 25mm inlet with a stop cock. The piping shall be allowed to stand full of water for a period of 2 hours and then the piping shall be put under pressure by means of manually operated test pump or by a power driven test pump. The pressure gauges used for testing shall be accurate and shall preferably be calibrated before the testing is carried out. All the leakages and defects in joints revealed during the testing shall be rectified to the entire satisfaction of the consultant. The system may be tested in sections parts as the work of erection of piping proceeds. The piping shall withstand 1.5 times the working pressure for at least 2 hours.

**6.0 PUMP SETS:** - Same as wet riser & Hydrant System specification.

## **7.0 ANNUNCIATION SPRINKLER PANEL**

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

- a. Panel should be made in a module of 20 zones e.g. each module will have audible and visual indications and will monitor the circuit conditions. With 24v DC battery.
- A.C. Power Supply
- Fault and Fire indication lamp
- Alarm acknowledgment push buttons
- b. The circuits provided in the control panel for each zone shall indicate the following conditions:
- |      |                              |
|------|------------------------------|
| i.   | Open Circuit in zone wiring  |
| ii.  | Short Circuit in zone wiring |
| iii. | Normal conditions            |
| iv.  | Power failure                |
| v.   | Low battery                  |
- c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation

of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.

- d. Suitable protection may be provided against charging of the battery over and above the specified values.

## **8.0 BATTERY UNIT**

- i. The system shall be powered by lead acid storage stationery complete with automatic dual rate charger boost and trick operating form 220 V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.
- ii. The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1 V 20 per cell, and operate at a trickle charge rate of 100 to 200 AH, when the battery terminal voltage exceeded about 2.25 per cell.
- iii. The power unit should have the following.
  - a. Voltmeter 0-03 V
  - b. Ammeter of suitable range
  - c. Indicator lights for mains
  - d. Indicator lights for DC output
- iv. The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (IF and isolated supply is provided a line earthing indicator should also be provided).
- v. The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.
- vi. The connection to the 220 V, 50 Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for earthling all non-current carrying metal parts of the sprinkler system, except those that are either doubly insulate or mounted at a height exceeding 2.2 meters.
- vii. The battery unit shall be housed in a steel cabinet at least 2 mm thick suitably painted with two coats of Post Office Red, Enamel necessary vent holes should be provided for proper ventilation.

## **1.10 STANDARDS AND CODES**

1. IS 1648 Code of practice for fire safety of building (general) fire fighting equipment and maintenance.
2. IS 3844 Code of practice for installation of internal fire hydrant in multistory buildings
3. IS 2217 Recommendations for providing first aid and firefighting arrangement in public buildings.
4. IS 2190 Code of practice for selection, installation and maintenance of portable first aid fire appliances.
5. Part IV, firefighting                      National building code
6. IS 5290                                      External fire hydrants
7. IS 5290                                      Internal landing valves

- |     |              |  |
|-----|--------------|--|
| 8.  | IS 904       | 2 & 3 way suction collecting heads   |
| 9.  | IS 884       | First aid hose reel  |
| 10. | IS 5132      | High pressure rubber pipe  |
| 11. | IS 1537      | C.I. Double flanged pipes  |
| 12. | IS 1538      | C.I. Double flanged fittings   |
| 13. | IS 780       | C.I. Sluice valves and gunmetal valves                                     |
| 14. | IS 6234      | Specifications for Water type (stored pressure) fire extinguisher.         |
| 15. | IS 2873/2171 | Specifications for fire extinguisher of Carbon-di-oxide & Dry powder type. |



## **CHAPTER Q**

### **Technical Specifications for Solar Power Plant**

#### **1.01 WORK DESCRIPTION**

This section specifies the engineering, supply, delivery to site, installation, testing, commissioning and maintenance of 15 KWp solar power plant as described in the Content.

##### **1. SOLAR PHOTOVOLTAIC MODULES:**

The total Solar PV minimum array capacity should not be less than the KWp specified for each location as above and should comprise of poly crystalline modules of minimum 250 Wp and above wattage. Module capacity less than minimum 250 Wp should not be supplied. The Photovoltaic module must be tested and certified by an independent testing laboratory that is accredited in accordance with ISO Guide 25.

- a. The PV modules should be of Indigenous make. The PV modules must conform to the latest edition of any of the following / equivalent BIS standards for PV module design qualification and type approval:

Crystalline Silicon Terrestrial PV Modules IEC 61215 / IS14286

Thin Film Terrestrial PV Modules IEC 61646 / Equivalent IS

In addition, the modules must conform to IEC 61730 Part 1 (requirements for Construction) & Part 2 (requirements for testing, for safety qualification).

Further, the PV modules must also qualify the Salt Mist Corrosion Testing as per IEC61701 / IS 61701

- b. SPV module Conversion efficiency should be equal to or greater than 14% at STC and AM 1.5 radiations.
- c. The PV modules shall perform satisfactorily in humidity up to 100 % with temperature between -40°C to +85°C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to that effect be provided.
- d. The prescribed electrical degradation shall not be less than 10 (ten) percent of the full rated original output at the end of the period of 12 years and not less than 20 (twenty) percent of the full rated original output at the end of 25 years.
- e. Manufacturers/suppliers should confirm whether they are supplying PV modules using a RF identification tag (RFID), which must contain the following information. The RFID can be placed inside or outside the module laminate, but must be able to withstand harsh environmental conditions:-
  - i. Name & Serial No. of the Manufacturer of PV Module.
  - ii. Name & Serial No. of the Manufacturer of Solar Cells
  - iii. Month and year of the manufacture ( separately for solar cells & module)
  - iv. Country of origin (separately for solar cells & module)
  - v. I – V curve for the module
  - vi. Peak Wattage, Im, Vm and FF for the module
  - vii. Unique Serial No. and Model No. of the module

- viii. Date and year of obtaining IEC PV module qualification certificate
- ix. Name of the test lab issuing IEC certificate
- x. Other relevant information on traceability of solar cells and module as per ISO 9000 series.

Until 31<sup>st</sup> March, the RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions. **However from 1<sup>st</sup> April onwards; RFID shall be mandatorily placed inside the module laminate.**

f. Other general requirement for the PV modules and subsystems shall be the following:

- i. Raw material (Solar cells) and technology employed in the module production shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted for the modules being supplied by the bidder.
- ii. The rated output power of any supplied module shall not have negative tolerance.
- iii. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) percent from the respective arithmetic means for all modules and/or for all module string, as the case may be
- iv. Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.
- v. The module frame, if any, shall be made of aluminum or corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.
- vi. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type IP65 rated.
- vii. Necessary I-V curves at 250 C, 450,600 and at NOC are required to be furnished.
- viii. Fill factor of module shall not be less than 0.70

## 2. ARRAY STRUCTURE:

- a. The array structure shall be so designed that it will occupy minimum space without scarifying the output from SPV panels.
- b. Wherever required, suitable number of PV panel structure shall be provided. Structures shall be of flat-plate design either or L sections.
- c. Structural material shall be corrosion resistant and electrolytically compatible with the material used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 micron on steel as per IS 5905, if steel frame is used. Aluminum frame structures with adequate strength and in accordance with relevant BIS/international standards can also be used.
- d. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the roof top site and the structure atop sloping roofs shall be done by the Bidder.

- e. The structures shall be designed to allow easy replacement of any module & can be either designed to transfer point load on the roof top or UDL as per site conditions and design to be approved by Client.
- f. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.
- g. The array structure shall be grounded properly using maintenance free earthing kit.
- h. Each panel frame structure should be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 200 km/hr. after grouting & installation. The front end of the solar array must be one meter above the rooftop. Grouting material for SPV structures shall be as per M20 (1:2:4) concrete specifications.
- i. The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site. If prior civil work or support platform is absolutely essential to install the structures, the supplier shall clearly and unambiguously communicate such requirements along with their specification in the bid. Detailed engineering drawings and instructions for such prior civil work shall be carried out prior to the supply of Goods.
- j. The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, but not limited to, the following:
  - i. Determination of true south at the site;
  - ii. Array tilt angle to the horizontal, with permitted tolerance;
  - iii. Details with drawings for fixing the modules;
  - iv. Details with drawings of fixing the junction/terminal boxes;
  - v. Interconnections details inside the junction/terminal boxes;
  - vi. Structural installation details and drawings;
  - vii. Electrical grounding (earthing);
  - viii. Inter-panel/Inter-row distance with allowed tolerances; and
  - ix. Safety precautions to be taken.
- k. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. All nuts and bolts shall be of very good quality stainless steel. Detailed design and drawing shall have to be submitted for acceptance and approval before execution of work.

NOTE: The structural design of the complete system should be compatible with the structural strength and load bearing capacity of the roof. Design calculations and certificate to this effect shall be provided by a qualified chartered structural engineer.

### **3. POWER CONDITIONING UNIT (PCU)**

The PCU required of appropriate capacities as follows, should convert DC power produced by SPV modules, in to AC power and adjust the voltage & frequency levels to suit the local grid conditions.

PCU should be appropriate capacity of proposed solar PV plants

**3.1.1 POWER CONDITIONING UNIT (INVERTER PLUS MPPT CHARGE CONTROLLER)**

Input Voltage:

- From PV Module: Minimum 15KWp, 120V nominal DC from Solar PV Array.
- From AC source: 410-415V (Phase to Phase) (+12%, - 20%), 3 ph, 50 Hz (+ .5 Hz).

Output Voltage:

Suitable for charging 120 V, 600AH tubular plate lead acid VRLA Gel type battery bank.

Protection:

- Short Circuit
- Deep discharge
- Over charging (Automatic trickle charge mode on full charge)
- Input surge voltage
- Over current (Load)
- Battery reverse polarity
- Solar Array reverse polarity

Indication (LED/LCD Indication):

- String on
- Mains on
- Input on
- Control on
- Charge on
- 80% charged, 100% charged
- Charger overload
- Battery on trickle
- Battery disconnected/fault battery reverse polarity
- Low solar power
- System fault
- Charger over temperature
- Input over/under voltage (for AC)

Operating Temp: 0-50 Deg C

Humidity: 0-95% non condensing

Enclosure IP 32

No Load Consumption: < 1%

**3.1.2 INVERTER:**

Common Technical Specification:

Control Type: Voltage source, microprocessor assisted, output regulation

Output Voltage: 3 phase, 415 Vac (+12.5%, -20% Vac)

Frequency: 50 Hz (+3 Hz, -3 Hz)

Continuous rating: As per Table Above

DC link voltage range: 0 to 800 V

Nominal Power: As per Table Above

Total Harmonic Distortion: less than 3%

Maximum current ripple:	4% PP
Reactive Power:	0.95 inductive to 0.95 capacitive
Operating Temp. Range:	0 to 55 deg C
Housing Cabinet:	INVERTER to be housed in suitable switch cabinet, Within IP 65 Degree of ingress protection for outdoor and IP 20 for Indoor.
Inverter efficiency:	95% and above at full load,
Power Control:	MPPT

#### **Other important Features/Protections required in the INVERTER**

- Mains (Grid) over-under voltage and frequency protection
- Fool Proof protection against ISLANDING
- Designed to withstand starting in – rush current when pump is started and provide trip free operation.
- Included authentic tracking of the solar arrays maximum power operation voltage (MPPT)
- Array ground fault detection
- LCD and piezoelectric keypad operator interface Menu driven
- Automatic fault conditions reset for all parameter like voltage, frequency and/or black out.
- MOV type surge arrester on AC and DC terminals for over voltage protection from lightening-induced surges.
- INVERTER should be rated to operate at 0-55 deg. centigrade unless provision for air conditioning is included in INVERTER
- All parameters should be accessible through an industry standard communication link.
- Overload capacity (for 10 sec) should be 150% of continuous rating.
- The INVERTER shall be self-commuted and shall utilize a circuit topology and components suitable for meeting the specifications listed above at high conversion efficiency and with high reliability.
- The PCU shall give the preference to feed the loads from Solar Energy being produced and shall draw the additional power from mains to meet the load requirements in case the load is more than the solar energy being produced.
- PCU shall be capable to synchronize independently & automatically/to be phase locked with Power Supply Authority grid power line frequency to attain synchronization & export power generated by the solar panel to Power Supply Authority grid.
- Since the INVERTER is to be used in solar photovoltaic energy system, it should have high operational efficiency. The DC to AC conversion efficiency shall at least be 95percent at full load. The idling current at no load must not exceed 2 percent of the full load current.
- Transformer less inverters shall be preferred. Restriction of DC components on AC side shall be achieved.
- The INVERTER output shall be 415 VAC, 50 Hz 3 phase.

