

HLL Lifecare Limited (HLL)

Tender No. HLL/HQ/NOIDA/2015

Request for Proposal (RFP)

for

CONSTRUCTION

OF

HLL OFFICE BUILDING (PHASE II)

AT

B-14A, SECTOR 62, NOIDA

THE COMPLETE TENDER DOCUMENTS CONSIST OF THE FOLLOWING:

- **Volume- I (NIB & ITB)**
- **Volume-II (GCC & SCC)**
- **Volume-III (Tech. Specs)**
- **Volume-IV (BOQ)**

Volume – III

- **Technical Specifications (TS)**

(March, 2015)

HLL Lifecare Limited
B-14A, Sector – 62,
NOIDA (UP) -201307

**CONSTRUCTION OF HLL OFFICE BUILDING (PHASE II) AT
B-14A, SECTOR 62, NOIDA**

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Construction of HLL Office Building (Phase-II) at B-14A, Sector 62, NOIDA

TECHNICAL SPECIFICATIONS

CHAPTER A

A BRIEF OF REQUIREMENT OF THE WORK:

1. General Scope of Work :

The scope of proposed work consists of construction of HLL Office Building at Plot No. B-14A, Sector 62, NOIDA. The building consists of two basements, Ground/Stilt plus four floors with infrastructure facilities including External Development Works.

The work includes a number of specialized Civil and Plumbing / Electrical / HVAC/ Mechanical / Firefighting System/ Lifts/Electronic services etc. to be executed as integral parts of the project

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, UPS
- k. Solar energy Systems.
- l. Interconnection works with respect to the existing Building,
- m. Additional works as required in the existing Building & Compound.

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 e to k above of works mentioned in Para 2 above to the HLL. Particular agency shall be approved by 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
- f. For items not covered by any of the above, the work shall be done, as per sound engineering practices and as directed by the Engineer-in-charge.

CHAPTER B

TECHNICAL SPECIFICATIONS AND CONDITIONS- CIVIL WORKS

1. EARTH WORK: As per relevant CPWD specifications.

- a. Irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract, the excavated earth shall be disposed of by the contractor at his own cost to the place as directed by Engineer – in-charge and/or permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the HLL for disposal of this excavated earth.
- b. 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.
- c. 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 issue 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, if required, within a period of 30 days from award of work. The contractor shall install batching plants (with in 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.
 - 1. It shall be fully computerized.
 - 2. Facility to pump concrete upto the highest point of the building.
 - 3. It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.
 - 4. 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.

- a) It shall be fully computerised.
 - b) It should have supplied RMC for Govt. projects of similar magnitude.
 - c) 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-in-Charge reserves the right to exercise check over the:-
- a) 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.
 - b) Calibration check of the RMC.
 - c) Weight and quality check on the ingredient, water and admixture added for batch mixing.
 - d) Time of mixing of concrete.
 - e) 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:-

a) 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.

b) 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,

c) 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.

d) 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.

e) 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.

f) 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.

g) PRODUCTION OF CONCRETE

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

- i) 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.
- ii) 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.
- iii) 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.
- iv) 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.

- v) Sampling of concrete, testing monitoring of results.
- vi) 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.
 - i) No addition of water or other ingredients shall be permitted in the RMC at site or during transit.
 - ii) 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.
 - iii) Pre-paid delivery tickets shall be produced with each truck load of RMC.
 - iv) The representative of RMC supplier shall attend the site meeting as and when decided by the Engineer
- x.
 - i) 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.
 - ii) 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)

a. HORIZONTAL SURFACE (RAFT SLAB)

i. Before the raft reinforcement is placed in position:

- a. Laying PCC as per drawings and specifications.(payable under the corresponding item)
- b. Cement slurry (cement and approved water proofing compound) is spread on the PCC for proper bonding with subsequent water proofing treatment.
- c. 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.
- d. After 24 hours, spreading cement slurry (cement and approved water proofing compound) on the 1st layer of mortar.
- e. 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:

- a. 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.
- b. 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.
- c. 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**

- a. The external surface is prepared and approved cement slurry is applied.
- b. 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.
- c. 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.
- d. 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.
- e. 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.
- f. 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. CEMENT PLASTER: - The use of PPC Cement shall be preferred.**6. 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.

7. 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.

8. 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 must 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.

9. **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.
- v. **Shop drawing:-** The contractor shall submit including required designing shop drawing for doorframes, shutters complete with
 - a. Plan, elevation with relative position of adjacent works
 - b. Glazing details with type size and fixing
 - c. Fitting and fixtures with type size, brand and fixing details.
 - d. 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. **Wooden Fire Doors & Frames**

- i. **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.
- ii. **Door Shutter:-**
 1. 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/m³ 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.
 2. The intumescent sealant shall be used to fill the gaps between board and internal wooden lipping.
 3. 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.

- iii. **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.
- iv. **Ironmongry Hinges:** - Stainless steel ball bearing butt hinges, 3mm thick shall be fixed flushed to the frame and shutter.
- c. **Metal Fire Doors & Frames:** - These shall conform to the BOQ and CPWD specifications.
- 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.

10. 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
 - 1. Metal finish: 150mm long section of patch fittings, rails and other items.
 - 2. Glass: 150mm square, showing exposed edge finish.
- e. MATERIALS
- i. Glass
 - 1. 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.
 - 2. 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
 - 1. Patch fittings: Stainless steel clad aluminium

2. 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.
3. Rails: Stainless steel clad aluminium.
4. 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.
5. Anchors and fastenings: Concealed
6. Weather stripping: Sweep type

iii. Hardware

1. Hardware should be heavy duty in matching finish
2. Concealed Floor Closer and Top Pivots
 - a. Centre hung; BHMA A156.4, Grade 1; including cases, bottom arm, top walking beam pivots, plates, and accessories required for complete installation.
 - b. Swing : Double acting; Positive dead stop, concealed with hold open angle
 - c. Delayed action closing
 - d. Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.
 - e. Push-pull set : Stainless steel finish
3. Lock set of approved make.

f. FABRICATION

1. 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.
2. Factory assembled components and factory installed hardware to greatest extent possible.

g. EXECUTION

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

h. CLEANING

1. The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes.
 2. 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.
 3. 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.
 4. 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.
 5. Prior to snagging inspections the Contractor shall, remove the internal protection sheets and carry out a thorough cleaning of all glass and aluminum.
 6. 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.
 7. 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.
 8. 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.
 9. 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.
 10. 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.

11. 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 1st 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.

12. 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.

13. 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.

| GLASS INSULATION WOOL BOARD (GREEN BUILDING) | | | |
|---|--|--|-----------------------|
| | Test Parameters | Standard Value | Tolerance |
| 1 | Physical Test | | |
| a | Visual Appearance | | |
| b | Shots Content | Free from Shot Content (Tested as per IS : 8183) | |
| c | Dimensions | | |
| | i. Length | 1200 mm | +20 mm/ -10 mm |
| | ii. Width | 600 mm | +10 mm/ -10 mm |
| | ii. Thickness | 100mm | +5 mm/ -5 mm |
| d | Bulk Density | 48 Kg/M ³ | ± 15% |
| e | Hydrophobic / Non Hyderophobic Behavior (Tested as per Is – 8183 / 3144) | | |
| | i. Moisture Content | 2.0% Max | |
| | i. 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) | |
| 2 | For Long Life Functionality / Dimension Retention / Rigidity | | |
| 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 | |
| 3 | Chemical Test :- Resistance To Corrosion Attack | | |
| 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) | |
| 4 | Type Test | | |
| a | Thermal Conductivity | 0.3 w/m k (At 25 dg. C mean temp.) | |

b. Installation Guidelines:-

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

14. ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

- 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 must 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 synchronies 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 must be visually flat. Any stiffener applied to compensate for wind load must 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 ⁴ /m |
| E | Acoustic Properties | Average airborne sound transmission loss R/N 25db (DIN 4109) |
| F | Mechanical Properties | Tensile strength \geq 130 N / mm ² 0.2 % proof stress 90 N / mm ² Elongation 5 % Modules of elasticity 70,000 N/mm ² |
| G | Thermal Transmittance | R = 0.014 m ² °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 Engineer-in-Charge for the design of the ACP and structural Glazing System.
- i. **Design Wind Loading**
- 850 N/m² positive and negative to Podium.
 - 1150 N/m² positive and negative to Tower.
 - 1500 N/m² 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.

b. Fixings

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

c. Weather seal

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

15. STRUCTURAL GLAZING SYSTEM

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/m² positive and negative to Podium.
 - 1150 N/m² positive and negative to Tower.
 - 1500 N/m² 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 must 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 must 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, must not exceed 9mm total at any location.

Change in deviation must 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 HLL.

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 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 Engineer-in-charge 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/m² 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 Engineer-in-Charge.

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 HLL.

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 HLL.

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 Engineer-in-Charge'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 Engineer-in-Charge.

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.

16. 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.

17. 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/cm². 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.

18. 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.

19. 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)

20. Antibacterial Paint

- 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.

21. 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 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.

22. 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.

23. 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.

24. 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.

25. 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

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:
 - a. Wall hung wash down or
 - b. single or double siphon type or
 - c. As per BOQ
- ii. Each W.C. set shall be provided with an approved type of plastic/wooden 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.
- iii. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- iv. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

b. Health faucet/spray (Optional)

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:

- b. For kitchens, pantries, and designated utility rooms the sinks shall be stainless steel sinks with or without drain boards.
- c. 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.
- d. 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.
- e. Each sink shall be provided with hot & cold CP mixer with approved type of a neck spout or individual taps as directed by the Project Manager.

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. 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.

8. 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:-
 - a. Sand Cast Iron Pipes & Matching Fitting shall be in conformity to I.S. 1729
 - b. 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
 1. 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.
 2. Fittings shall be of the required degree of curvature with or without access door.
 3. 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
 1. 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).
 2. 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.

3. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Project Manager/Building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

4. Clamps

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. For sleeves, RCC cutting, hole, chasing etc. anchor fasteners and clamp spacing chart see Special Conditions.
7. 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 and anti-siphonage pipes shall be jointed with Lead joint/Drip seal joint as mentioned in the BOQ. The following minimum procedures shall be complied with while making the pipe joints:-

- i. Ensure that the pipes are clean internally and undamaged.
- ii. The pipes shall be cut square with sharp tools.
- iii. The cut ends of the pipes shall be filed/ reamed and finished smooth.
- iv. Any deformed ends shall be re-rounded.
- v. It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.
- vi. The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.
- vii. Each metal pipe spigot shall be centered with three lightly wedged pieces of hardwood or folded lead.
- viii. The jointing surfaces shall be cleaned to remove any coatings or cutting oils, etc.

f. Floor Trap Inlet/GI Inlet Fitting:

Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type cast iron or G.I. inlet hopper without or with one or two or three inlet sockets to receive the waste pipe. Joint between G.I. waste pipe and hopper inlet socket shall be Drip seal joint. Hopper shall be connected to a CI 'P' or 'S' trap with at least 50mm seal (hopper and traps shall be paid for separately). Floor trap inlet hoppers and the traps shall be set in cement concrete blocks/and supports as required for Floor trap above shall be provided without any extra charge.

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 Project Manager.

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 cromate 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 chase 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 Project Manager.
- g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.
- h.

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 HLL's 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 / CPCV steel tubes conforming to I.S. 1239 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 Project Manager. 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 Project Manager.

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:
 1. On straight runs not exceeding 30 m, near bends and at connections to main branch lines.
 2. On all valves ends
 3. On equipment /pump connections as necessary and required or as directed by Engineer – in - charge.
- j. 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.

k. 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.

- i. 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.

m. 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.

n. 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)

o. 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 $30 \pm 2 \text{ kg/cum}$.

5. Valves

a. Ball valves

- i. 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^2 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. Overhead Tanks

Overhead water storage tanks for water supply shall be reinforced cement concrete .

b. Tank connection and accessories

- i. Contractor shall provide the following to each tanks:
 1. Inlet and outlet connections to pumps, equipment and main pipe lines.
 2. Tank overflows with mosquito proof gratings
 3. Scour drain and valve as per drawings
 4. 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.

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 /cm² 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. Project Manager's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

SECTION – 5 **Water Supply Pumping System & Allied services**

1. Scope of work

- a. 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 supply pumping 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:
 1. 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, if required.
 2. 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 .

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 Project Manager.

v. Cabling from PHT sensing probes to the panel

5. Pressure filters for Water Supply System , if required.

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^2 (Test pressure 3.75 kg/cm^2). 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^2 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.

d. Water Filtration Plant (For Domestic Water)

- i. Design parameters for the proposed filter shall be as follows:
 1. 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%.
 2. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer's design)
 3. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m^2 of filter surface area and water supply from raw water pumps by reverse flow)
 4. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria

e. Chemical Dosing Pumps

- i. Pump applications
 1. 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.

f. Air Blower for Back Washing

- i. 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.
- ii. 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/m² air capacity at 0.5 kg/cm² pressure. (This may be modified to suit manufacturer's requirement for filters offered.)
- iii. The electrical switchgear shall be included in the respective MCC panel of the system

SECTION 6 Pipes & Fittings

1. Headers, piping and connections

- a. 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. /CPVC pipes medium class and thickness specified. Pipes up to 150 mm dia. shall conform to I.S. 1239.
- b. 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.
- c. 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.
- d. 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 Project Manager.

2. Jointing

a. 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)

b. Flanged joints / Dead Joints

- a. Flanges shall be provided on:
 - i. Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.
 - ii. Both ends of any fabricated fittings e.g. bends, tees etc. of 50 mm dia or larger diameter. (When Permitted)
 - iii. Both end of all suction delivery and other headers.
 - iv. For jointing valves, appurtenances, pumps, connections with pipes, to water tanks and other places necessary and required as good for engineering practice.

- v. Flanges shall be as per applicable I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion rubber gasket complete.
- vi. The cost of flanges is included in the rates of pipes along with fittings.

c. 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.

d. 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.

3. Valves

a. Sluice valves

- i. Full way Sluice Valves shall be used on the suction connection to pumps and headers.
- ii. 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.
- iii. Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class

b. Butterfly Valves (PN 1.6 rating)

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

c. Non Return Valves (NRV PN 1.6 rating))

- i. Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
- ii. 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
- iii. Built in flanges for screwed on flanged connections.

d. 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/cm² and accompanying coupling and steel handles (to B.S. 5351).

4. '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.

5. Measurements (Part 1, 2 & 3)

a. General

- i. 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 be measured separately in this contract only.
- ii. All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

b. Drainage Pumps & Sewage Pumps

Drainage pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

c. 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.

d. 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.

SECTION 7 Specifications for Electrical Installation

1. Electrical Control Panels

a. General

- i. 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.
- ii. The Switch Boards shall comply with the latest edition with up to date amendments of relevant Indian Standards and Indian Electricity Rules and Regulations.

b. Switch Board Configuration

- i. The Switch Board shall be configured with Air Circuit Breakers, MCCB's, and other equipment as called for in the Schedule of Quantities.
- ii. 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.
- iii. The Switch Boards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear.

c. Equipment Specifications

- i. 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.

d. Constructional Features

- i. The Switch Boards shall be metal enclosed, sheet steel cubicle pattern, extensible, dead front, floor mounting type and suitable for indoor mounting.
- ii. 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 54 as specified. All doors and covers shall also be fully gasket with synthetic rubber and shall be lockable.
- iii. 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.
- iv. All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.
- v. 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.

e. Switchboard Dimensional Limitations

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

f. Switch Board Compartmentalisation

- i. The Switch Board shall be divided into distinct separate compartments comprising.
- ii. A completely enclosed ventilated dust and vermin proof bus bar compartment for the horizontal and vertical bus bars.

- iii. Each circuit breaker and MCCB shall be housed in separate compartments enclosed on all sides.
- iv. Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "on" and "off" position.
- v. 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.
- vi. A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.
- vii. 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.
- viii. Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from top.
- ix. Adequate and proper support shall be provided in cable compartments to support cables.

g. Switch Board Bus Bars

- i. 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.
- ii. The bus bars and interconnections shall be insulated with insulation tape/ fiber glass.
- iii. The bus bars shall be extensible on either side of the Switch Board.
- iv. 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.
- v. All bus bars shall be colour coded.
- vi. 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.

h. Switch Board Interconnections

- i. 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.
- ii. 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.

i. Draw out Features

- i. 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.

j. Instrument Accommodation

- i. 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.
- ii. For MCCB's instruments and indicating lamps can be provided on the compartment doors.
- iii. The current transformers for metering and for protection shall be mounted on the solid copper/aluminium bus bars with proper supports.

k. 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.

l. Cable Terminations

- i. 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.
- ii. The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located at the rear / top of the panel.
- iii. 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.
- iv. 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.

m. 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.

n. 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.

o. 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.

p. Sheet Steel Treatment and Painting

- i. 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.
- ii. 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.

q. 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.

2. 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. Project Manager 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

3. Testing at Site

- a. 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.
 - i. 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.
 - ii. Physical checking and inspections of Inter panel wiring
 - iii. Checking free movement of ACBs/MCCBs/SFUs
 - iv. Checking of operation of breakers
 - v. Insulation tests of bus bar supports and control wiring etc. with 1.1 kV megger.
 - vi. Primary & secondary injection tests of relays and CTs.
 - vii. Checking of Interlocking function.

4. Cables

i. Medium Voltage Cables

- a. 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 mm² shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 mm² 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 |
| 3.5/4 Cores | : | Red, Yellow, Blue and Black |

b. Current ratings shall be based on the following conditions.

| | | |
|------|-------------------------------|---------|
| i. | Maximum conductor temperature | 70° C |
| ii. | Ambient air temperature | 45° C |
| iii. | Ground temperature | 30° C |
| iv. | Depth of laying | 1000 mm |

c. Short circuit rating of cables shall be as specified in IS 1554 Part-I.

d. 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.

e. 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.

ii. On Trays/Walls

a. 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.

b. 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.

- iii. 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.

5. 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.

6. 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.

7. 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.

SECTION 8 Commissioning and Guarantees

1. 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.

2. General requirements:

- a. 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
- b. Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.
- c. 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.

3. Pre commissioning

- a. 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:-
 - i. Testing of M.C.C
 - ii. Tests to be carried out for motor control centres shall be:
 - iii. Insulation resistance test with 500 volt megger, before and after high voltage test, on all power and control wiring.
 - iv. High voltage test sat 2000 volts A.C. for one minute on all power and control wiring.
 - v. 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.
 - vi. Low Voltage continuity test (6 volts) on all control wiring.
 - vii. 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.
 - viii. 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.
 - ix. Operation of all instruments and meters provided on the MCC.

b. Pipe work

- i. Check all clamps, supports and hangers provided for the pipes.
- ii. 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.
- iii. Check all face piping and valves
- iv. check air blower connections

4. Commissioning & testing

a. 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.

b. Test runs the entire system to ensure satisfactory performance.

5. Handing Over

a. All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager and the job handed over to the Project Manager or his authorized representative.

b. Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals, 4 sets of As Built drawings and all other items as per the terms of the contract with soft copy.

6. Guarantees

a. The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

b. The form of warranty shall be as approved by the Engineer-in-charge.

c. The warranty shall be valid for a period of one year from the after getting virtual completion certificate.

d. The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

e. 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 Project Manager.