- The INVERTER shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting line-to-line fault currents and line-to-ground fault currents.
- The INVERTER shall be able to withstand an unbalance output load to the extent of 30%.
- The INVERTER shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array damage in the event of INVERTER component failure or from parameters beyond the INVERTER's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the INVERTER front panel to cause the INVERTER to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the INVERTER, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.
- The INVERTER shall go to shut down/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay;

#### I. Insufficient Solar Power Input

When the solar available from the PV array is insufficient to supply the losses of the INVERTER, the INVERTER shall go to a standby/shutdown mode. The INVERTER control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

#### II. Utility-Grid Over or Under Voltage

The INVERTER shall restart after an over or under voltage shutdown where the utility grid voltage has returned to within limits for a minimum of two minutes.

#### III. Utility-Grid Over or Under Frequency

The INVERTER shall restart after an over or under frequency shutdown when the utility grid voltage has returned to within limits for minimum of two minutes.

- The INVERTER generated harmonics measured at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonics current distortion of 3 percent, a single frequency current distortion of 4 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.
- The INVERTER power factor at the point of utility services connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output.
- The internal copper wiring of the INVERTER shall have flame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.
- The INVERTER shall withstand a high voltage test of 2000V rms, between either the input or the output terminals and cabinet (chassis).
- Full protection against accidental open circuit and reverse polarity at the input shall be provided.
- The INVERTER shall not produce Electromagnetic Interference (EMI) which may cause malfunctioning of electronic instruments including communication equipment, which are located within the facility in which the INVERTER is housed.

- The INVERTER shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. Each of these measurements\ displays shall have an accuracy of 1 Percent of full scale or better.
- The display shall be visible from outside the INVERTER enclosures. Operational status of the INVERTER, alarms, trouble indicators and A.C and the D.C disconnect switch positions shall also be communicated by appropriate messages or indicator lights on the front cover of the INVERTER enclosure.
- Communication Modbus protocol with LAN/WAN options along with remote access facility and SCADA package with latest monitoring systems including individual string monitoring with Web/IP data monitoring.
- The Inverter shall be with Bi-directional full sine wave charge controller 120 V DC output.

#### **Electrical safety, Earthing and Protections**

- a. Internal Faults: In built protection for internal faults including excess temperature, communication failure, and overload and cooling fan failure (if fitted) is obligatory.
- b. Galvanic Isolation: Galvanic Isolation is required to avoid any DC component being injected into the grid and the potential for AC components appearing at the array.
- c. Over Voltage Protection: Over Voltage Protection against atmospheric lightening discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.
- d. Earth fault supervision: An integrated earth fault device shall have to be provided to detect eventual earth fault on DC side and shall send message to the supervisory system.
- e. Cabling practice: Cable connections must be made PVC Cu. cable, as per BIS standards. All cable connections must be made using suitable terminations for effective contact. The PVC Cu cables must be run in GL trays with covers for protection.
- f. Fast acting semiconductor type current limiting fuses at the main bus-bar to protect from the grid short circuit contribution.
- g. The INVERTER shall include an easy accessible emergency OFF button located at an appropriate position on the unit.
- h. The INVERTER shall include ground lugs for equipment and PV array grounding. The DC circuit ground shall be a solid single point ground connection in accordance with WEC 69042.
- i. All exposed surfaces of ferrous parts shall be thoroughly cleaned, primed and painted or otherwise suitably protected to survive a nominal 30 years design life of the unit.
- j. The INVERTER enclosure shall be weatherproof and capable of surviving climatic changes and should keep the INVERTER intact under all conditions in the room where it will be housed. The INVERTER shall be located indoor and should be wall/pad mounted, Moisture condensation and entry of rodents and insects shall be prevented in the INVERTER enclosure.
- k. Components and circuit boards mounted inside the enclosures shall be clearly identified with appropriate permanent designations, which shall also serve to identify the items on the supplied drawings.

- l. All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks. All openings shall be provided with grills or screens with openings no larger than 0.95 cm. (about 3x8 inch).
- m. In the design and fabrication of the INVERTER the site temperature (50 to 550 C), incident sunlight and the effect of ambient temperature on component life shall be considered carefully. Similar considerations shall be given to the heat sinking and thermal for blocking diodes and similar components.

#### **Factory testing**

- a. The INVERTER shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.
- b. Operation of all controls, protective and instrumentation circuits shall be demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.
- c. Special attention shall be given to demonstrate utility service interface protection circuits and functions, including calibration and functional trip tests of faults and isolation protection equipment.
- d. Operation of startup, disconnect and shutdown controls shall also be tested and demonstrated. Stable operation of the INVERTER and response to control signals shall also be tested and demonstrated.
- e. Factory testing shall not only be limited to measurement of phase currents, efficiencies, harmonics content and power factor, but shall also include all other necessary tests/simulations required and requested by the Purchasers Engineers. Tests may be performed at 25, 50, 75 and 100 percent of the rated nominal power.
- f. A factory Test Reports (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.
- g. Factory testing of the INVERTER should be carried out and witnessed by the Purchaser's Engineers at the manufacturers premises.

#### **Operating modes:**

The following operating modes are to be made available:

- a. Standby mode: Where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 10 watts)
- b. Operational or MPP tracking mode: The control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold. Front Panel display should prove the status of the INVERTER, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

#### **Codes and standards:-**

The quality of equipment supplied shall be controlled to meet the guidelines for engineering design included in the standards and codes listed in relevant ISI and other standards, such as:

- IEEE 928 Recommended Criteria for Terrestrial PV Power systems.



- IEEE 929 Recommended Practices for Utility Interface of Residential and Intermediate PV Systems.
- IEEE 519 guide for Harmonic Control and Reactive Compensation of Static Power Controllers.
- National Electrical NEPA 70-(USA) or equivalent national standard.
- National Electrical safety Code ANSI C2-(USA) or equivalent national standard.
- JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.
- The inverter manufacturer should attach efficiency certificate from Independent Third party Testing laboratory i.e. IEC, TUV, SNL/ERTL or STQC. PCU should confirm to IEC 61683 for efficiency measurements and IEC 600682 for environmental testing. MPPT unit should confirm to design qualification IEC 62093.

#### **Plant metering/data logging**

- a. PV array energy production: Digital Meters to log the actual value of AC/DC Voltage, Current & Energy generated by the PV systems shall have to be provided. 1 Nos. two way LT 415V energy meters (import – export) class 0.2S ABT compliant shall be incorporated in the system one for each Solar PV Plant.
- b. Solar Irradiance: An integrating Pyranometer (Class-II or better) should be provided, with the sensor mounted in the plane of the array. Readout should be integrated with data logging system.
- c. Wind Speed: An integrated wind speed measurement unit to be provided.
- d. Temperature Sensor: Integrated temp. Sensor for measuring the module surface temp, inverter inside enclosure temp. and ambient temp to be provided complete with readout integrated with the following features:
- e. Data logging systems(Hardware and software) one for each Solar PV Plant, for plant control and monitoring shall be provided with the following features suitable Computers: Desktop Computer 3 GHz Pentium i7 latest (3MB Cache) with 500 GB HDD, 4 GB RD RAM, 2 Parallel & 2 Serial Port, Wi-Fi Lan Card, DVD RW Drive, 20" LED Display, USB Scroll Mouse, along with All in one 1200 dpi/12 ppm Desktop LaserJet printers along with a 1 KVA on-line ups with 1 hour battery backup.
- f. GSM Modem / Wi Fi modem in case GSM connectivity is used or Wireless Router + modem in case Ethernet connection is being used for remote access must be provided.
- g. Remote Supervisory Control and data acquisition through SCADA software at the purchaser location through Handheld device /GSM cellular device with latest software/hardware configuration and service connectivity for online/real time data monitoring/control complete to be supplied and operation and maintenance /control to be ensured by the supplier.
- h. All major parameters should be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital LCD/LED front panel at any time the current values, previous values for up to a month and the average values. The following parameters should be accessible via the operating interface display:
  - AC Voltage
  - AC Output current
  - Output Power

- DC Input Voltage
  - DC Input Current
  - Time Active
  - Time disabled
  - Time Idle
  - Temperatures (C)
  - Inverter Status
- i. Protective function limits (viz-AC Over voltage (both input & output), AC Under voltage (both input & output), Over current (both input & output), Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage, Over voltage delay, Under voltage delay over frequency, Ground fault delay, PV starting delay, PV stopping delay over temperature, short circuit).

#### **Maximum Power Point Tracker (MPPT)**

Maximum power point tracker shall be integrated in the Inverter to maximize energy drawn from the array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism of MPPT shall be mentioned. The MPPT must have provision (manual setting) for constant voltage operation. MPPT unit should confirm to IEC 62093 for design qualification and to IEC 600682 for environmental testing.

#### **Disconnection and islanding**

Disconnection of the PV generator in the event of loss of the main grid supply is to be achieved by in built protection within the power conditioner. This may be achieved through rate of change of current, phase angle, unbalanced voltage or reactive load variants. Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are:

- Neutral voltage displacement
- Over current
- Earth fault
- Reverse power

In case of the above, tripping time should be less than 0.5 seconds. Response time in case of grid failure due to switch off or failure based shut down should be well within 5 seconds.

#### **Automatic reconnection after the grid failure is restored**

INVERTER shall have facility to reconnect the inverter automatically to the grid following restoration of grid, subsequent to grid failure condition. The system should have integrated SCADA and software or plant control and remote communication with web monitoring to monitoring individual strings and complete power plant.

#### **4. ARRAY JUNCTION BOX, MAIN JUNCTION BOXES WITH STRING MONITORING FEATURE TO THE INVERTER:**

The junction boxes are to be provided in the PV yard for termination of connecting cables. The Junction Boxes shall be made of FRP/Powder Coated Aluminum with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The J.Bs shall be such that input & output termination can be made through suitable cable glands.

- Made of FRP or cast aluminum
- Copper bus bars/terminal blocks housed in the junction box with suitable termination

- threads
- Conforming to IP65 (for outdoor)/ IP 21 (for indoor) standards and IEC 62208
- Hinged door with EPDM rubber gasket to prevent water entry.
- Single compression cable glands.
- Provision capacity MOVs provided within the box to protect against lightening.

## **5. PLANT CONTROL, DATA LOGGER & PLANT MONITORING UNIT**

Basically, this unit should perform the following:

- Individual Array monitoring via string monitoring system.
- Measurement and/or recording of energy parameters.
- Simple data logger or energy meter to record the energy data on a predetermined interval basis.
- Measurement & continuous acquisition of ambient air temperature, wind speed, solar radiation, PV module temperature, individual string current, inverter output voltage and current, output frequency.
- Operating state monitoring and failure indication.
- Representation of monitoring data in graphics mode or in tabulation mode.
- Controlling & monitoring the entire power system through remote
- Necessary hardware & software shall have to be supplied by the contractor. Both the software and hardware required for interfacing the plant including CPUs, modems, Printers, UPS, cellular device are to be supplied and installed by the contractor.
- Remote control/instrumentation: The microprocessor control unit should have the provision for installation of Rs-232/485 communication link, should have remote control and monitoring capability (by personal computer). All parameters, status and indicators and targets accessible through the local operator interface may be accessed remotely through these ports. Optional analog outputs (0-5 DC) for AC powers, DC current, DC Voltage can be supplied to interface with external data acquisition systems. Optional contacts input from an external SCAD/RTU or other remote control device can be provided within the inverter enclosure for remotely disabling or resetting the unit.

## **ENERGY METER**

A 3 Phase, 20-60 A Energy Meter shall be provided as approved by Engineer-in charge to measure the quantum of energy. Meter must be provided with the necessary data cables. Energy Meter should be 0.5 Class of accuracy.

## **6. DC DISTRIBUTION BOARD:**

Each Solar PV Plant shall have its separate DC Distribution panel to receive the DC output from the array field with analog measurement meter for voltage, current and power from different MJBs so as to check any failure in the array field.

DCDBs shall be dust & vermin proof. The bus bars are to be made of copper of desired size. Suitable capacity MCBs/MCCBs to be provided for controlling the DC power output to the INVERTER along with necessary surge arrestors.

## **7. AC DISTRIBUTION PANEL BOARD**

Each plant shall be supplied with its dedicated AC Distribution panel which shall be located at an appropriate location in the building itself. ACDBs are to be provided at the cable

terminating points emanating from the inverters. The AC power from inverter of each individual

Solar PV Plant shall be fed into its dedicated AC Distribution panel. Thereafter, the outputs shall

be terminated into the main LT supply.

AC Distribution Panel Board (DPB) shall control the AC power from inverter and should have necessary surge arresters. Interconnection from ACDB to mains at LT bus bar is to be

carried out and complete equipment along with metering to be installed in the ACDB.

Requirement/specifications of DCDB and ACDB may be changed as per site conditions.

All switches at the circuit breakers, connectors should confirm to IEC 60947, part I II & III

#### **DC/AC Distribution Board**

DCDB:	Circuit - I (from Array) 80 A DC Circuit Breaker: 2 Nos. (1 in use, 1 standby)
ACDB:	Incoming Circuit – I (from Inverter) 63 Amp, MCB: 2 No. (1 in use, 1 standby)
Outgoing:	32 Amp SPN MCB 4nos. (3 in use, 1 standby)
Panel type:	Wall mounting type & CRCA 2.5 mm thick with IP 32 protection Cable Gland suitable to Incoming & out going cable

#### **8. CABLES & WIRES**

- Cabling in the yard and control room: Cabling in the yard shall be carried out as per IE rules. All other cabling above ground should be suitably mounted on cable trays with proper covers. Only LSZH XLPE cables must be used.
- The size of cable for connecting module to terminal box, terminal box to panel junction box, panel junction box to array junction box and array junction box to PCU to Battery Bank/ACDB shall be as per site requirement. The decision of Engineer-in-charge shall be final.
- Wires: Only FRLS copper wires of appropriate size and of reputed make shall have to be used.
- Cables ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of cable glands.
- Cable marking: All cable/wires are to be marked in proper manner by good quality ferule or by other means so that the cable can be easily identified. Any change in cabling schedule/sizes if desired by the bidder/supplier be got approved after citing appropriate reasons. All cable schedules/layout drawings have to be got approved from the purchaser prior to installation. All cable tests and measurement methods should confirm to IEC 60189.
- Multi Strand, Annealed high conductivity copper conductor
- PVC type 'A' pressure extruded insulation

- Overall PVC insulation for UV protection and confirm to IEC 69947.
- Armored cable for underground laying
- All cables shall confirm to BIS standards (IS 694) and (IS 1554)
- The size of each type of cable selected shall be based on minimum voltage drop, however the maximum drop shall be limited to 2 %
- Selected cable should carry a current density of minimum 1.2 Amp/Sq.mm
- All electrical/wires inside the building to be fixed in Rigid Steel Conduit for wiring inside the building.
- Proper/trenches as per site requirement.
- Voltage rating 660/1000V.
- Excellent resistance to heat, cold, water, oil, abrasion, UV radiation.
- For laying/termination of cables, latest BIS/IEC codes/ standards to be followed.

## **9. Civil Work**

### **9.1 Concreting**

- Concrete mix shall be of M-20/M-25 grade for pedestal and earth pit chambers.
- Pedestal base shall be provided with tapered gola using water proofing compound of IS-2649.
- Curing of all concrete work shall be carried out continuously for minimum of 7 days.

### **9.2 Array layout:**

Contractor shall design the array layout by incorporating following dimensions:

- Minimum 750mm space around the periphery wall of rooftop.
- Minimum 900mm space nears the rain water exhaust pipe, water tank and rooftop entrance.

### **9.3 Structural Design:**

IS 800-2007 shall be followed for structural design. Contractor shall submit the DBR calculations along with the structural design.

## **10. FIRE EXTINGUISHERS:**

The firefighting system for the proposed power plants for the fire protection shall be consisting of:

- CO2 type 4.5 kg fire extinguishers in the control room for fire caused by electrical short circuits.
- Sand buckets in the control room. The installation of fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing the batteries and PCUs.

## **11. LIGHTENING PROTECTION**

There shall be required number of suitable lightening arrestors installed in the array field. Lightening protection shall be provided by the use of metal oxide arrestors and suitable earthing such that induced transients find an alternate route to earth. Protection shall meet the safety rules as per Indian Electricity Act.

## **12. EARTHING PROTECTION**

Each array structure of the PV yard should be grounded properly. In addition the lightning arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of plant should be thoroughly grounded in accordance with Indian Electricity Act./IE Rules. Earth resistance should be tested in presence of the representative client after earthing by calibrated earth tester. INVERTER ACDB and DCDB should also be earthed properly.

### **13. DANGER BOARDS**

Danger board should be provided as and where necessary as per IE act/IE rules as amended up to date.

### **14. DRAWING & MANUALS**

- 5 copies of Engineering, electrical drawings and installation and O&M manuals are to be supplied with each Plant.
- Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the power plant and power evacuation, along with protection equipment. Approved ISI and reputed makes for equipment to be used.
- For complete electro-mechanical works, bidders shall supply complete design details and drawings for approval before progressing with the installation work.

### **15. TOOLS & TACKLES AND SPARES:**

After completion of installation & commissioning of the power plant, necessary tools & tackles and spares are to be provided free of cost by the contractor for maintenance purpose. A list of requisite spares in case of Inverter comprising of a set of logic cards, IGBT driver cards, Junction Boxes, Fuses, MCCBs etc. along with spare set of PV modules shall be supplied with the equipment. A minimum set of spares shall be maintained in the plant itself for the entire period of warranty and O & M which upon use shall be replenished.

### **16. QUALITY AND ADAPTABILITY OF THE EQUIPMENT:**

Bidders must verify the grid behavior, solar insulation levels, and general site conditions on their own before bidding. The bidder shall accordingly ensure that the equipment and the design submitted shall be able to perform as per guaranteed performance levels in the available site conditions. The design of the plant and the equipment offered by the bidders shall be evaluated for its quality and adaptability to the site conditions based on the purchasers past experience, projects earlier executed by the bidders and from other sources. Bidders must submit detailed technical operational parameters and latest performance indicators.

**Construction of Regional Institute of Allied Health Sciences (RIAHS)  
at BHUBNESHWAR, ODISHA**

**List of Approved Makes of Materials**

**1. List of Approved Makes- CIVIL & Plumbing Services including pumps & machinery**

S.No	Details of equipment/ material	Make/manufacturer
<b>Civil Works</b>		
1.	Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In- Charge.  Or The RMC shall be procured from the source as approved by Engineer – in Charge.
2.	Anti – Termite Treatment	Pest Control India Ltd. In case PCI is not able to undertake the work, it should be done by permanent members of IPCA as approved by Engineer-in-Charge.
3.	Water Proofing treatment Agencies	To be approved by the Engineer-in-Charge
4.	Adhesive for Door Work	Fevicol/ Vamicol/ Dunlop
5.	Aluminium and other Accessories and Hardware	Classic/ Argent/ Oxford /Newlite /Crown /EBCO / Earl Bihari
6.	Aluminium Cladding Sheets	Aludecor / Armstrong / Alucobond / Alupan / Alstone
7.	Aluminium Die-Cast handles & two point locking kit	Giesse / Securistyle / Alu – alpha
8.	Aluminium Extrusion	Hindalco / Jindal / Indal/ Mahavir
9.	Aluminium Fabricators	To be approved by the Engineer-in-Charge
10.	Anchor Fastner	Hilti / Faischer / Bosch
11.	Automatic variable temperature control / fixed temperature control faucets	Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics
12.	Back up rod	Supreme Industry or equivalent
13.	C. I Fitting	Electrosteel/ Kesoram/ Neco/ RIF
14.	Calcium Silicate Board/ Tiles	Hilux/ Aerolite or equivalent
15.	Carpet Flooring & Skirting	Forbo/ Polyflor
16.	Cement	ACC / Ultra tech / Birla Corp. Ltd. (Cement Divn.) / JK Cement / Jaypee-Rewa / Ambuja / Lafarge /Prism / India Cement / Bangur/ Shree/ Century
17.	Cement: White	Birla White / JK or equivalent
18.	Ceramic tiles	Somany / Kajaria / Nitco
19.	Ceramic tiles Adhesive	Cico / Pidilite / BalEndura / Sika
20.	Compressed Chequered tiles	Somany / Kajaria / Nitco
21.	Concrete Additive	Sika /CICO/Pidilite / Fosroc / Fairmate / MC Bauchemie

22.	Curtain Rod / Drapery Rod	Vista work / Mac Decor
23.	Dash Fasteners	Hilti / Faischer / Bosch
24.	Door closer / Floor spring	Ozone/Dorma/ Becker FS/ Doorking / Everite / Hardwyn/ Master
25.	Door Locks	Godrej / Harrison / Link
26.	Door Seal – Wool pile Weather Strip	Anand Reddiplex/ Enviroseal
27.	Doors & Windows Fixtures / Fitting.	Everite / Classic/ Crown / Earl Bihari
28.	E.P.D.M Gaskets	Anand Reddiplex / Enviro Seals
29.	Epoxy Floor	Fosroc/ BASF/ Cico/ Sika Pidilite
30.	Epoxy SLF Flooring	Sika/ /BASF / Pidilite
31.	Extruded Polystyrene Board	Styrofoam by DOW Chemicals / Insulboard by Supreme Industries
32.	False Ceiling - Calcium Silicate Boards & Tiles	India Gypsum/ Armstrong / Aerolite / Hilux / Saint Gobain (Gyproc)
33.	False Ceiling - Gypsum Board & Gypsum False Ceiling	Beral Gypsum / Laffarge / Saint Gobain (Gyproc) / India Gypsum
34.	False Ceiling - Metal	Armstrong / Unimet or equivalent
35.	False Ceiling - Mineral fibre	Armstrong / Decosonic / AMF/ Saint Gobain (Gyproc)/ Nittobo
36.	Fire rated Doors & Frames (Wooden)	Navair / Shaktimet / Promat
37.	Fire Rated Glass	Asahi India Safety Glass Ltd./ Modi/ Saint Gobin
38.	Fire Retardant Paint	Viper FRS 881, Nullifire, Burger
39.	Fire Seal	Sealz, Alstroflam, Abacus
40.	Fire: Door Closures, Mortise Dead locks	Becker Fire Solution, Inersoll Rand LCN Series, Dorma TH Series.
41.	Fire: D-Type Pull Handles	Becker Fire Solution, Dorma, Hardwin
42.	Fire: Hinges, Ball bearing Hinges	Becker Fire Solution/ Inersoll Rand/ Dorma/ Geze
43.	Fire: Panic Exit Device	Becker Fire Solution/ Inersoll Rand LCN Series/ Dorma PHA Series. Dorma / D-line
44.	Fire: Tower Bolts	Suzu, Nulite, Dorset
45.	Flexi Tape	Nortan/ Dizzare or equivalent
46.	Flush Door Shutters	Duro / Greenlam / Century/
47.	Glass fiber acoustic tiles	Ecophon / UP Twiga
48.	Glass Wool / Insulation Boards	Rockwool / UP Twiga / Lloyds Insulation
49.	Glass: Clear Glass / Clear Float Glass / Toughened Glass	Modi / Saint Gobain (SG) /Asahi India Safety Glass Ltd
50.	Glass: Aluminum Doors/ Windows/ Structural Glazing	Modiguard / Saint Gobain / Pilkington/ Asahi India Safety Glass Ltd.
51.	Glass: Mirror	Modiguard / Atul / Saint gobain/ Asahi India Safety / Modi Float
52.	Heat Resistant Terrace Tiles	Thermatek or equivalent
53.	Laminates	Century/ Greenlam/ Formica/ Sunmica/ Merrino
54.	Liquid Soap Dispenser	Euronics/ Utec/ Kopal
55.	Louvers- Aluminum	Hunter Douglas/ Schuco or equivalent
56.	M.S. Pipe	Jindal / Prakash – Surya /TATA
57.	Expansion Joint System	Sanfield India Ltd./ Hercules Systems/ Tristar
58.	Modular Grab bars and Disabled Hardware	Dorma / D-line