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

SECTION 9 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
 - a. Centrifugal pumps- I.S. 1520
 - b. Electrical Motors - I.S.7538
- xii. Pipes
 - a. G.I. Pipes - I.S. 1239
- xiii. Valves
 - a. Butterfly Valves-IS 23339/13095
 - b. Slim Type NRV-I.S. 7312
 - c. Sluice valve -I.S. 780
- xiv. Vibration Eliminator
- xv. Water Shock Absorbers
- xvi. Pipe Colour Code as per I.S. 2379-1983.

SECTION 10 Technical Information for Water Supply & Drainage Pumps to be furnished by Bidder:

- i. **Pumps**
 - a. Make
 - b. Model
 - c. Pump Discharge - Max/Min
 - d. Pump Head Min/Max,
 - e. Impeller Material
 - f. Motor HP
(Specify make, class of insulation & rated voltage \pm %)
 - g. Shaft Seal Type & make
 - h. Type of Coupling
 - i. Efficiency of Pump
 - j. Type of Bearings
 - k. RPM

ii. Pressure Tanks (Where specified)

- a. Make
- b. Material of Construction
- c. Internal finish
- d. External finish
- e. Air balloon/ diaphragm
- f. specifications

iii. Submersible pumps - Basement Sewage

- a. Make

- b. Model No.
- c. Pump discharge lpm - max / min
- d. Pump head min/max,
- e. Impeller material
- f. Motor HP (Specify make, class of insulation & rated voltage \pm %)
- g. Shaft seal Type & make
- h. Type of coupling
- i. Efficiency of pump
- j. Type of bearings
- k. RPM

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

- a. Make
- b. Type (floor/wall mounted)
- c. Make of switch gear
- d. Make of meters
- e. Make of accessories
- f. Confirm that all switch gear starters match the capacities of pumps offered.

v. Power & control cables

- a. Make

vi. Electronic Level controllers

- a. Make
- b. Model No.

vii. Electronic High Water Alarm

- a. Make
- b. Model No.

viii. Electronic Level Indicator

- a. Make
- b. Model

ix. Pipes /CPVC

- a. Make offered
 - i. Heavy Class 150 mm dia. & below
 - ii. Heavy Class 200 mm dia. & above
- b. CPVC Pipe

x. Butterfly Valves

- a. Make
- b. Material
- c. Test pressure

xi. NRV Slim Type

- a. Make
- b. Material
- c. Test pressure

xii. Vibration eliminators

- a. Make

- b. Material
 - c. Test pressure
- xiii. **Pressure**
 - a. Working pressure
 - b. Test pressure
 - c. Filtration/holding Capacity
 - d. Inlet/outlet sizes
- xiv. **Painting/coating**
 - a. Inside
 - b. Outside
- | | | | | |
|------------|---|------------|-------------------|--------------------|
| xv. | Equipment | - | Air Blower | Chlorinator |
| | a. Make | | | |
| | b. Model | | | |
| | c. Pump Discharge | -Max/Min | | |
| | d. Pump Head | - Min/Max, | | |
| | e. Impeller Material | | | |
| | f. Motor HP (Specify make, class of insulation & rated voltage \pm %) | | | |
| | g. Shaft Seal | | | |
| | h. Type of Coupling | | | |
| | i. Efficiency of Pump | | | |
| | j. Type of Bearings | | | |
| | k. Speed of Pumps | | | |
- xvi. **Motor control centres**
 - a. Type (floor/wall mounted)
 - b. Make of switch gear
 - c. Make of panel meters
 - d. Confirm that all switch gear starters are of capacities for pumps offered.
- xvii. Pipe fitting scheduled.
- xviii. C.I. Pipe
- xix. RCC Pipe.
- xx. L.A. Pipe.
- xxi. HDPE Pipe.
- xxii. Insulation Material
- xxiii. Flow Meter.
- xxiv. PRV
- xxv. Hyroneumatic Pump.
- xxvi. Water meter.

CHAPTER D

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 say 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 dying 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 abeled. 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 E

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 (BSES) 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, stoving 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 F

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.

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| 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. |

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|-------------------|---|
| 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 |
|-----|---|---------------------------------|

6 CABLE DETAILS

| | | |
|----|------------------|---|
| i. | Internal Wiring. | Copper conductor PVC insulated 1.1 KV grade as called for in BOQ. |
|----|------------------|---|

- 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 G

TECHNICAL SPECIFICATIONS FOR ELECTRIFICATION

SECTION –I : 11KV VCB SWITCHGEAR

SCOPE

All the necessary Approvals & Liasoning for Load enhancement from present approved load to the required load shall be in the scope of the contractor. Only fee paid to the authority shall be reimbursed against the submission of the receipt and nothing shall be paid extra.

All the necessary arrangement for connecting existing ESS to the proposed new ESS shall be in the scope of contractor

Manufacturing and supplying of integrated cubicle type metal clad, form 3 a, floor mounted and draw out type free standing, front operated indoor type 11 KV switchgear as per specifications given below:

The switchgear enclosure shall conform to degree of protection IP 4 X. The switchgear shall be made from MS sheet steel 2 mm thick (CRGO) 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 arrestor.

2 STANDARDS AND CODES

Updated and current Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 2003, Indian Electricity Rules 1956, National Building Code 2005, National Electric Code 2008, Code of Practice for Fire Safety of Building (general): General Principal and Fire Grading – IS 1641 - 1988 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

11000 volt Circuit Breaker IS 13118; 1991

Metal Enclosed Switchgear and Control gear for voltages above 1000 volts IS 3427: 1969

Electrical Relays for Power System Protection IS 3231: 1986

Voltage Transformers IS 3156: 1978

Current Transformers IS 2705: 1981

Rubber Mats for Electrical Works IS 5424: 1983

Danger Notice Plate IS 2551: 1982

AC isolators and earthing switches IEC 129

AC metal enclosed Switchgear IEC 298

HT AC contactors

3 BREAKER COMPARTMENT

Vacuum Circuit Breaker shall be mounted in draw out truck 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.

4 BUS BAR COMPARTMENT

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents up to 18.4 KA for one second shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

5 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.

6 SEPARATE COMPARTMENTS

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a district different compartments as required for form 3 a, compartmentalization. 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.

7 TECHNICAL PARTICULARS OF VCB CIRCUIT BREAKER

| | | |
|--------------------------------------|---|--------------------|
| Rated Current | - | 630 A |
| Rated Voltage | - | 11 KV |
| Rated Frequency | - | 50 Hz |
| Rated Short Circuit breaking Current | - | 18.4 KA for 1 Sec. |
| Rated short circuit making current | - | 50 KA |
| Insulation Level (KV rms/KVP) | - | 28KV / 75 KV |

8 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.

9 ISOLATING CONTACTS

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ± 10 mm.

10 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

11 INTERLOCKS

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 cannot be switched 'ON' when the truck is in any position between test and service position.

Front part of the truck cannot be removed when the breaker in 'ON' position.

The low voltage plug and socket cannot be disconnected in any position except test/isolated position.

The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.

Earthing switch cannot be switched 'ON' when the truck is inside the panel.

The truck cannot be inserted when the earthing switch is 'ON'.

12 SAFETY DEVICES

The following Safety devices shall be provided for the safety of the operating personnel:

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.

Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.

Circuit breaker and sheet metal enclosure shall be fully earthed.

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.

13 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.

14 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 secondary's.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CT's 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

15 POTENTIAL TRANSFORMERS

The potential transformers shall be confirming to IS 3156/ IEC 185. 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 – 609385/ IEC – 282. Miniature Circuit breaker shall comply with IS –608828/ IEC – 898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

| | | |
|------------------------|---|--------------------------------------|
| Ratio | : | 11000/ V3/ 110/ V3/ 110 V |
| V A Burden | : | 100 V A for 100/V3 and 110 V winding |
| Class | : | CL –1 for both the windings. |
| Basic Insulation level | : | 28/75 KV |
| Over voltage factor | : | 1.2 Continuous |

Single phase PT'S shall be used and shall be connected in Star/ Star.

16 PROTECTION AND TRIPPING ARRANGEMENT

PROTECTION

The protection and tripping arrangement of circuit breaker shall be :

Numeric Type Instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.

Numeric Type Back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.

Numeric Type Ground fault protection Device No.50G with stabilizing resistor. CT's. Range 20 – 80% shall be provided.

Lockout and trip supervisory relays etc shall be provided with manual reset facility.

Auxiliary relay for transformer fault.

Surge Arrestor

17 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.

18 METERING INSTRUMENT PANEL ACCESSORIES

METERING

Digital type Trivector meter of approved make shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy : Class 0.2, compliant to revenue class certification.

ANS I – C 12.20 – 1998 on all measurements.

- : Real time measurement per phase & average
V, I, PF, KW, KVAR, KVA
- : Peak demand, sliding window. Protected.
- : V & I unbalance, Phase reversal
- : Time of Use (TOU)

Power Quality Measurement : Total Harmonics

Logging & recordings for all measurement: Interval or event-based, 32
channel measurement &
recording

- : Event logging
- : "Bust" data recording
- : Min/ Max recording
- : Over & under measurement detection by
24 set point functions.

Alarming

Multiport Communication : One each of RS 485 and RS 232 ports.

II. INSTRUMENT PANELS

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

III. INSTRUMENTATIONS

Digital type Power factor meter of class of 1.0 accuracy conforming to IS : 1248 shall be provided at incomer panel.

Digital type Ammeter of specified range to class 1.0 accuracy and 96 x 96 sq mm in size as per IS - 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

Digital type frequency meter class of 1.0 accuracy conforming to IS:1248 shall be provided at incomer panel.

IV. The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open / closed / tripped, spring charged, trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

V. After meeting all necessary control and indication requirements 2 nos. NO and 2 nos.. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block.