59.	Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware
60.	Night Latch	Godrej / Harrison / Link
61.	Paints - Cement Based / Dry Distemper	Snowcem plu/, Berger (Durocem Extra)/ Norolac (Super Acrylic)/ Tatacem
62.	Paints - Epoxy paint	ICI / Asian/ Nerolac / Cico / Sika / BASF / Berger / Pidilite
63.	Paints - Oil Bound Distemper / Acrylic Washable Distemper	Asian (Tractor)/ Burger (Bison)/ Nerolac (Super Acrylic)
64.	Paints - Other Paints / Primer	ICI Dulux/ Asian/ Berger/ Nerolac
65.	Paints - Plastic Emulsion Paint	ICI Dulux/ Asian/ Berger/ Nerolac
66.	Paints - Synthetic Enamel Paints	ICI Dulux (Gloss)/ Berger (Luxol Gold)/ Asian (Apolite)/ Goodlas Nerolac (Full gloss hard drying)
67.	Paints - Texture paint	Berger / Spectrum / Unilite heritage /Asian
68.	Paver blocks (All Types)	KK Manholes / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles
69.	Plywood/Block board/Ply board	Duro/ Greenply/ Century/ Kitply/ Greenply / National / Anchor
70.	Polycarbonate Sheets	Galina/ GE Plastic / Vergola / Skyarch/ Polytechno/ FlexyTuff/ Sunpal
71.	Polysulphide Sealant	Pidilite / Fosroc / Cico / Sika
72.	Pre-Laminated Particle Board	Novapan /Century /Green Ply
73.	Pressed Steel M S Doors Frames	West Wind Concepts Pvt. Ltd., Gurgaon/ Shiva Steel Pvt. Ltd., Noida /AGEW Steel Manufacturing, Ahmedabad
74.	PVC continuous fillet for periphery packing of glazing / Structural Glazing	Roop / Anand / Forex Plastic/ Nagalia/ Trading Company
75.	PVC Doors	Sintex/ Polyex/ Rajshri
76.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong
77.	R.C.C Pipes	Indian Hume Pipe / Pragati Concrete Udyog /ISI Marked Pipes/Daya/KK / JSP
78.	Reinforcement Steel	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd.
79.	SFRC / RCC Manhole Covers/ Grating	KK Manholes / SK Precast Concrete/ Advent concrete-o-vision / Daya concrete
80.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon/ Pidilite/ Forsoc/ Cico/ Dow Corning/ Sika
81.	Stainless Steel	Salem Steel (SAIL) / Jindal Steel or as approved Engineer-in-Charge
82.	Stainless Steel bolts, Washers & Nuts	Kundan / Puja / Atul
83.	Stainless Steel Clamps	Hilti / Intellotech Konzept
84.	Stainless Steel D-handles	D-line / Giesse /Dorma
85.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
86.	Stainless Steel Pressure Plate Screws	Kundan/ Puja/ Atul
87.	Stainless Steel Screw for Fabrication and fixing of Windows	Kundan / Puja / Atul
88.	Stall / Toilet Partitions	Merrino/ Shaktimet/ DEBO
89.	Sunken Portion Treatment	Choksey / Sika / Cico, MC Bouchemie / MC

		Bouchemie / BASF
90.	Super plasticizer	CICO/ Roffes Construction Chemicals/ Pidilite Industries
91.	Terracotta Coloured Tiles	Jindal Mechno Bricks Pvt. Ltd./ Dovtex (DPG Enterprises)/ Prakariti Ceramics/ Unistone.
92.	Tiles: Ceramic tiles	Kajaria / Somany / Nitco
93.	Tiles: Glass Mosaic Tiles	Mridul / Bisazza
94.	Tiles: Glazed tiles	Kajaria /Somany / Nitco
95.	Tiles: Vitrified Tiles (Double / Multi- Charged)	Kajaria / Nitco /RAK /Hindware
96.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
97.	Veneered Particle Board	Duro / Greenply / Century / Novapan / Action Tesa
98.	Water Proofing Materials	BASF/ Fosroc / Sika / CICO /Lloyd Industries
99.	Wooden Laminated Flooring	Nitco /Euro / Pergo
PLUMBING SERVICES INCLUDING PUMPS & MACHINERY		
100.	Air Blowers	Beta/ Everest/ TMVT
101.	Air Release Valve	Azud/API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto
102.	Ball valves with floats	Zoloto / Leader / Sant / Jayco /GPA/Audco
103.	Brass stop & Bib Cock	Zoloto / Sant / Jaquar
104.	Butterfly valves	KSB/Zoloto/Audco/SKS/ AIP /Sant
105.	C.I Sluice Valve & Non Return Valve	Kirloskar / IVC/ Leader /Zoloto/ L&T/ Audco/ Sant/ AIP
106.	C.I Valves (Full way, Check and Globe Valves)	Leader / Kirloskar / SKF / Zoloto / Sant / Kartar
107.	C.I. Manhole Covers	Neco/ R.I.F./ B.C./ Hepco/ SKF/ Kajeco
108.	C.P. Fittings, fixtures and accessories such as Mixer / Pillar taps/ angle valve/ Washers/ Waste/ Spreaders for Urinals	Parko /Jaquar /Marc/ Sanitaryware (ARK) Parry/ Orient/ Kohler/ Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco
109.	Central Control	Rain Bird, USA/ Toro/ Nelson
110.	Centrifugally cast C.I Rainwater fitting / Bronze gratings etc.	Sages Metals/ GMGR/ Electro Steel / Kesoram/ Neco / Neer
111.	Centrifugally casted C.I. Pipes (IS 3989)	Neco / Hepco / Kapilash/ Anand
112.	Chlorinator	Thermax Ltd/ Watcon/ Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon / Jesco / Prominent Heidelberg
113.	Cockroach Trap	Chilly/ Player/ Camry
114.	Copper Fittings (Capillary)	Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.
115.	Copper Pipes	Rajco Metal works/ Mumbai / IBP Conex Ltd.
116.	CPVC Pipes & Fittings	Flowguard/ Astral/ Ashrivad
117.	Disc Filter	Azud, Spain/ Amaid / Arkal,
118.	Ductile Iron Pipes (IS:8329) & Fittings (IS:9523)	Electrosteel/ Kesoram/ Tisco/ Jindal
119.	Filter Press	Pharmatec/ Sachin or equivalent
120.	Flush Valves	Gem/ Jaquar / Marc
121.	Forged Steel Fittings & Flanges (For	Rohini/ Kanwal/ Vijay Cycle & Steel (VS)

	Welded joints)	
122.	G.I. Fittings	R/ Unik/ Zoloto/ K.S./ Sun/ Swastik
123.	G.I. Pipes	Jindal / Tata / Prakash Surya / SAIL / Swastik
124.	Geyser	Spherehot / Racold / Usha Lexus / Bajaj
125.	Hand Drier	Kopal / Utech Systems / Euronics Automat
126.	HDPE Pipes / Moulded Fittings	Emco / Polyefins/ Pioneer Plyfab/ Jain
127.	HDPE Solution tank	Watcon/ Ion Exchange/ Water Supply Specialist Pvt. Ltd.
128.	Hydro Pneumatic System	HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar/ Wilo/ DP Holland/ Wilo
129.	Inbuilt Drip Line	Azud/ Rainbrid-USA/ Netafim
130.	Insulation of Hot water pipes	Vidoflex insulation / Superion insulation Kaiflex – Kaimann/ Armoflex/ Thermaflex
131.	Irrigation Systems	Jain irrigation system limited/Jindal/Prakash
132.	Liquid Level Controllers / Indicators	Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer
133.	Mainline Isolation Valve	Sant / Leader /Zoloto
134.	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird/ USA
135.	RCC (NP 2) Pipes	Indian Hume Pipe / Pragati Concrete Udyog /ISI Marked Pipes/ Daya/ KK / JSP
136.	P.R.S. Dials	Rain Bird/ USA/ Toro/ USA/ Nelson
137.	P.T.M.T. Fitting	Prince/ India/ Symet
138.	PE-AL-PE Pipe and Accessories	Jindal/ Kitec/ Kissan/Vista
139.	Pipe coat material (pipe protection)	RPG Raychem/ Pypkote/ Makphalt/ Lwl
140.	Plastic seat cover of W.C	Commander/ Hindware / Parryware
141.	Polyethylene Water Storage Tank	Sintex/ Polycon / Rotex
142.	Pop up Connecting Assembly	Rain Bird/ Dura/ Lasco,
143.	Popup Spray Head	Rain Bird/ Toro, USA/ Nelson
144.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
145.	PP-R Pipes (PN – 16)	Amitex Polymers Pvt. Ltd. / Prince/ Supreme
146.	Pre-coated Galvanized Steel Sheet	Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals
147.	Pressure Gauge	H-guru/ fiebig/ scientific
148.	Pressure Relief Valve	Omega/ Sant/ Leader/ Zoloto / Upadhyay/ Audco
149.	Pumps:	DP Holland / Wilo/ Grundfos
150.	Pumps: Centrifugal Pump	Crompton / Kirloskar/ KSB
151.	Pumps: Drainage Pumps	Grundfos/ KSB/ Salmson/ Kirloskar/ DP Holland
152.	Pumps: Horizontal Centrifugal / Monoblock Pumps	Kirloskar / DP Holland / Wilo/ Grundfos/ Ebara/ Wilo
153.	Pumps: Re-Circulating Pump	Grundfos/ Ebara/ Wilo
154.	Pumps: Submersible Drainage pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt / Kishor / JS/ Wilo/ ITT
155.	Pumps: Water supply pumps	KSB/ Grundfos/ Kirloskar/ Crompton/ Mather & Platt
156.	PVC flushing cistern	Commander / Parryware / Hindware
157.	PVC Pipes & fitting SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Prince / Supreme / Finolex

158.	PVC Water Stops	Prince / Supreme/ Finolex
159.	R.O. System	Ion Exchange/ Sterling India Ltd. / Pentair water/ CSMCRI
160.	R.O. Water Purifier Unit	Eureka Forbes/ Kent/ Zero B
161.	RQRC Hydrant	Harvel/ Alprene/ Rain Bird, USA
162.	RQRC Key	Harvel/ Aqua/ Drip& Drip
163.	Sensor Operated Auto Flushing System Urinals	Jaquar / AOS-Robo/ U-tec/ Angash/ Euronics
164.	Softening System	Bikon water / Ion exchange / Thermax/ Pentair/ Eureka Forbes/ Doshi Ion/ Fontus
165.	Solar Hot water system	Tata BP Solar / EPL India Limited / Solahart (India) Edwards (Australia) / WBS Innovations
166.	Solenoid valve	Rain Bird, USA/ Toro/ Nelson
167.	SS Gratings, Soap Dish Towel Rail etc.	Camry/Glacier/Gem
168.	Stainless steel CP Grating	Chilly / Camry
169.	Stainless Steel Sink	Hindware / Neelkanth / Nirali
170.	Stone ware pipes & Gully Traps	Perfect / SKF/ R.K/ Hind / Anand / Burn
171.	Thermometer	H-guru/ omicron / scientific
172.	UPVC Pipes & fittings	Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral
173.	UV System	Alpha UV/ Creative UV/ AM Ozonic
174.	Valve Box	Rain Bird, USA/ Carson Brook/ USA/Dura
175.	VFD Pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt
176.	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal or equivalent
177.	Vitreous China/ Sanitary ware fittings and fixtures	Hindware / Parryware / Cera
178.	Water Cooler	Blue Star/ Voltas/ Usha/ Godrej
179.	Water Meter	Capstan / Kranti/ Anand/ Kant
180.	White Glazed Fire Clay Sink	Hindware / Parryware / Cera
181.	Y Strainer	Caliber/ leader/ flowtech /strainwell
<b>WATER TREATMENT PLANT, DRINKING WATER PUMPING SYSTEMS AND PRE-TREATMENT FACILITIES</b>		
1.	WTP Contractors	Thermax/ Pentair/ Ion Exchange/ Watcon/ UEM India Ltd./ Enhanced WAPP Systems/ Jsc Unitherm/ Geo Miler & Co./ Flagmo marketing Pvt. Ltd
2.	Raw water pump set/ Treated water pump set/ Drainage pump set	Grundfos/ WILO/ Ebara/ Kirloskar
3.	Sodium hypochlorite dosing system	Asia LMI/ Grundfos/ Seiko/ E - Dose
4.	Chain pulley block	Indef/ Ardee/ J.K. Morris
<b><u>SEWAGE / EFFLUENT TREATMENT PLANT</u></b>		
1.	STP/ETP Contractors	ION Exchange / Enhanced WAPP Systems/Flagmo marketing Pvt. Ltd./UEM India Ltd. / Watcon / Geo Miler & Co./ Jsc Unitherm/ Thermax / Pentair
2.	Pump Sets i/c Water transfer and	Grundfos/ WILO/ Ebara/ Kirloskar/ DP

	sludge disposal/transfer pump	
3.	Chemical dosing system	Asia LMI/ Seiko/ E - Dose
4.	Filter Press/ Plate	Pharmatec/ Sachin
5.	Air Blowers	Beta/ Everest/ TMVT
6.	UV Systems	Alpha UV, Creative UV, AM Ozonic

## 2. SOLAR POWER

S. No.	Details of equipment/ material	Make/ Manufacturer
a.	Solar system	Tata BP Solar / EPL India Limited / Solahart (India), BHEL/ BEL

## 3. FIRE ALARM SYSTEM:

**Note: All fire alarm components/ Panels shall be UL listed & confirm to NFPA standard.**

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Fire Alarm System	Zicom/ FirePro, Honeywell/ Siemens/ Schneider/ Bosch/ Notifier/ Tyco
2.	Fire Alarm Detectors, Hooters, Manual Call Point UL Listed	Zicom/ FirePro/ Honeywell/ Siemens/ Schneider/ Bosch/ Notifier
3.	Data Cables	Molex/ Awaya/ Delton/Hua-wei
4.	Switcher	Clipsal/ Crabtree/ Legrand/ Hua-wei
5.	Cable TV Cables	Skytone/ Bonton/ Finolex/ Delton/ Hua-wei
6.	Termination Control Cable	Dowell's/ Elemex/ Wago/ Phoenix
7.	Cable Tray	Pilco/ Slotco/ Needo
8.	Control Cable	RR CABLE/ Bonton
9.	Photo Chromatic Switch	Bajaj/ Wipro
10.	Splitter Box	Shyam Antenna/ CAT vision
11.	Panic Button	Eureka Forbes/Fire Pro
12.	Response Indicator	MORLAY/SEIMENS FINDER/NOTIFIER
13.	Fibre Optic	BELDEN/SIMONE/ SYDSTEMAX
14.	Change Over Switch	HPL/ L&T
15.	Luminaires	Philips/ Surya / Bajaj/Pierlite
16.	Mica Tape Cable	Bonton/Skytone/Radox/FRTEK,

## 4. LIFTS:

S. No.	Details of equipment / material	Make/ Manufacturer
1	Lifts	OTIS/ Kone / Mitsubishi/ Schindler/ Johnson Lifts Pvt. Ltd., Chennai

## 5. LVPackage

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	PA Speaker	Bosch/ Ahuja/ Evacpro/ Ateis
2.	Amplifier	Bosch/ Ahuja/ Evacpro/ Ateis
3.	CD Player	Bosch/ Ahuja/ Evacpro/ Ateis
4.	RG 6, RG 11/Wire	Belden/ Skytone/ Bonton/ Finolex

5.	CAT 6 Wire/Accessories -Jack panel , Face Plate	Huwavei/ Belden / Panduit/ Ststemax / Simone
6.	Ethernet / Switch	Huwavei / Avaya / Alcatel /Cisco
7.	Telephone Exchange	Avaya /Alcatel /Cisco
8.	Handsets	Avaya / Alcatel / Cisco / Beetal
9.	Speaker Wire	Belden / Canare /Extron /Leoni
10.	CCTV Camera/ DVR , Other Items	Honeywell / Pelco / Vicon
11.	Partition Track/ Curtain	TSI/Trilux/LSR/MDD/Biomed

## 6. HOT WATER GENERATOR SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Hot water generators	Enmax/ Sunmax/ Goodsun / Tata Bp Solar/ Thermax/ Voilation Projects
2.	Recirculating pumps	Grundfoss/ Ebara /Wilo
3.	Ball valve	Rb/ Itap/ Leader
4.	Check valve	Caliber/ Leader / Peco
5.	“Y” – strainer	Caliber/ Leader/ Flowtech /Strainwell
6.	Air release valve	Rb/ Tbs/ Cimbrion
7.	GI/MS pipes	Tata / Jindal / BST/ SAIL
8.	Insulation	Vidoflex/ Almaflex
9.	Temperature indicator	H-Guru/ Omicron / Scientific
10.	Pressure indicator	H-Guru/ Fiebig/ Scientific

## 7. BUILDING MANAGEMENT SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Signal / Power cables	Finolex / Skytone / Delton / Fusion Polymers / Polycab
2.	2-way Motorized Valve	Johnson/ Sontay Siemens /Honeywell/ Schneider/ Belimo
3.	Air / Water DP switches	Johnson / Sontay/ Greystone / Siemens / Honeywell/ Schneider
4.	Air/Water Pressure / Velocity Sensors	Johnson / Sontay/ Greystone/ Siemens/ Honeywell/ Belimo
5.	Central Processing Unit	HP/DELL/Lenovo/Toshiba
6.	CO2 / CO Sensor	Honeywell / Siemens / Sontay/ Belimo
7.	Colour Monitor	Dell(Ultra Sharp) / HP(Pavillion) / ASUS / Samsung(Sync Master) / LG (Flatron)
8.	Colour Printer	Cannon / Epson/ Hewlett Packard
9.	Communication cables	Finolex / Skytone / Delton / Fusion Polymers/ Polycab

10.	Conduit Accessories	COMEX / Super Sales or equivalent
11.	Current Relay	Veris / Seto / Mamac/Omron / ABB
12.	Damper Actuator	Siemens /Schneider/ Honeywell/ Belimo/ Johnson
13.	DDC Controllers	Johnson/ Cylon/ Siemens/ Honeywell/ Schneider
14.	Differential Pressure Switch-Air	Schneider / Honeywell / Sontay / Siemens
15.	Differential Pressure Switch-Water Application	Honeywell / Sontay / Siemens
16.	Differential Pressure Transmitter-Air & Water Application	Schneider / Honeywell / Siemens
17.	DP Switch Flame Proof	Honeywell / Sontay / Veksler/ Schisek
18.	Duct Static Pressure Sensor/ Temperature Sensor	Schneider / Honeywell- Alerton / Siemens
19.	Duct Type RH Sensor	Schneider / Honeywell - Alerton / Siemens/ Sontay/ Greystone
20.	Electromagnetic / Ultrasonic Flowmeter	Schenitech / Honeywell / Kampstrup
21.	Energy Monitoring Software	Siemens / Honeywell / ABS / Schneider
22.	Flame Proof Level Switch / Level Transmitter	Veksler / Filpro / Sontay / Techtrol
23.	Flame Proof Level Switch / Level Transmitter	Veksler / Filpro / Sontay / Techtrol/ Belimo
24.	Flow Meter	Schenitech / Honeywell / Kampstrup
25.	GI FLEXIBLE PIPE	BEC / AKG or equivalent
26.	Immersion Type Temperature Sensor	Honeywell-Alerton / Siemens/ Schneider / Belimo/ Sontay/ Greystone
27.	Indoor Air Quality Sensors	Honeywell/ Seimens/ Sontay
28.	LAN cables for BMS Network	Belden / D-Link / Avaya
29.	Motorized Butterfly Valves	Schneider / Honeywell / Siemens/ Belimo
30.	Mouse- WIRELESS	HP/Microsoft / I-Ball/Epson/Canon
31.	MS Conduit ISI Embossed Black Enameled / Galvanized	BEC / AKG or equivalent
32.	Occupancy Sensors	Honeywell/ Schneider/ Siemens
33.	Operation Workstation Hardware Software	IBM / HP/ Dell/ Johnson/ Cylon/ Siemens/ Honeywell
34.	Outside Air Temperature Sensor / Outside Temperature & RH sensor	Honeywell -Alerton/ Siemens /-Schneider/ Belimo/ Greystone/ Sontay/ Johnson
35.	Personal Computer	HP / Dell / Lenovo / Toshiba
36.	PH Sensor / TDS Sensor	Honeywell / Hach / Greisinger
37.	Pressure Transmitter – Water/ Differential Pressure Transmitter	Honeywell-Alerton / Siemens/ Schneider/ Belimo
38.	Room Temperature & RH Sensor	Honeywell - Alerton / Siemens/ Schneider/ Belimo
39.	Room Thermostat for FCU	Johnson / Siemens/ Anchor/ Honeywell
40.	Tenant Billing Software	Siemens / Honeywell / ABS / Schneider