VI. Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.

VII Anti-condensation space heaters suitable for operation on 240 V single phase, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

19 DRAWINGS/DOCUMENTS REQUIRED FOR REVIEW/APPROVAL

Following drawings documents shall be submitted by the manufacturer for approval.

General arrangement (GA) of equipment layout.

Equipment list.

Relay and metering system schematics.

Supply and erection schedule.

Catalogue and specification sheets.

20 QUALITY ASSURANCE

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.

21 TEST AT MANUFACTURERS WORKS

Copies of type tests and of routine tests carried out at manufacturer's works shall be furnished along with the delivery of the switchboards. Architects/Owners reserves the right to get the switchboard inspected by their representative at manufacturer's works prior to dispatch to site to witness the routine tests, for which purpose the contractor shall provide the necessary facilities and also give due notice.

22 TESTS AT SITE

Pre-commissioning tests as per manufacturer's recommendations shall be carried out on the switchboard a site after installation including but not restricted to the following.

Physical checking of the switchboard including checking for damage or cracks in components, bolt tightness, gasket ting etc.

Checking of vacuum bottles to ensure leak tightness

Insulation testing of Bus bar supports by 2.5 kV megger

Insulation testing of Control wiring by 1.1 kV megger.

Testing of relays and CTs with secondary injection kit.

Checking of breaker operation.

Checking of earth continuity.

High potential test / Pressure testing

SECTION –II : DISTRIBUTION TRANSFORMER

A. 11/0.433 KV OIL TYPE DISTRIBUTION TRANSFORMER WITH ON LOAD TAP CHANGER MECHANISM WITH AUTOMATIC VOLTAGE REGULATOR

1 GENERAL

The step down double wound core type transformers shall be suitable for Outdoor mounting with a voltage ratio of 11000/433 volts and of the naturally oil cooled with a Delta/Star configuration. The transformer shall comply with the regulations of IEC 76, B.S. 171 and I.S. 11171: 1985 as amended up to date.

2 TRANSFORMER DETAILED SPECIFICATIONS

2.1 TRANSFORMER OPERATION

The transformer shall be suitable for operation on 11 kV, 3 phase 50 cycle earthed system, connected Delta on H.V. side and star on the L.V. side with neutral brought out for independent Earthing (Vector Group DYN II). The transformer shall be suitable for continuous operation at the rated capacity under Site conditions.

2.2 TRANSFORMER MATERIAL

The material used in the manufacture of the transformer shall be of the best quality of their respective kind available as per standard specifications.

2.3 CORE

The core shall be built up with high grade non-aging, low loss and high permeability CRGO lamination special silicon steel suitable for transformers. After being sheared, the lamination shall be treated to remove all burs and shall be reannealed to remove all residual stresses. Each lamination shall be coated with a durable, insulating coating. Core assembly shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformers. Core and coil shall be so fixed that there is permanent displacement of windings on other parts when the transformer is moved or during short circuit. Core frame parts shall be galvanized.

2.4 WINDINGS

The HV and LV windings shall be of copper conductors using highly densified glass fiber reinforcement. Temperature rise of winding shall not 50 deg C by resistance on continuous full load above ambient of 500C and temperature rise of oil shall not exceed 45 deg C above ambient of 50 deg C. Flux density at any point in winding and core shall not exceed 1.7 T on normal rated voltage and frequency.

2.5 On Load Tap Changer (OLTC)

The transformer shall be provided with an Automatic On Load Tap Changer (OLTC) with Remote Tap Changer Control (RTCC) facility. The OLTC suitable for an incoming voltage variation from +10% to -10% in 16 steps on H.V side so as to give a near constant voltage of 433 volt on the L.V. side. The OLTC shall be provided with automatic voltage sensing relay and shall be fully automatic in operation.

The OLTC shall be supplied with the first filling of the oil, oil surge relay, shut off valve for the OLTC oil surge relay, trip contracts, access windows for OLTC connection etc. The OLTC shall be provided with motorized / manual operation alongwith handle for operating manually. Mechanical tap position indicator shall be provided.

OLTC shall be provided with remote / local operation facility with selector switch for remote/local operation. The Remote Tap Changer Control (RTCC) shall have remote indicator for the position of the steps and automatic voltage regulating relays. The RTCC shall have Push buttons for Raise and Lower. The RTCC shall have indicating lamps for :-

Tap in progress

Raise

Lower

Out of step indication

2.6 INSULATION CLASS

The insulation material used shall be insulation class 'A'.

2.7 TRANSFORMER TAPPINGS

'ON' load tap changing links on HV side. The tappings to be provided for variation on HV side from + 10% to – 10% in steps of 1.25%. each.

2.8 TRANSFORMER CHARACTERISTICS

The no load voltage ratio of the transformer shall be 11000/433 volts and the percentage impedance shall not exceed 5% or as per IS.

2.9 TRANSFORMER TERMINATIONS

The transformer shall have self supporting cable boxes with suitable glands and cable sockets for receiving 11,000 volt grade XLPE cables on the H.V. side as required.

On the MV side the transformer shall have a suitable self supporting terminal arrangement with extended busbars to receive 1100 volt grade PVC insulated and sheathed aluminium conductor armoured cable as specified.

2.10 TEMPERATURE RISE PARAMETERS

Thermistor sensors shall be embedded in the low voltage winding for warning and tripping, for temperature control. The temperature detectors shall be suitable for 24 volts D.C. The temperature rise when continuously operated of windings by resistance method shall not exceed 20 deg C over 50 deg C ambient for warning and 45 deg C over 50 deg C ambient for tripping.

2.11 TRANSFORMER FITTINGS

The transformer alongwith OLTC shall be manufactured in accordance with the requirements as specified in the Standards stated above and shall be fitted with:

1. Diagram and Rating plate
2. Lifting Lugs.

3. Two earthing terminals on either side of the tank.
4. Four bidirectional rollers on the under carriage for movement.
5. Winding Temperature Indicator with alarm contacts for alarm and trip circuits.
6. Externally operated tapping switch with position indicator & locking arrangement.
7. Terminal marking plate.
8. Jacking Lugs.
9. H.V. cable box for 3 core XLPE cable as required.
10. L.V. cable box suitable for reception of PVCA armoured cables or chamber for receiving bus duct as required.
11. Oil conservator with drain plug.
12. Oil filling hole and cap.
13. Filter valve with plug.
14. Drain valve with plug or cover plate.
15. Oil level indicator with minimum marking.
16. Dehydrating breather (Silica gel breather)
17. Air release valve.
18. Explosion vent.
19. Thermometer pocket with plug.
20. 150 mm dial type contact thermometer with maximum temperature indicator and alarm and trip contacts for oil temperature.
21. Buchholz relay of double float type with alarm and trip contacts and M.S. box for terminating control cables of 4 x 2.5 sq. mm. size.
22. L. V. Neutral bushing
23. Shut-off valve between Buchholz relay and conservator.

The transformer shall be complete with the first filling of insulating oil as per IS 335 - 1983 including makeup fill at site.

2.12 TRANSFORMER GUARENTEED TECHNICAL PARTICULARS

The following guaranteed technical particulars of the transformer shall be furnished.

- a) Core loss
- b) Load loss
- c) Percentage Impedance

2.13 TRANSFORMER TESTING

Prior to acceptance and dispatch of the transformer, the owner reserves the right to witness the routine tests at manufacturers works. The transformer shall be subjected to the following routine tests as per relevant Standards at the manufacturers Works. The test certificates shall be submitted to the Owners/Architects for approval prior to dispatch. Except type test.

- a) Measurement of Winding Resistance
- b) Ratio polarity and phase relationship
- c) No load and load losses
- d) Impedance voltage
- e) No load and load current
- f) Insulation resistance
- g) Induced over voltage withstand
- h) Separate source voltage withstand

In addition type test certificate for following parameters shall also be submitted to Owners / Architects for record. Any type test if specifically asked for by Owners shall be carried out on the equipment covered by this contract shall be done at extra cost prior to dispatch.

- a) Temperature Rise
- b) Impulse voltage withstands.

2.14 INSTALLATION

The transformer shall be installed as per the manufacturers instruction manual and shall conform to the requirements of IS 10028 : 1981.

Transformer and all other accessories shall be handled carefully in its upright position as indicated on the packing cases. Lifting lugs and jacking pads shall be use for lifting the transformer. 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.

Transformer shall be mounded on concrete plinth/foundation prepared for the purpose. Rollers shall be checked and locked to prevent movement of the transformer after being positioned after on the plinth.

The transformer cable end boxes shall be sealed to prevent entry of moisture.

The transformer neutral and body earthing shall be as per the requirements of IS 3043-1966 and the Local Inspecting Authorities

2.15 COMMISSIONING TESTS

The following tests shall be carried out prior to commissioning at site by third party

- a) Insulation resistance of the winding between phases and phase and earth on the H.T. side.
- b) Winding resistance of all the windings on all tap positions.

- c) Voltage ratio test shall be carried out by applying low voltage on H.T. side and measuring the voltage between phases and phase and neutral on the L.T. side for every tap setting.
- d) On commissioning of the transformer the following readings shall be taken
 - MV side voltages at all tap settings
 - Temperature rise under no load conditions
- e) Transformer oil test
- f) If necessary, the transformer shall be heated by applying low voltage on the HT side and shorting the LT side. This shall be done for a period of 48 hours or till all the moisture has been removed from the transformer.

3.0 L.T. PANELS & SWITCHGEARS

The contractor shall consider the following details in their scope of works no additional cost shall be paid, wherever required:

- Supporting rigid steel framework.
- Cubicle type, 14 gauge CRCA sheet steel enclosed.
- Complete with interconnections and distribution bus bars.
- Proper bonding to earth.
- Painting/ lettering on Breakers and distribution boards, the location they serve, providing on each panel its circuit diagram.
- Providing cable clamps / supports within distribution boards cable alley.
- TPN ACB's / MCCB's shall mean 3 pole ACB's / MCCB's with adequate size of neutral link.
- All MCB's /MCCB shall be of minimum KA breaking capacity as per CPWD General Specification Part-IV Substation
- All motor feeders MCCBs shall be of motor duty.
- Distribution panels shall be Powder Coated with Siemens gray paint shade no. RAL-7032 of IS-5 or as per direction of EIC.
- Degree of protection for following type of distribution panel enclosure shall be as per IS: 13947-1993.
- All MCCB's shall be provided with operating mechanism for door interlock.
- Current density of aluminium shall be 0.8amp per sqmm for rated current of bus bars and current density of copper shall be 1 sq.mm for 1.2 amps for rated current of bus bars.
- Tinned copper earth bus shall be provided through out the length of each board.
- All measuring instruments (Meters) shall be of digital electronic with LED of approved make and compatible with BAS.
- All hinged door shall be earthed through 2.5 sq mm tinned braided copper wire.
- All panels shall have provision of the following:
 - Pad locking of Switch board doors.
 - Pad locking of MCCB's handles in "OFF" Position.
- Additional set of C.T.s, potential free contacts, connectors, contactors with wiring etc are to be provided for BAS including space required for various transducers in Main Switch Board sections. Only transducers shall be supplied by BAS contractor.

- All MCB's used for protection of resistive and lightly inductive load shall be type "B" characteristic and inductive (motor) load shall be of type "C" characteristic and discharge lamps and UPS etc. shall be of type D characteristic.
- All incoming and outgoing air circuit breakers shall be placed on middle portion of the vertical in single tier formation.
- All PTs / control transformer shall be provided with centre tap earth secondary.
- All DOL & Star-Delta Starters shall be provided with SPPR (single phase preventor relay) and 2 nos. of Aux.Contacts for Remote operation/monitor.
- The Panel fabricator shall provide Al./ Copper Bus-bars link from Breakers wherever more than two nos. of cables are terminated in the breakers.
- Readymade 16SWG Sheet steel Enclosure with cut out For MCBs
- The breaking capacity of MCCB's are mentioned panel wise. All MCCB's shall be with thermal magnetic releases upto 200 amps and microprocessor based above 200 amps capacity, unless specified otherwise.

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/mm² for Aluminium and 1.5 Sq.mm/mm² 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).

General Note for ACBs/MCCBs/MCBs

Preferred Specification/Selection of Air Circuit Breaker and Moulded Case Circuit Breakers; These should be confirmed entering into the agreements:-

- (I) MCCBs: MCCBs should preferably be used for loads below 800 Amperes.
 - (1) Upto 160 A MCCBs shall be of > 20 Ka (Ics=Icu) at 433 V Short Ckt. Current rating and should be Thermal Magnetic.
 - (2) From 200 A- 250 A MCCBs shall be of > 35 Ka (Ics= Icu) at 433 V Short Ckt. Current rating and should be Thermal Magnetic.
 - (3) From 300A0 onwards MCCBs shall be of > 50 Ka (Ics=Icu) at 433 V Short Ckt. Current rating and should be microprocessor based having over load and short circuit protection. If used as incomer should also have earth fault protection & time delay. Earth leakage modules are not acceptable.
- (II) ACBs: From 800 A onwards ACBs shall normally (MCCBs should be used judiciously for such loads) be used. These should have 50 Ka (Icu=Ics) Short Ckt. Current rating with microprocessor based overload, short circuit and earth fault protection at 415 volts, 50 Hz

ACB (IEC 60947-2; IS 13947)

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 Ics = Icu). 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 arching 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)

MCCB shall conform 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 devise 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 le
- Breaking Capacity equal to or more than 8 le

For AC4 Duty

- Making Capacity equal to or more than 12 le
- Breaking Capacity equal to or more than 10 le

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

- a. 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.
- b. 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.
- c. The Battery Charger shall have automatic output Current Limiting feature.

COMPONENTS

The Battery Charger shall essentially comprise of the following:

- a. 1 No. Double Pole ON/OFF MCB at A.C. Input.
- b. 1 No. Pilot Lamp to indicate Charger ON.
- c. 1 No. MAIN TRANSFORMER: Double Wound, naturally air – cooled, having Copper winding.
- d. 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 asphalting 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 HLL/ Consultant. Q.A. documents as applicable.

Q.A. involvement will commence at enquiry and follow through to commissioning 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 (amendement)

Summary on related directives

| Directive Ref. | Date | Objective | Remarks |
|---------------------------------------|-------------------|--|--|
| 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. <ul style="list-style-type: none"> • <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 Packaging 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: <ul style="list-style-type: none"> • <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+ > 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:

- i. 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.
- ii. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
- iii. 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.
- iv. 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.

- v. 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.
- vi. 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.
- vii. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
- viii. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
- ix. The normal current rating of all XLPE insulated cables shall be as per IS: 7098.
- x. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
- xi. Outer sheath shall be provided by extrusion process as per IS: 5831
- xii. 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.
- xiii. In plant repairs to the cables shall not be accepted.
- xiv. 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 hardwares 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 HLL.

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 | - | - | - | - | - | - |

| 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 |
| 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 be 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 be 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:

| 14.0 | SYSTEM SPECIFICATION FOR THE UPS | RG-6 | RG-11 | Quality power Supply The UPS shall be ON-LINE double |
|------|----------------------------------|---------------|---------------|---|
| | | 7CA4 | | |
| | Centre Copper Conductor Dia | 1.02mm | 1.63mm | |
| | 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 DbA at 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 Standard 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 niche 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 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.

CHAPTER H

TECHNICAL SPECIFICATIONS FOR D.G.SETS

General

All items of work under this Contract shall be executed strictly to fulfil the requirements laid down in the specifications. Type of equipment, material specification, methods of installation and testing and type of control 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 fulfil the above mentioned requirement.

The unit rate for all equipments or materials shall include cost in RUPEES for equipment and materials including all taxes and duties and also including forwarding, freight, insurance and transport into Contractor's store at site, storage, installation, testing, balancing, commissioning and other works required.

The rate for each item of work included in the Schedule 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 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 for the job in accordance with the contract documents, good practice and recognize 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 Schedule of Quantities and other documents including the Specifications, the most stringent shall apply. The interpretation of the Consultant/ Project Manager shall be final and binding.

All equipments, quantities and technical data indicated in this Schedule are for the Contractor's guidance only, these are based on the documents prepared by the Consultant.

This schedule must be read in conjunction with other 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.

This Schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK including NIL items.

No alteration whatsoever is to be made to the text or quantities of this Schedule unless such alteration is authorised in writing by Consultant. Any such alterations, notes or additions shall, unless authorized in writing, be disregarded when tender documents are considered.

In the event of an error occurring in the amount of the Schedule, as a result of wrong mention of the unit rate and quantity, the unit rate quoted by the tenderer shall be regarded as firm and the amount shall be amended on the basis of rates.

Any error in totalling in the amount column and in carrying forward total shall be corrected. Any error, in description or in quantity, omission of items from this Schedule shall not vitiate this Contract but shall be corrected and deemed to be variation required by the Construction Manager/ Consultant / Client.

Rates have been called for a number of items of works, as alternatives which, for the present do not form part of the total value of tender. However the rates for these items shall be quoted, with due care so that in the event of choice of an alternative item of work, said rate shall form part of the contract and shall not violate the contract any way.

The Contractor shall procure and bring Materials/ Equipment to the site only on the basis of drawings approved for construction and shop drawings and not on the basis of Schedule of Quantities which are provisional only. This also applies to the Contractor's requisition for Client supplied materials. Choice of make shall be as per approved makes

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 equipments 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 Consultants/Architect/ Owner 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 / trays 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 HLL's decision with regard to the quality of the material and workmanship will be final and binding, any material rejected by the HLL shall be immediately removed by the Contractor from the site. The HLL 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.

FOREMAN / SUPERVISOR

The Contractor shall employ a competent, licensed qualified full time electrical engg./ foreman/ supervisors to direct the work of electrical installations in accordance with the drawings and specifications. The foreman / supervisor shall be available at all times on the site to receive instructions from the Architect / Engineer in the day to day activities throughout the duration of the Contract and as long as there after as the consultants may consider necessary until the expiration of the "Defect Liability Period". The Foreman / Supervisor shall correlate the progress of the work in conjunction with all the relevant requirements of the supply authority. The skilled workers employed for the work should have requisite qualifications and should possess competency certificate from the Electrical Inspectorate of the Local Government. The Contractor shall on the request of the consultants immediately dismiss from the works any person employed there on who may, in the opinion of the consultants, be unsuitable or incompetent or who may misconduct himself and such person shall not be again employed or allowed on the work without the permission of consultants/Employee.