41.	Third Party Integrator Unit	Schneider / Honeywell / Siemens
42.	Ultrasonic BTU Meter	Schenitech / Honeywell / Kampstrup
43.	UPS	Delta / Uniline/ Toshiba/ Intellipower/ Luminous / Microtek
44.	Variable Air Volume Boxes	Trox/ Belimo / Barcolair
45.	Variable Frequency Drives	Schneider / Honeywell / Siemens/ Danfoss/ ABB
46.	Velocity Sensor	Greystone / Sontay/ Belimo
47.	Voltage / Current / Power Factor Transducer	SETO / ABB / L&T / Enercon / SETCO
48.	Water Flow Switch	Honeywell-Alerton / Siemens/ Anergy / Johnson
49.	Water Level Switches / Level Transmitter	Veksler / Filpro / Sontay/ Belimo
50.	Web Based BMS Software with unlimited user license	Siemens (Design Insight) / Honeywell-(WEBs / Alerton/Trend) / Schneider
51.	Web Based Router / Network Area Controller	Honeywell-WEBs / Alerton - Siemens / Schneider
<b>8. HVAC</b>		
<b>S. No.</b>	<b>Details of equipment/ material</b>	<b>Make/ Manufacturer</b>
1.	<b>HVAC Contractor</b>	<b>ETA / Blue Star / Voltas / Sterling Wilson/Dyna Aircor</b>
37.	2/3 way modulating valve for AHU	Honeywell/ Siemens/ Danfoss/ Sauter/ Sontay/ Schneider/ Belimo
74.	ACB	L&T/ Seimens/ ABB/ Schneider/ GE
91.	Acoustic Lining for Ducts / AHU Rooms	UP Twiga/ Owens Corning/ Kimcco
2.	Acoustically Insulated Inline Fans	Humidin / Airflow /Alfa Therm / Caryaire/ Wolter/ Kruger/ Nicotra
3.	Adhesive	Fevicol/ Superlon or Equivalent
68.	AHU/ Ventilation Electrical Panels	ABB/ L&T/ Siemens/ Control Well & Switchgear/ KEPL/ EAPL/ Tricolite/ GE/ Schneider/ SPC/ Advance Panel/ Adlec/ Tricolite/ Sudhir/ Jakson/ Zeta/ ASPL/ NEC
8.	AHUs (Floor Mounted / Ceiling Suspended)	Zeco/ Systemaire/ Caryaire(Flakwoods)/ Fedders Lloyd/ Voltas/ Airflow/ Edgetech/ Waves/ Balance Air
4.	Air Distribution, Ducting GI Sheets	Sail / Tata/ Jindal
50.	Air Separator	Spirotrech/ Spirotherm/ Comfort
17.	Air Washer	Humiden/ Zeco/ Waves/ Fedders Lloyd / Nicotra/ Comfrei/ Kruger/ Greenheck
5.	Aluminum Sheet/ Sections	Hindalco / Balco / Nalco
45.	Aluminium tape	Johnson/ Birla 3M/ Milton
6.	Automatic Air Vent	ABB/ Seimens/ Anergy/ Rapid Control/ Emerald/ CIM
7.	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	System Air / Kruger / Airflow / ABB / Humidin / Alfa Therm / Nicotra
33.	Ball valve with Y- strainer	Rapidcool/ Leader/ Emerald/ Festo/ Oventrop/ CIM/ Castle/ Intervale



32.	Ball/ Gate/ Globe valve without Y strainer	CIM/ Rapidcool/ Leader/Oventrop/ Festo
83.	Bus- Ducting	L&T/ Siemens /ABB /Schneider/ C&S Electric/GE
30.	Butterfly/ Check Valve/ Balancing Valve/ Purge valve/ drain Valve	Audco/ Advance/ Flowcon/ Danfoss/ Belimo/ C&R/ SKS/ Econosto/ Intervall
82.	Cable lugs/thimbles/glands	Dowell/ Combat/ Raychem/ Jainsons/ Lotus
81.	Cable tray	Pilco/ Slotco/ Manav/ Ricco
8.	Centrifugal Fans, Fan Section	Nicotra/ Krugger/ Humidin/ Brightflow/ VTS/ comefrei
9.	Change Over Switch	Elecon / L&T/ Siemens
10.	Closed Cell Fire Retardant XLPE (For Duct Insulation)	Supreme / Trocellene / Paramount / Armacell/ Aeroflux
60.	Closed cell fire retardant XLPE (for pipe/valve insulation )	Paramout/ Armacell/ Supreme / Armaflex/ Eurobatex – Union Foam
43.	Closed cell nitrite rubber with aluminium foil	Armaflex/ Vidofex / Trocellen/ Eurobatex/ Kflex/ Superlon
11.	Cooling / Heating Coil (AHU & FCU – ARI Certified Coil)	Waves / Caryaire / Suvidha Savier / Zeco/ Roots/ International Coil Company/ Cooling/ Waves/ Edgetech/ Humidin/VTS
6.	Cooling Tower	Paharpur/ Mihir/ Advance/ Bell/Delta /Coron/ CASE
41.	Cooling/Heating Thermostat	Honeywell/ Siemens/ Danfoss/Johnson Control/ Schneider/ Belimo
66.	Copper Refrigerant piping for DX System	Diamond/ Star/ Rajco/ Shri Shyam/ Totalline
80.	CT/PT	Kappa/ AE/ Pragati/ C&S/ Precise
12.	Dash Fasteners	HILTI / Fischer / Cannon/ Bosch/ TKS/ Mungo
40.	Dial thermometer(capillary Type)	Tadington/ H Guru/ Feibig/ Emerald/ Japsin
13.	Digital Thermostat / Humidistat	Siemens / Johnson / Honeywell / Danfoss / Belimo/ Anergy/ Schneider
77.	Digital type Voltmeter/Ammeter	Conzerve/ L&T/ ABB/ AE/ IMP
76.	DOL or Star-Delta Starters, contactors/ OL Relays/ changeover switch/ push buttons/ Rotary switches/ fuse and fittings/ 1-phase preventor/ indicating Lamps	L& T/ GE /Siemens/ Schneider/ C&S Electric/ BCH/ ABB
14.	Duct / Pipe Support	Easyflex / Resistoflex / Diamond
15.	Duct UVGI System (Ultra Violet Germicidal Irradiation System)	Ruks / Trimed / Magneto
93.	DX Split ACs	Carrier / Daikin/ Voltas/ Hitachi/ Bluestar
16.	Electric Motors	Siemens/ ABB / Crompton/ Kirloskar/ BBL
67.	Electrical Panels (Main HVAC Panel)	ABB/ L&T/ Siemens/ Control Well & Switchgear / Tricolite/ KEPL/ EAPL/ GE
85.	Energy Recovery Wheel (ERW)	Tomkins/ Novelair/ Desicaant Rotors (DRI)/ Flakwood/ Bryair/ Heatex/ APPIDI
17.	Evaporative Cooling Unit, Exhaust Scrubber Unit	Roots Cooling/ Waves/ Edgetech/ Humidin
18.	Expanded Polystyrene Insulation	Beardsell / Styrene Packing / Toshiba / Indian Packaging / Quality Thermopack
49.	Expansion tank(pressurized)	ITT/ Wessels/ Grundfoss/ Emerald/ Armstrong/ Anergy
19.	Extruded Aluminium Grills, Diffusers	Caryaire /Ravistar /Servex / Airflow /Titus/ Trox/

		Airmaster/ fedders Lloyd/ Tomkins
56.	<b>Factory fabricated spiral duct</b>	Atco/ seven star / GP Spiro/ Up twiga/ Techno Duct / Rolastar/ Zeco
20.	Fan Coil Unit (AMCA Certified Fan for Sound & Performance)	Carrier / Caryaire / Edgetech / Waves / Zeco / Fedders Lloyd /Daikin / VTS / Flaktwood/ Brightflow
21.	Fibre Glass Rigid Board	Lloyd insulation/ U.P.Twiga / Owen corning / Kimco
28.	Filters (pre/ fine/Hepa)	AAF/ Purolator/ Thermadyne/ Specturm
22.	Fire /Smoke Damper	Caryaire / Ravistar / Titus / Trox / Airflow/Ruskin/ Systemair/ Airflow
23.	Fire Damper Actuator	Belimo / Siemens / Danfoss / Honeywell
24.	Flexible Duct Connection	Airflow/ Pyroguard or Equivalent
25.	Flexible Pipe Connection	Resistoflex/ Kanwal/ Dunlope/ EasyFlex
26.	Flow switch	Rapidcool/ Siemens/ Honeywell/ Rapid Control/ Danfoss
26.	Galvanised MS Sheet	SAIL / Tata / Jindal/ ESSAR
92.	GI / Cu Wire or Strip (For Earthing)	Bharti/ Indiana/ Slotco
90.	Heat Exchanger	Heatex/ Mark/ AlfaLavel
27.	Hot Water Generator & Pan Humidifier	Sant / Enmax / Rapid Control / KEPL/ Emerald/ Sandhu Engg.
28.	HRC Fuse and Fittings	L&T / Siemens / GE/ C & S
70.	HVAC controls	Danfoss/ Honeywell/ Johnson controls / Siemens/ Penn/ Carrier ALC
16.	Ducted In Line Fan	SystemAir / Kruger/ Nicotra / Caryaire/ Pine Air
29.	Indicating Lamps	Siemens / L&T/ Emco
30.	Industrial Type Thermometer	Emerald / Guru / Waaree/ Fie big/ H-Guru
31.	Insulated Flexible Duct	Caryaire / Atco / GP Spiro
32.	Laminar Flow Diffusers	Ravistar/ Systemair/ Airflow
72.	MCB	Legrand/Schneider/Siemens /ABB/ L&T ( Hager )/GE
73.	MCCB	Legrand/Schneider /ABB/ L&T ( Hager)/GE
59.	Mineral wool/Fibre glass insulation	Lloyd insulation/ UP Twiga/ Kimcco/ Owens Cornings
33.	Modulating Motor	Honeywell/ Johnson/ Belimo/ Rapid Control
31.	Motorised butterfly valve	Belimo/ Honeywell/ Siemens/ Danfoss/ Tour Andover/ Johnson Control
34.	MS / GI Piping (Chilled / Drain/ Condensate)	Jindal/ TATA/ SAIL
84.	MS Conduit	NIC/ BEC/ AKG/ Steelcraft
35.	MS Painted / GI Cable Tray (Factory Fabricated)	Indiana / Slotco / Pilco / Kepl / Ricco
36.	Nitrile Rubber Insulation (For Pipe Insulation)	Armaflex / Superlon / K-flex
37.	Paints	Shalimar / Asian / Nerolac /Burger/ ICI
38.	Panel for sec VFDs	EAPL/ Tricolite/ Trident/ KEPL/ CWS
39.	PID balancing cum motorized valve For AHUs and FCUs	Danfoss/ Oventrop/ Flowcon
40.	Power & Control Cables	Universal / Polycab / RR Cables/ Havells/ Finolex
24.	Pre- insulated Chilled water pipe	Zeco/ Seven star or equivalent
54.	Precision AC units	Emerson/ GEA/ Stulz/ Blue star
41.	Pre-Insulted Fabricated Ducts	Pal / P3 / Kingspen/ Spiro/ Techno/ Rolastar/ Zeco
42.	Pre-moulded PUF section for insulation	Lloyd/ Malanpur/ Beardsel/ Supreme

42.	Pressure Gauges	Feibig / Emerald /H Guru/ Taylor
43.	Primary chilled water Pumps & Condenser water Pumps	ITT/ Armstrong/ Grundfoss/Mather & Platt/ Beacon/ Kirloskar/ Wilo
44.	Propeller Fans	CG/ Magneto/Khaitan/ Alstom/-GEC/ Caryaire/ Systemaire/ Greenheck
44.	PUF pipe supports	Malanpur/ Lloyd/ Beardsel
45.	Red Oxide, Zinc Chromate Primer	ICI/ Berger or Equivalent
87.	Return Air Temp Sensors	Siemens/Honeywell/JhonsonsSauter
38.	Room thermostat/humidistat	Honeywell/ Siemens/ Danfoss/Johnson Control/ Schneider/ Belimo
46.	Rotary Switches	L&T / Siemens / GE / BCH
47.	RP Tissue	UP Twigra/ Styrene Packing or Equivalent
39.	Safety thermostat for heater	Honeywell/ Siemens/ Danfoss/ Johnson Control/ Schneider/ Belimo
48.	Scale Preventer System	Scale Guard (Aqua Treat) / Crystallo / Scaloid
3.	Secondary Chilled Water System (Variable speed pumping System)	ITT/ Grundfoss/ Armstrong/ WIL0
4.	Secondary Pump VFDs	Siemens/ Danfoss/ Honeywell/ ABB
10.	Section (Single Skin ) for fresh Air, Exhaust, Staircase, Lift Well pressurization	Voltas/ Trane/ Caryaire (Flakwoods)/ Fedders Lloyd
49.	Selector & Toggle Switch	Kaycee / L&T/ Siemens/ Schnieder
50.	Single Phase Preventer	L&T / Minilec / Siemens
51.	Starters, Contactors, Push Buttons, Overload Relay	L&T / GE / Siemens / BCH / Schneider / Hager
52.	Suction guide	Anergy/ ITT/ Emerald/ ABB/ Sandhu
53.	Tar felt / CPRX compound	Shalimar tar product/ Asian or equivalent
54.	Terminal Block	Elmex/ Siemens/ Schneider
88.	Thermal storage	CALMAC/ Dunhumbush/ Cristopia
55.	Three phase motors	ABB / CG / Siemens / Bahrat Bijli / Kirloskar
56.	Time Delay Device	Siemens / L&T/ BCH
78.	Timer	L&T/ English electric/ Siemens
14.	Tube Axial Fans	Kruger/ Nicotra/ Comefri/ Systemair
53.	Ultra violet germicidal Irradiation system (UL listed or UL recognized components )	Ruks/ Trimed/ Voltas
47.	V Belt	Dunlop/ Fenner or equivalent
57.	Vacuum Degasser/ Air & Dirt Separator/ Air Separator	Spirotech / Spirotherm / Comfort/ Anergy
58.	Variable Frequency Drive	Johnson / Siemens /Emerson /Honeywell / ABB/ Danfoss/ Schneider/ Allen Bradley/ L&T
59.	VAV Boxes /Constant air volume boxes	Trox/ Belimo/ Titus/ Trane/ York/ Barcolair
60.	Vibration Isolation Spring & Flexible Pipe Connector	Resistoflex / Diamond/ Kanwal/ Dunlop
46.	Vibration isolator	Resistoflex/ Dunlop/ Kanwal/ Easy Flex
61.	Water / Air Cooled Screw Chilling Machine	Carrier/ Daikin-McQuay/ Climaveneta/ York/ Clivet/ Dunhambush/ Trane / Hitachi
62.	Water Flow Switch	Anergy / Rapid Cool / Honeywell / Rapid control/ Danfoss/ Honeywell