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) Sprit 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- 320 KVA

The D.G. set shall be provided with Diesel Engine of Model no. & no. of Cylinder as given below, vertical 4 stroke cycle, **Air cooled radiator** having turbo charged after cooled Engine at 1500 RPM under NTP conditions of BS: 5514. The D.G. set shall be provided with electrical

starting arrangement and shall give the electrical output of as given below at 0.8 power factor, 415 Volts at the alternator terminal.

| ELECTRICAL OUTPUT | No. of Cylinder |
|--------------------------|---|
| 320 KVA | 12 or as per approved manufacturer |

Other accessories of the engine would be as under:

COOLING SYSTEM

- ▣ Thermostat
- ▣ Corrosion Inhibitor
- ▣ Self contained piping

FUEL SYSTEM

- ▣ PT fuel pump
- ▣ Injectors
- ▣ Fuel filters
- ▣ Self contained piping

LUBRICATING SYSTEM

- ▣ Oil pump
- ▣ Strainer
- ▣ Lub oil cooler
- ▣ Oil filter
- ▣ Bypass filter
- ▣ Self contained piping

AIR INTAKE SYSTEM

- ▣ Dry type filter
- ▣ Air intake manifold with necessary connections
- ▣ Turbo charged after Cooled

EXHAUST SYSTEM

- ▣ Exhaust manifold
- ▣ Flexible piping
- ▣ Silencer (**Hospital**)

GOVERNING SYSTEM

- ▣ Electronic Governor

STARTING SYSTEM

- ▣ Starter, 24V, DC
- ▣ Battery charging Alternator
- ▣ With in-built Regulator

ENGINE CONTROL PANEL (ECP) (it will display)

- Lub oil pressure
- Jacket water temperature
- Engine RPM
- Battery voltage
- Engine Running Hours

SAFETY SYSTEM

- Low lub oil pressure
- High water temperature
- Over speed

OTHER SYSTEM

- Flywheel
- Flywheel housing

ALTERNATOR:

| | | |
|--------------------------|----|--|
| Output | i) | 320KVA |
| Power factor | : | 0.8 |
| Rated Generating Voltage | : | 415 Volts |
| Voltage regulation | : | +/- 1% all load between no load to full load & factor 0.8 to unity |
| Frequency | : | 50 Hz |
| Speed | : | 1500 RPM |
| Class of insulation | : | H |
| Winding connection | : | Star connection (all six leads will be brought out of stator frame) |
| Overload capacity | : | 10% for one hour in any 12 hours of operation without exceeding temperature rise limits specified in BS:2613 or BS:5000 when corrected to ambient temperature at site. |
| Bearings | : | Long life single bearing |
| Enclosures | : | Drip proof & screen protected IP-23 |
| Parallel operations | : | All machines shall be suitable for operation in parallel. Damper winding shall be provided to facilitate parallel operation |

Power Command Paralleling Genset Controls (PCC3.3 of Cummins or equivalent)

The features shall be given as below:-

- Digital governing
- Digital Voltage regulation
- AmpSentry Protection for true alternator O/C protection on PCC 3.3 for solo / paralleling applications.

- Analog/ Bargraph/ Digital AC output Metering
- Battery Monitoring System to sense and warn against a weak battery condition
- Digital Alarm and Status Message Display
- Genset Monitoring : Displays status of all critical engine and generator set functions
- Smart Starting Control System : Integrated fuel ramping to limit black smoke and frequency over shoot
- Advanced serviceability
- Synchronizers and load sharing controls
- KVAR and power factor controls
- Import / Export controls for paralleling with utility / main bus.

The alternator shall be of self-excited, self-regulated, self-ventilated in brush less design, provided with suitable automatic voltage regulator and shall conform to BS:2613 or BS : 5000 and shall give rated output at NTP conditions.

ESSENTIAL ACCESSORIES:

One set of essential accessories shall be supplied with each D.G. Set. This set of accessories shall comprise of the following:

BASE FRAME:

One no. MS Fabricated adequately machine Channel Common Base Frame with lifting facility, pre-drilled foundation holes suitable for permanent installation on concrete foundation for direct grouting or on anti-vibration mountings which will be suitable to receive the offered engine and alternator duly coupled through a flexible coupling. A suitable coupling guard shall also be provided.

FUEL TANK:

One no. Daily fuel tank of 990 LITRES capacity / **or as per OEM Supplier Specification** for each DG set made out of 3 mm thick MS sheet complete with inlet and outlet connections, drain plug, manhole, etc. & suitable for mounting on floor with mounting pedestals. Wire-braided hoses shall also be supplied with fuel tank.

BATTERIES:

For electrical control circuit of 24 volt DC, 2 Nos. batteries of 12 volts 180 AH for **each set** respectively (dry and uncharged) of approved make with battery leads for electrical starting of each DG Set.

4.0 DIESEL GENERATING SET

DESIGN

- 1.1 The engine alternation set shall be capable of working at ambient temperature between 0°C to 50°C and relative humidity upto 95%.

The operating capacity of each set shall be arrived at after considering a load with power factor of 0.8 lagging, and after taking into consideration suitable de-rating on account of above parameters of the station.

- 1.2 The engine/alternator set shall be capable of taking 10% over-load for a period of one hour during any 12 hours period, while operating continuously at full rated load.

- 1.3 Nominal output voltage of engine/alternator set shall be 415 volts 50 Hz AC Supply with manual adjustment at all conditions of load with coarse and fine controls with a range of $\pm 5\%$.

The frequency shall be maintained at 50 Hz $\pm 2\%$ for the set.

- 1.4 The output wave-form shall be sinusoidal at all load conditions.
- 1.5 The engine/alternator set shall be selected for a high degree of performance with over all low fuel consumption for the normal life of the alternator set.
- 1.6 The engine/alternator set shall meet the requirements of all linear & non-linear loads, but over-sizing of the alternator in order to meet the non-linear characteristics of loads in not envisaged.
- 1.7 The Engine shall be capable to minimum 60% bulk load of the rating during transfer of the load from NO Load position without tripping.

SYSTEM OPERATION

The set may be idle for a long time except for periodical test whenever there is a electrical supply failure, the set may required to run continuously for period even exceeding 24 hours.

SYSTEM FEATURE

The entire work shall confirm to Bureau of Indian Standards safety standards; British Standards, and C.P.W.D. specifications.

DETAILS OF ENGINE/ALTERNATOR

Scope

The scope of this section covers general requirement for reciprocating diesel engine and alternator complete with drive, safety controls, lubricating system, cooling system, instruments etc., including erection, testing and successful commissioning on load.

Diesel Engine

Diesel engine shall be multi-cylinder, 1500 RPM reciprocating, 4-stroke internal combustion conforming to BS 649 and shall be of welded construction or of fine grain cast iron. The crank case shall be of iron alloy, casting, crank shaft shall be of high tensile forging corresponding to medium carbon steel of 1045 (AISI) grade, Main B.E bearing shall be of high grade bearing material, connecting rod shall be of 1 beam high grade of drop forged steel corresponding to carbon steel of 1139 grade, cylinder liner shall be wet type cast alloy iron with specially machined groomed in the bores to serve as oil retaining surfaces, piston shall be of low expansion aluminium alloy with machined surfaces.

The engine shall be equipped with all required standard accessories:

Fly wheel & housing

Oil bath air cleaner

Exhaust turbo charger & after coolers **as called for.**

Flexible coupling and coupling guard

Flexible connection between heat Exchanger and water pipe.

Lubricating pump and fuel injection pump

Nozzles

Electronic / hydraulic Governor as called for in BOQ.

Oil pressure gauge and water temp gauge

Fuel filter, fuel tank and fuel lines

Turbo charged aspiration

Water-cooled radiator/ Heat Exchanger as called for in BoQ.

12 cylinders or as required.

Other fittings as recommended by the manufacturer.

The lubricating system shall be positive pressure type for all moving parts. No moving parts shall require lubricating by hand, either prior to starting or while in operation.

The lubricating system shall consist of following major components.

Oil pan

Oil pump

Oil filter

Oil pipe/hose

Oil cooler

Piston cooling nozzle

Oil temperature & gauge

Oil pressure gauge

By-pass filters.

Lubricating oil filter shall be provided for operation of 500 hour without any necessity of replacement or cleaning.

The engine shall be water cooled with Heat Exchanger. All standard accessories like inlet, outlet connection, fuel connection, drain plug etc. shall be provided.

Engines shall be suitable for running at 1500 RPM the speed of the engine shall be controlled by means of a governor which may sense the actual speed and make adjustment to the fuel system when required. The speed governing system shall be Class A hydraulic type as per BS 649. The maximum change in speed of engine shall be not more than 10% or 4% when the full load is either taken off or thrown ON temporary or permanently as the case may be. The engine/alternator set shall be able to attain the steady speed within a time period of 3 seconds from the time load change takes place.

Engine Starting

The engine shall be self starting type. The starter motor shall conform to BS-2613-1970. Time required for starting of engine from cold conditions shall be 10-20 secs maximum.

Fuel Tanks

Fuel tank(s) shall be fabricated from 3 mm thick MS sheet and of 990 litres capacity. Fuel lines shall be of MS "C" class welded pipe & standard hose pipes. The fuel tank shall have all standard fittings like outlet, fuel return, drain & vent connection. The fuel tank shall also level indicator so as to indicate the quantity of fuel present in litres with calibration chart. It shall be provided with high & low level switches having potential free contacts for annunciation and also for auto control of fuel oil pump.

Exhaust System

Industrial type Air intake filter shall be provided in the turbo charger assembly of the engine unit. The exhaust system shall consist of turbo charger with clad pipe inter connecting it with the cylinder head inlet. The exhaust manifold shall be suitably lagged and covered as well. The exhaust pipe shall discharge the exhaustible smoke at the top of the building.

The exhaust system, which carries away the products of combustion from the engine to the atmosphere, shall be such as to restrict the backpressure within prescribed limit (below 75 mm of Hg) to ensure proper engine operation. The exhaust system shall consist exhaust pipe, flexible pipe of minimum 30 cm length, and exhaust noise suppressor silencer, and catalytic converter.

The silencer shall be of hospital type, which can provide suppression in noise as per specifications. A test certificate to this effect shall be furnished.

The exhaust piping system shall have a provision of condensate trap with drain plug valves. Exhaust piping shall be insulated with a layer of 75 mm dia glass wool with aluminium cladding rope to minimize the heat radiated to the room.

DETAILS OF D.G.SET

Engine Instrumentation on Engine

Speedometer with time totalizer.

Lub oil pressure gauge.

Lub oil temperature gauge.

Cooling water temperature gauge.

Battery Charger (Separate).

Starting switch with key.

Over speed relays.

Run/Idle toggle switch

Alarms/Trip (Audio and Visual)

Over speed.

High Cooling water temperature.

Low lub oil pressure.

Alternator

Screen protected, drip proof, 3 phase 415 Volts, 4 wire, 50 Hz, 0.8 p.f., 1500 RPM, self regulated, class H insulation, brushless alternator; continuous rating as per relevant Indian Standards, A removable gland plate shall be provided for the cables. Also an automatic voltage regulator at 415 Volts \pm 2.5% shall be provided. Enclosure shall be as per IP-23. Rated voltage shall be 415 V suitable for 50° ambient temperature and overload capacity shall be 10% for one hour during 12 hours continuous running must have droop characteristics and others for synchronizing system and fine adjustment of voltages.

Exciter

Self excited, self regulated, providing alternator output regulation at plus or minus 2.5%, from no load to full load along P.F. between unity to 0.8 lagging, with 4% speed variable, of the engine. Solid state excitation system is preferred.

BATTERY CHARGING EQUIPMENT

Battery charging equipment should be incorporated in the generator control panel and shall comprise of:

- AC and DC "ON" and "OFF" switches with HRC fuses.
- Indicating lamps for indicating mains "ON" and battery charging.
- Ballast to give charging.
- Single phase double wound (copper conductor) impregnated natural air cooled mains transformer for rectifier stock.
- Rotary switch to give step control.
- Single phase full wave bridge connected silicon rectifier stack.
- Moving coil ammeter to indicate charging current.
- Moving coil Voltmeter with a selector switch to measure the battery/charger voltage.
- Silicon blocking diodes connected to a suitable tap to maintain continuity of DC supply. Trickle and boost arrangement must be there.
- AC and DC contactors of suitable rating as required

SPECIFICATION OF MATERIALS

Exhaust Silencer Piping

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to Class C. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendations of the manufacturer. MS screwed flanges and bends shall be used as per site requirements.

Exhaust pipe inside the building shall be lagged with 75 mm dia glass wool with aluminium cladding and suitably bonded with asbestos cloth.

Water Piping and Oil Piping

Water Piping shall be of C class MS pipe. Oil piping shall be of MS or braided flexible type only. Cooling water and oil piping shall be tested in accordance with ASA-B 31.1 pressure piping code.

Wiring

All the wiring outside the panel shall be drawn to 16 gauge MS conduits.

The minimum size of wires outside the panel shall be 2.5 sq. mm stranded copper conductor.

The minimum size of control cables inside the panel shall be 1.5 sq. mm stranded copper conductor.

All the wires and cables suitable for 650/1100 Volts. As per IS-694-1990 latest amendment.

INSTALLATION OF GENERATING SET

The engine and alternator shall be mounted on specially designed common MS base plate and frame of extremely rigid welded construction, so as to provide no deflection.

The engine/alternator set shall be installed over the Dunlop-make, S-type anti-vibration cushy base in order to isolate the transmission of vibrations to the floor or building structures.

The exhaust system shall be designed and installed in such a manner that it avoids excessive stresses on the exhaust manifold of turbocharger, washing spray or any other source.

The exhaust pipe shall pass through an oversized collar, filled with glass wool when crossing floor/wall.

All exposed metal parts shall be suitably painted to prohibit corrosion under the climatic conditions at site.

The installation of fuel piping, power distribution and control panels shall be carried out in accordance with the specification of respective items.

PRELIMINARY TRIALS

After completion of erection of generating sets and before carrying out main trials, preliminary trials shall be conducted in the presence of the **ENGINEER-IN- CHARGE** and the results shall be recorded in the test sheet at 30 minutes intervals. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 15% shall be allowed on the fuel oil consumption to cover possible errors of measurement.

Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in BS: 639. Alternator insulation resistance and commutation check shall be as per BS 2613/BS 5000. Starting time of sets shall be tested at least five times the sufficient time integral to allow for cold start. On completion of tests, inspection doors shall be removed and running gears inspected and alignment has to be checked. A further reasonable trial as suggested by the HLL shall be carried out with no extra charges. All instruments, materials and labour required for carrying out the trials shall be provided by the Contractor. Test sheets of trials shall be forwarded in quadruplicate to ENGINEER-IN-CHARGE. The successful bidder has to submit a list of recommended spares to HLL for purchasing the same. A set of tools and tackles has to be supplied alongwith each set. List of recommended spares shall be indicated to HLL.

DAY SERVICE TANK

Day service tank shall be of 3mm thick MS sheet fuel oil storage tank of capacity 990 litres for each set with all accessories such as oil level indicator, inlet pipe connection. Outlet pipe connection, with gun metal valve through to collect split oil, air vent pipe, manhole with cover, low level and full level float valve arrangements and interconnections between tanks and painting. The tank shall be provided with Suitable calibration scale. The tank shall be fabricated from 3mm thick MS sheet.

FOUNDATION

Foundation shall be casted as per the recommendations of the manufacturer in consultation with the Supplier and as per the requirements of the site. The successful bidder shall submit detailed foundation drawings within 7 days of award of work.

PAINTING

The Contractor shall paint all exposed metal parts and equipment supplied by him. All sheet metal work shall undergo a process of phosphating, passivating and then sprayed with high corrosion treatment of two coats of synthetic enamel paint of approved colour. All piping shall be colour coded.

5.0 VOLTS DC BATTERIES & BATTERY CHARGER

Lead acid type batteries, 2 x 12V - 25 plates: 180AH as required conforming to IS shall be provided for each set for starting purposes as per requirements. These batteries shall be

fitted with electrolyte (specific gravity 1.280) and initially charged, discharged and recharged and placed in suitable enclosure, in ready to use shape.

SHOCK TREATMENT CHART

Shock treatment chart explaining the method of shock treatment in English, Hindi and local language shall be provided dully framed in glass in the diesel generating station.

WIRING

Providing conduits and drawing wires for the following: -

- Control wiring between diesel generating set and the automatic mains failure panel.
- All wiring associated with the fuel oil transfer pump and including level controllers and circulating water pumps.
- All wiring associated with DC supply.
- All earthing conductors associated with this installation.
- All wiring and cables shall be PVC insulated stranded copper conductor wires and cables suitable for 660/1100 volts minimum size of wires for control wiring shall be 2.5 sq. mm and minimum size of wire for pumps shall be 4 sq.mm. The wires would be as per IS.

CABLES

MV cables shall be XLPE aluminium conductor armoured cables, laid in trenches between diesel generating set and DG panel. All power & control cables will be rated for 1.1 KV grade. Storing, laying, jointing procedures as same as that for the LT cables stated elsewhere.

TEST PERFORMANCE

Scope

This section lay down the procedure for conducting test on the installation. In general the procedure laid down here shall be followed. However, if manufacturer of the equipment has prescribed different procedure which is at variance, the same may be adopted. All required artificial load, testing equipment other required material required for testing purpose shall be supplied by agency.

Physical Test

- Particulars such as name plate details of all major component equipment shall be recorded and compared with what has been offered by the contractor as per agreement.
- Level of foundation.
- Firmness of mounting.
- Verticality of installed set.
- Tightness of nuts & bolts.
- Proper installation of exhaust pipe.
- Insulation of exhaust pipe with 75 mm dia glass wool with aluminium cladding.
- Provision of guard on engine/alternator set coupling joints.
- Termination of various cables.
- Rating of various fuses.

- Termination of earth leads on neutral & body.

Earth Resistance

The resistance shall be measured by isolating the connecting earth lead in respect of all earth stations.

Run Test

The engine shall be given a test run continuously for at least six hours with alternator supplying full rated load. During this run following observation shall be recorded.

| S.No. | ITEMS | TIME AFTER START OF RUN/TEST | | | | | | |
|-------|--------------------------|------------------------------|------|------|------|------|------|-----|
| | | 1 Hr | 2 Hr | 3 Hr | 4 Hr | 5 Hr | 6 Hr | 7Hr |
| 1. | Lubricating oil pressure | | | | | | | |
| 2. | Exhaust gas colour | | | | | | | |
| 3. | Speed engine | | | | | | | |
| 4. | Output voltage | | | | | | | |
| 5. | Load current | | | | | | | |
| 6. | Load (KW) | | | | | | | |
| 7. | Noise Level (DB) | | | | | | | |

Stator Temperature Rise Test

The alternator shall be loaded of full rated load and stator (alternator) body temperature be recorded as under at intervals of 30 minutes till such time that there consecutive readings are the same.

| S.No. | TIME | AMBIENT TEMP | STATOR TEMP |
|-------|------|--------------|-------------|
| (Hr) | | (°C) | (°C) |

- The temperature rise shall be maintained within 60°C above the ambient.

Fuel Consumption Test

- Fuel consumption for half an hour shall be measured after the full load operation condition have stabilized.
- During this measurement the load shall be maintained unchanged.
- The fuel consumption shall be compared with values given in the technical particulars.

Over Load

- Over load test to the extent of 10% over the rated load shall be conducted immediately after the full load run test.
- The various parameters as in the case of run test shall regularly be monitored and recorded.
- After the over load test, the load shall be normalized to rated value and all parameters recorded.

Insulation Test

- Insulation test shall be conducted after testing the engine/alternator set at overload.
- The insulation resistance between the starter coil and from shall be measure with 5000 volts meggar.
- The insulation resistance of alternator winding shall be not below:

Rated output voltage + 1 Mega Ohms

1000 + Rated output in KVA

- Insulation resistance of control wiring with 500 volts meggar shall be measure, which shall not be less than one mega ohms.