63.	Welding Rods	Advani / L&T or equivalent
64.	Y-strainer / Pot – strainer	Rapid control/ Sandhu Engg/ Emerald / Maharaja/ Sant / DS Engg/ Leader

## 9. FIRE FIGHTING WORKS

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Air Break Contactors	Seimens / L&T / ABB/ Schneider/ GE
2.	Air Release Valve	Rb / Tbs /Cimbrio/ Zoloto
3.	Alarm valve & Hydraulic (Alarm motor with coupling)	HD fire protect/ Mather&Platt or Equivalent
4.	Alternator	Stamford/ Lorey Somer/ kirloskar/ Toyo denki/ avk
5.	Ammeter, Voltmeter, PF, kW, Hz, meter (Analogue), Energy Meter	AE/ Enercon/ Conserve
6.	Ball Valve	Audco/Rb / Zoloto / Leader / Danfoss / Sant /Rapid / Castel/ Emerald
7.	Battery	Exide/ Amco/ Amaraja/ Chabbi/Statcon
8.	Butt welded fitting (UL Listed)	V.S.Forge /True Forge / DRP-M
9.	Butterfly valves / C.I. Double flanged sluice Valves & check valves	Audco / Zoloto / Safex/ Intervale/ Leader/ Audco / Sant/ Kirloskar / Advance
10.	Cable lugs and glands	Comet/Dowell/Lotus/Jainson/Baliga/ Stripwel
11.	Cables	Universal / CCI /Gloster/ Elektron/ Polycab/ Finolex
12.	Control / Potential / Current Transformer	Gillbert & Maxwell/ AE/ Kappa/ Meher/ L&T/ Areva
13.	Deluge valve	Eversafe / HD / Tyco
14.	Diesel engine driven pump	Kirloskar/ Ashok Leyland / Mather & Platt / Wilo
15.	ELCB	MG/MDS Legrand – Lexic/ L&T Hager/ Siemens
16.	Electrical Motors	ABB/ Kirloskar / Seimens / Wilo / Mather & Platt/ C&G
17.	Electrically driven Fire Pumps / Terrace Pump	Kirloskar / Mather & Platt / Wilo/Ashok Leyland
18.	Emergency Hose Reel	Minimax /Usha Fire / Omaxe/ Padmini Fire/ Newage /Minimax/Ceasefire
19.	2/3/4 WAY Fire Brigade Inlet / Draw out Connection	Ceasefire / Newage / Safex/ Minimax/Ushafire/Omex
20.	Fire Buckets	Safex / Minimax/ Peter Autokit
21.	Fire Extinguisher	Ceasefire / Newage/ Exflame/ Safex/ Minimax/ Peterautokit/ Omex/ Padmini Fire
22.	Fire Man's Axe	Ceasefire / Newage / Safex/ Minimax/ Exflame
23.	Flow switch	Wiking/ Exflame/ Rapidcool/ / Rapid Control/ Danfoss
24.	Foot Valve(Cast Iron)	Kiloskar or equivalent makes as approved by EIC
25.	Foot Valve(Gunmetal)	Neta / Leader / Zoloto
26.	Forged steel fitting	V.S.Forge/True Forge / DRP-M
27.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini / Kanwal or Equivalent
28.	GI / MS Pipes	Tata / Jindal / BST / SAIL/Praksh Surya

29.	Gunmetal Branch Pipe	Newage / Ushafire / Winco / Kailash
30.	Gunmetal Valves (full way Check and Globe Valves)	Audco / Zoloto / Sant
31.	Hose Box	Newage/ Minimax/ Exflame/ Omex
32.	Hose Reel Drum	Newage/ Minimax/ Exflame
33.	HRC fuses	Havells / GE or equivalent makes as approved by EIC
34.	Hydrant Valves	Newage / Minimax / Safex/ Ceasefire/ Peterautokit/ Exflame/ Omex
35.	Indicating Lamps & Push Buttons	L&T / Technico / Led Type
36.	M.S. Conduit	Steel Craft/ BEC/ AKG
37.	MCB	Legrand/ Schneider/ Siemens / ABB/ L&T (Hager )/ GE
38.	MCCB	Legrand/ Schneider /ABB/ L&T ( Hager)/GE
39.	Non-Return Valve – Swing	AIP/ Intervale / Audco(Cast Iron)/ Zoloto/ Sant
40.	Nozzle	Newage / Winco/ Ushafire/ Kailash
41.	Over Load Relays	ABB/GE / L&T / Siemens
42.	Paint	ICI / Berger/ Asian/ Nerolac
43.	Pipe coat material (pipe protection)	Pypcoat / Makphalt / Safex
44.	Pipe Hangers/ Clamps/Supports	Chilly/ GMGR /CAMRY/ Hilti
45.	Power/auxiliary Contactors	MG/ Siemens/ ABB/ GE/ L&T
46.	Pressure gauge	Feibig / Emerald/ H Guru / Taylor
47.	Pressure Switch	Danfoss / Indfoss / Switzer
48.	Push Buttons, Indicating lamps LED	MG/ Larsen&Toubro/ Schneider/ Rank/ BCH
49.	PVC Insulated Copper Wires	Finolex / incap / polycab/ Cable Corporation Of India/ Elektron/Universal/ havells/ nicco/ Rallison/ gloster
50.	RRL Hose/ CP Hose	Newage /Ushafire / Padmini Fire/ Ceasefire/ Safeguard /Superex /Jyoti/ Exflame/ Minimax/ Omex
51.	SFU`S , FSU`S	GE / L&T / Siemens
52.	Single Phase Preventer	L&T/ Minilac/ Grinnel/ Tyco/ Yiking/ Eversafe
53.	Sluice Valves	Kirloskar / Audco /Unik / Leader/ Zoloto/ Sant
54.	Solenoid valve, Spray nozzle	Eversafe / HD / Tyco
55.	Sprinkler (ICV) / Zonal Control Valve	HD /Fire safe / Reliable / Wormald/ Padmini Fire/ Prakash Surya
56.	Sprinkler Heads	Tyco/ Newage/ Omex/ Viking/ Eversafe/ Grinnel / Reliable/ HD/ Firesafe / Padmini Fire
57.	Steel flexible extension	Eversafe / Safex or equivalent
58.	Suction “Y” Type Strainer / Pot Strainer	Kirloskar / Leader / Zoloto/ Sant/ Prakash Surya
59.	Termination Lugs	Dowells / Usha/ Lotus/ Jainson/ Comet
60.	Vibration Eliminator Connectors	Resistoflex /Kanwal/ EasyFlex/ Dunlop
61.	Weld Electrodes	Advani/ ESAB/ L&T/ Victor
<b>10. EPABX&amp; TELEPHONE SYSTEMS</b>		
<b>S. No.</b>	<b>Details of equipment/ material</b>	<b>Make/ Manufacturer</b>
1.	EPABX	Alcatel/ Matrix/ Avaya/ CISCO / Siemens/ Nortel
2.	ANALOG PHONES	Beetel/ Panasonic/ Siemens/ Alcatel

3.	VOICE BOX – RJII	Krone/ TVS/ Finolex
4.	MDF/IDF	Krone or equivalent makes as approved by EIC
5.	Data/ Telephone cable (2 / 4/ 10/ 20/ 50/ 100 Pair Cables)	Delton / Finolex / RR Cable
<b>11. <u>PUBLIC ADDRESS SYSTEM</u></b>		
<b>S.No.</b>	<b>Details of equipment/ material</b>	<b>Make/ Manufacturer</b>
1.	Amplifiers and Speakers	BOSCL/ Philips/ PLENA/ ATE/ AHUJA
2.	Cables / Control cables	Universal/ CCI/ Gloster/ Elektron/ Polycab/ Finolex
<b>12. <u>DATA NETWORKING</u></b>		
<b>S. No.</b>	<b>Details of equipment/ material</b>	<b>Make/ Manufacturer</b>
1.	Active Components – Core and Edge switch	CISCO/ Enterasys/ Juniper
2.	Passive Components – Horizontal and vertical cabling	AMP/ Systimax / Nexans/ Panduit
3.	Enclosures – Distribution rack and server rack	APW/ Netrack or equivalent
4.	Server	IBM / Dell / HP
<b>13. <u>Electrical Works</u></b>		
<b>S.No</b>	<b>Description</b>	<b>Make/manufacturer</b>
1.	11 KV VCB	L&T, GE,ABB , Areva , Schneider , Siemens
2.	11KV, 433 V OLTC oil type transformer	GE/ ABB/ Siemens/ Areva/ kirloskar/ Crompton/ Schneider
3.	A/C cutlet 32 Amps with MCB	Hensel/ North West/ Crabtree
4.	A/C Outlets	North West/ MDS-Legrand/ Crabtree
5.	ACB (TP,4P) with variable microprocessor based releases (O/C, S/C & E/F) compatible with PLC	L&T (u-power)/ Siemens (Sentron)/ Schneider (Nw Masterpact)/ GE (entelliguard)/ ABB (emax).
6.	APFC Panels	L&T/ Siemens (Siepan)/ GE/ Schneider/ ABB
7.	APFC-Relay	L&T/ Siemens/ GE/ Schneider/ ABB
8.	ATS	L&T/ Mitsubishi/ Schneider/ socomec
9.	Auxiliary relays compatible with PLC etc.	Siemens/ L&T/ GE/ ABB/ Areva
10.	Batteries	Hitachi Global/ Yuasa/ Exide, Amco/ SF, Microtek/ Amaraja
11.	Battery charger	Amaraja/ Sabnife/ Chhabi/ Statcon
12.	Battery Charger-cum-DCDB	Amaraja/ Volstat/ Chabbi Elect/ Caldine/ Expo-Fyn/ BCH/ HBL
13.	Brass compression gland (Heavy duty)	Commex/ Gripwell or equivalent
14.	Bus bar	Jindal/ Hindalco or equivalent
15.	Bus trunking , rising mains, end feed unit, top-off box(plug-in type)	L&T/ ABB/ Siemens/ Schneider / GE/ C&S
16.	Cable lugs & gland	Dowel/ Jhonson/ Gripwell/ Comex/ Hex/ Comet
17.	Capacitors with harmonic filters	Epcos/ L&T/ GE / Siemens (Siepan)/ Schneider/ ABB
18.	Ceiling fans	Crompton/ Usha/ Orient/ Bajaj/ Havells/ GE/ Khaitan/ Alstom
19.	CFL lamps	Philips/ Crompton/ Wipro/ GE/ Osram/ Bajaj

20.	Coaxial wires	Finolex/ Delton/ Skytone/ Anchor/ L&T/ Beldon/
21.	Colour Monitor	Samsung / Philips/ LG
22.	Contactors	ABB L&T/ Schneider/ GE/Siemens
23.	Control Cables	Polycab/ Nicco/ Ecko/ UIL/ Elektron/KEI /
24.	Control fuse base with HRC fuse HRC Fuse	L&T/ GE/ Siemens/ ABB/ Alstom
25.	Conventional fire alarm panel	Edwards/ Honeywell/ GST/ Johnson control/ System sensor/ cease fire
26.	Conventional detectors & hooters & accessories	Edwards/ Honeywell/ GST/ Johnson control/ System sensor/ Cease fire
27.	Copper control cable (FRLS)	Havell's/ RR Cables/ Elektron Harsh
28.	Crimping lugs/thimbles	Dowells/ Hex/ Commet
29.	CT/PT's	Meher/ CGL/ Kappa/ Maxwell/ Areva/ L&T/ AE/ Jyoti/
30.	CT's (Cast resin)	L&T/ AEI/ Kappa/ Pragati/ Gilbert
31.	Cubical type Synchronizing & capacitor control panel (Bolted , Folded fabrication)	L&T, ABB/ Schneider/ GE/Siemens (Siepan)/ GE
32.	Cubicle type fuse unit	Siemens/ L&T/ ABB/ Schneider /GE
33.	Data Outlets	SYSTEMAX/ amp/ clipsal
34.	MCBs , RCCB & DBs	Legrand/ Schneider/ Siemens/ GE/ ABB/ L&T (Hager)/
35.	DG Set- Alternator	Stamford/ Lorey Somer/ kirloskar/ toyo denki/ avk
36.	DG sets package	Jakson Engineers/ TIL/Caterpillar/ Sterling generators Ltd./ Perkins/ Kirloskar
37.	Diesel engine	Cummins/ Mitsubishi/ Perkins/ Kirloskar/
38.	Digital lighting control system	Aura dimming/ relux controls/ lightolier control/ effectron/ Philips/ Schneider.
39.	Digital Numerical Relays	L&T/ ABB / Siemens/ Schneider / GE/Areva
40.	DWC HDPE Pipe	DURA-LINE / REX / CARLON/ EMTELLE
41.	Energy Digital meters	Enercon/ L&T/ Rishabh/ Secure/ Trinity/ Schneider Electric/ Havells/ HPL/ GE/ Siemens/ ABB/ Conzerv
42.	Exhaust fan	Usha/ Crompton/ Havells/ GE/ Bajaj/ Alstom
43.	Feeder pillars, Meter cubicle Panels, Floor panels for upto 400A ic switchgear	ABB/ L&T/ GE/Siemens/ Schneider
44.	Fiber Optic Cable	Sterlite Industries/ Finolex
45.	Fire extinguisher	Ceasefire/ Exflame/ Minimax/ Life Guard/ Safex/ Peter Autokit
46.	FRLS - PVCAluminum , copper 1.1 KV grade ,cables & wires	Elektron/ Havells/Polycab / Finolex/ RR
47.	G.I. pipes	Jindal (Hissar)/ Tata
48.	G.I./Cu. Strip & earthing material	Bharati/ Indiana/ Slotco
49.	Glands	Comet/ Stripwel/ Baliga
50.	H.T. Cables	Cable corporation of India/ Universal/ KEI/ Havells/ Nicco/ Polycab/ Finolex/ Rallison/ Gloster
51.	H.T. Panel	ABB/ Alstom/ GE/Siemens/ Schneider/ L&T
52.	Hand gloves & rubber mat	Premierpolyfim Ltd/ Polyelectrosafe/ Challenger/ Electromat/ Safe Hold
53.	Indicating Lamp(LED)	BCH/ L&T/ Rank/ MG

54.	Indicating lamps	AE/ Kaycee/ Vaishnav/ L&T/ Siemens/ Emco
55.	Industrial socket outlets	GE/ ABB/ Hager/ Legrand
56.	Insulators	Jaya Shree/ Modern/ IEC/ WSI.
57.	Intelligent detectors & hooters & accessories	Notifire/ Honeywell/ Johnson Control/ Schneider/ edwards
58.	Intelligent fire alarm panel	Notifire/ Honeywell/ Johnson Control/ Schneider/ edwards
59.	Inverter	Microtek / Luminous / Su-Kam
60.	Isolators	Siemens/ L&T/ ABB/GE
61.	Jointing kit	Reychem/ Xicon/ Birla 3M
62.	Light fittings/ Lamps	Philips/ Wipro/ Bajaj/ Havells/ Keslec/ Pierlite
63.	Lightning arrestor	Indelec/ Gersom/ Helitta/ MDS/ Hager/ Duval Messin/ L&P Electro/ LPI
64.	LT cables (XLPE,PVC)	Cable Corporation Of India/ Universal/ Havells Nicco/ Polycab/ Finolex/ Rallison/ Gloster/ Elektron/KEI
65.	LT panels	ABB/ L&T/ GE/ Siemens/ Schneider/ SPC/ Advance Panel/ Adlec/ Tricolite/ Sudhir/ Jakson/ Zeta/ ASPL/NEC
66.	Lugs	Dowell's/ HAX
67.	MCCB with variable Microprocessor based (O/C, S/C, E/F) / Thermo magnetic releases	L&T D-sine , Siemens(3VL) / Merlin Gerin (NSX compact) / GE(Record)/ ABB-T Max
68.	Measuring instruments (Digital type)	L&T/ Ducati/ Conzerv/ HPL/ Siemens
69.	Modular switches/ socket outlets and wiring accessories with moulded cover plate	Anchor (ave)/ MK (wraparound) / Siemens/ legrand (mosiac)/ L&T/ clipsal (neo`c' metro)/ Havells (piccadilly)
70.	MS Conduit	BEC/ AKG/ Steel Craft
71.	MS Conduit accessories	Rama/ Novel/ BEC/ AKG/ steel craft
72.	Multi-function Meter	L&T/ ABB / Siemens/ Schneider/ Ducati/
73.	Overload relay single phase preventer	ABB/ L&T/ GE/Siemens/ Areva
74.	Panel accessories	L&T/Rishab/ Siemens/ BCH
75.	Poles- Light	Bajaj/ Transrail /Power control corp/ National tubing co/ sancube/ Hilite
76.	Power capacitor with batter than 14% harmonic filter at 525 V (long life mixed Dielectric)	L&T(Meher) / EPCOS (Siemens)/ DUCAT/ GE/ Schneider/ ABB
77.	Programmable timer (self-powered electronic digital)	L&T/ Siemens/ Hager/ MDS/ Legrand
78.	Projection system	Aties/ Harmonpro/ JBL
79.	Protective relays (Microprocessor based compatible with PC & PLC)	Siemens/ L&T/ ABB/ GE/Areva
80.	Push button, indicating lamps (led type)	Siemens/ L&T/ ABB/ Schneider / C&S
81.	PVC conduit	Precision/ Avonplast/ Clipsal/ Harsh/ Polypack/ BEC/ AKG
82.	PVC conduit Accessories	Precision/ Avonplast/ Clipsal/ Harsh/ Polypack/ BEC/ AKG.
83.	Race ways/ Cable Trays/ Floor trunking /	MK/ Legrand/ Needo/ Rico Steel/ Pilco/ Slotco



	wall channels	
84.	Relay and Control Panel	Siemens / L&T/ GE/ Schneider/ ABB
85.	Relays- Auxiliary / Numerical /Bi metal relay	L&T/ GE/ ABB/ Alstom/ Siemens/ Areva.
86.	Sandwiched bus-duct	Siemens/ ABB/ GE/Schneider/ L&T/ C&S
87.	Selector switch	Salzer/ Kaycee/ Siemens/ HPL/ L&T/ BCH
88.	Selector Switch	Kaycee / Salzer
89.	Starters	Siemens/ L&T/ GE/ABB/ Schneider / Areva
90.	Surge diverter	Tercel/ ABB/ Siemens/ Emerson/ Hager/ Phoenix/ Legrand
91.	Tap-off, Splitter box	Zinwell/ Novatron/ Catvision
92.	Telephone cables/ wires	Polycab/ Finolex/ Havells/ RR Kabel/ L&T/ Bonton/ Skytone/ Rallison/ Cable corporation of India/ Gloster
93.	Telephone tag block	Krone/ Tvs/ R&M/ Phoenix/ Wago
94.	Telephone wires	Bonton / Delton/ Polycab/ Connect well/ Phoenix/ WAGO
95.	Terminal strip	Connect well/ Phoenix/ WAGO
96.	Termination Kits	Raychem/ Birla/ 3M
97.	Trivector - Meter (Digital type) only for SEB supply.	L&T/ Secure/ Enercon/ Siemens/
98.	UPS	Emerson / A.P.C /Socomec/ GE/ Mistubishi/ Eaton
99.	Voltmeter and ammeter	AE/ Mecor/ Universal/ Rishab/ Yokins
100.	11 KV RMU	ABB/ Crompton & Greaves/ Schneider Electric/ L&T
<b>14. Fuel and HSD Tank</b>		
<b>S. No.</b>	<b>Details of equipment/ material</b>	<b>Make/manufacturer</b>
1.	<b>Pipe &amp; Fittings</b>	
a.	Pipes ERW	Tata/ Jindal (Hissar)
b.	Pipe Seamless	Tata/ Maharashtra Seamless
c.	Pipe Fittings	V.S.Swastic/ Unik
2.	<b>Valves</b>	
a.	Ball Valve	Cim/ Audco/ R-B/ KSB
b.	Check Valve/Non Return Valves	Kirloskar/ Audco/ Leader/ Keystone/
c.	Globe Valves, Gate Valves	Sant/ Kirloskar/ Audco/ Leader
d.	Solenoid Valves	Avcon/ / Festo/ Indfoss/ Blue Star
e.	Pneumatic Control Valves	Intervall/ Continental/ Avcon/ SMC
3.	<b>Strainers</b>	JP/ Sant/ Emeralt/ Strain Well
4.	<b>Gear Oil Pumps</b>	Tushaco/ Rotadel/ Strok/ Bornneman
5.	<b>Motors</b>	Kirloskar/ Crompton Greaves/ Siemens
6.	<b>Mechanical Seals (For Oils)</b>	John Crane/ Sealol/ Dura Metallic
a.	Level Switches/Controller	V-Automata/ Techtrol/ NandShyam/ Cirrus/ Minilac/ Techtrol
b.	Temp. Gauge	H.Guru/ Gluck/ General Ins.
c.	Pressure Gauge	Flebig/ H.Guru/ United
d.	Flow Meters	Kent/ Forbes Marshal/ Eureka
e.	Levels Indicators	V-Automata/ Techtrol/ Forbes Marshall
8	<b>Welding Electrode</b>	Advani/ ESAB/ Dewkam

**Note:-**

1. The contractor will use one of the approved makes as approved by the Consultant, Engineer -in-charge.
2. In case of different quality, pattern of same make, the pattern, quality shall be approved by the Consultant, Engineer – in – charge.
3. All the items included in the list or otherwise to be used in the work should conform to CPWD and relevant BIS specifications, relevant codes, as applicable.
4. If any item is missing in the above list its make will be decided by the Engineer –in-charge/ Consultant.
5. If any major equipment is using a small component of make other than that given as a standard component with the equipment the same shall be accepted.
6. If any make is not available in the respective subheads of Equipment, in such case makes available in other subheads shall be applicable.