Regulation Test

- The voltage regulation from no load to full rated load at 0.8 p.f. and from no load to half the rated load at 0.8 p.f. shall be measured between phase & neutral under automatic and manual regulation mode, which shall not exceed 0.5% of the nominal rated output voltage.
- In automatic regulation mode, the recovery time shall be noted which shall not exceed 3 seconds.
- The frequency of output supply of various load conditions shall be noted and recorded.
- The variation shall be compared with the accuracy standards specified.
- Change in speed of engine with change in load shall be observed and compared with standard reading for the speed governor.

Data Sheet:

Vendors shall fill in the performance data in the block columns of the attached Data sheets.

6.0 ACCOUSTIC ENCLOSURE

Construction Details

The Structure is fabricated using CRCA sheets of 14/16 SWG Thickness and steel members. The enclosure is fabricated on a MS Channel Frame work further strengthened by suitable cross members to make it robust and sturdy. Rock wool / Mineral wool of suitable thickness and density conforming to IS 8183 is used for acoustic insulation to reduce the sound level to 68 – 70 d b from the original sound level of 105 – 110 d b, when measured at 1mtr.distance from the D.G. Set. The acoustic enclosure consists of following:

a) Acoustic Insulation :

High density Fireproof Acoustic Enclosure Material i.e. resin bonded rock wool / fiber glass wool (75 – 100mm thick of 64Kg/m³ density) conforming to IS:8183 is provided on all doors and roof to absorb noise. The insulation material used is fire retardant. The insulation is covered with fiber glass cloth and is supported by perforated sheet. Sound attenuators / down stream silencers are provided at all openings for air inlet/outlet to facilitate free air flow but to absorb sound resulting in extremely low noise level. Detachable partitions are provided inside the enclosure to attain further noise attenuation of the engine.

b) Noise Suppressor :

A suitably designed absorption type Hospital noise suppressor is provided which minimize the exhaust noise of the engine.

c) Exhaust System :

The exhaust gas is taken out through a specially designed flexible pipe, which prevents any back pressure on the engine.

d) Thermal Insulation :

The exhaust system and noise suppressor is provided thermal insulation by using glass wool & covering it with Aluminum sheet. This prevents it from radiating excess heat on the engine, makes it safe for the operator and enhances aesthetics.

e) Surface Treatment :

The enclosure is surface treated and painted with high quality polyurethane epoxy paint with prior zinc oxide primer base, which makes it weather proof and suitable for outdoor application. The paint is highly resistant to acids, alkaline, salt sprays, halogens, solvents, lubricants etc and has very good dielectric properties and is resistant to abrasion and cracking.

f) Air Circulation & Ventilation System:

A suitable forced air circulation and ventilation system is designed to maintain safe operating temperatures inside the enclosure. Requisite air circulation for engine aspiration combustion and cooling is provided by means of Exhaust fans or tube axial fan driven by a 3 phase squirrel cage induction motor according to need of engine.

g) Vibration Isolation:

The engine and alternator is mounted on Anti-Vibration Mounting pads to eliminate engine vibration.

h) Hardware:

Inlet and Outlet for cable, draining of lube oil and diesel etc. are provided. The doors are gasketed with high quality EPDM gaskets to avoid leakage of sound. All doors are lockable.

i) Testing / R&D:

The Gen set shall be thoroughly tested on load before it is dispatched from factory.

| Technical Data Sheet Diesel Generator (Alternator) 320KVA(As per BOQ) | | Project: HLL Office Building Phase-II at NOIDA |
|---|--|---|
| | | 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 | (PLEASE SPECIFY) |
| 7 | Manufacturer | |
| 8 | MAXIMUM VALUE OF MOTORLOAD WHICH DOESNOT AFFECT STARTING | (PLEASE SPECIFY-minm. 60% of the rating) |

| | | | |
|---|---|-----------------------|--|
| 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 th 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: _____ | | | |

CHAPTER I

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 at least Three (3) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this Three (3) year period shall be included in the submittal bid.

1.5.0 POST CONTRACT MAINTENANCE:

- A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of three (3) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment and response travel costs for each year of the maintenance period. Submittals which do not identify all post contract maintenance costs will not be accepted. The rates and costs shall be valid for the period of three (3) years after expiration of the guaranty.
- C. 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 semiannually.
 - 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:

- 1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
- 2. 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.

3. 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.
4. 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 ² | | 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 / 1.06 Cu | 3 | 2 | 0 | 5 | 10 | 8 | 18 | 12 | | | | | | |
| 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 | | 5 | 4 | 8 | 7 | | | | | | |
| | | | | 2 | | 4 | 3 | 6 | 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 ² | | 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 heart 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 devises |
| No of devices | Each loop shall be able to cater to minimum as per IS or manufacturer standard |
| 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 ² , 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 membrane 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 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.

2.6 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.

2.7 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.

2.8 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

2.8.1 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.

2.8.2 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.

2.8.3 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.

2.8.4 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

2.8.5 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.

2.8.6 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.

2.8.7 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.

2.8.8 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.

2.8.9 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.

2.9 EXECUTION

2.9.1 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.

2.9.2 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.

2.9.3 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.

2.9.4 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.

- 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.

2.10 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.

2.11 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 J

TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT TELEVISION SYSTEM & PA SYSTEM

1. CLOSE CIRCUIT TELEVISION SYSTEM (CCTV)

1.1 SYSTEM REQUIREMENT

The CCTV System shall be real time system consisting of Indoor dome cameras and Outdoor P/T/Z Cameras, Network-able Digital Video Recorders, Video Analytics, Monitors and Keyboard controller for PTZ cameras.

1.2 SYSTEM OBJECTIVE

- 1.2.1 To enable the important areas of the premises to be monitored remotely
- 1.2.2 To enable critical areas to be scanned from pre-selected position and generate alarms if any changes captured.
- 1.2.3 To enable automatic recording by Digital Multiplex Recorder on hard disk and to play back the recorded events on selected monitors & back-ups of the events on CD.

1.3 CAMERA

- 1.3.1 1/3" CCD, 580TVL, Min0.1 lux, 48dB, DC12V, 2.8-10mm varifocal Lens PAL INDOOR DOME CAMERA .

The camera shall have following specifications:

| | |
|-----------------------------|--------------------------------|
| Analog / IP | Analog |
| Video Format | PAL |
| Horizontal Resolution (TVL) | 580 |
| Type of CCD | Interline CCD |
| Scanning Process | Interlaced |
| Minimum Illumination | 0.1lux(colour), 0.01 lux (B/W) |
| Minimum Illumination | 0.1 Lux@F1.2, 30IRE, AGC On |
| Electronic Shutter | 1/50 - 1/100,000 sec |
| S/N Ratio | 48 dB or more (AGC Off) |
| AGC | Yes |
| White Balance | Auto |
| Day & Night | No |
| BLC/BMB | BLC |
| Synchronization | Internal |
| Optical Zoom Ratio | NA |
| Optical Lens Specifications | 2.8-10mm lens |
| Enclosure details | Indoor Ceiling/Wall |
| Power Input, Current Rating | DC 12V (±2V),Max. 1.0W |
| Listing & Approval | UL/CE/FCC |
| Operating Temperature | -10°C ~ 55°C |

Additional Features

- 1/3" CCD (NTSC: 410,000 / PAL: 470,000)
- Lux Minimum illumination
- High performance 580 TV Lines Resolution
- 48dB
- Dip Switch control
- Flicker less
- BLC (Back Light Compensation
- AGC (Auto Gain Control)

1.3.2 1/4" Supper HAD CCD, Outdoor/ Indoor High Speed PTZ Dome, 36X optical, 12x digital zoom, TDN, DSS, BMB, PAL cameras.

The camera shall have following specifications:

| | |
|--|---|
| Analog / IP | Analog |
| Type of Camera | PTZ Camera |
| Video Format | PAL |
| Horizontal Resolution (TVL) | 530 |
| Type of Camera | Super HAD CCD |
| Scanning Process | Interlaced |
| Minimum Illumination (Color) | |
| Wide area coverage | 0.005 |
| Wide dynamic range. | |
| Minimum Illumination | 1.0 lx (30IRE) : Night shot OFF |
| 0.1 lx (30IRE) : Night shot ON | |
| 0.01 lx : x128 Field integration(DSS) ON | |
| 0.005 lx (30IRE) : Night shot & DSS ON | |
| Electronic Shutter | 1/50 to 1/10000 |
| S/N Ratio | >50 dB |
| AGC | Auto with Manual Override |
| White Balance | Manual / Auto / Indoor / Outdoor / One push / |
| ATW | |
| Day & Night | True Day & Night |
| BLC/BMB | BLC/BMB |
| Synchronization | Internal / External |
| Optical Zoom Ratio | 36X |
| Optical Lens Specifications | 3.8 to 95 mm |
| Digital Zoom Ratio | 12X |
| Pan Range | 360 Deg Continuous Panning |
| Tilt Range | 0 deg ~180 deg |
| Max Preset Speed | 380°/sec. |
| No of Presets Supported | 248 |
| Number of Patterns Supported | 4 |

| | |
|--|--|
| Number of Privacy Masking Zone Supported | 8 |
| Number of Guard Tours Supported | 8 |
| Number of Auto Pan supported | 16 scan + 1 auto pan |
| Relay Inputs | 8 |
| Relay Outputs | 2 |
| Enclosure details | Outdoor/Indoor Pendant with sunshield & blower |
| Enclosure Protection Rating | IP66 |
| Power Input, Current Rating | 18 to 30VAC, 24VAC nominal, |
| Listing & Approval | UL/CE/ FCC |
| Communication | RS422, RS485, |
| Operating Temperature | 0°C to 50°C |

Additional Features

- Built-in x36 optical power zoom lens (Total : x360 zoom with digital x12 zoom)
- Built-in Super HAD CCD
- True night shot function with IR cut filter removal mechanism
- 248 Presets : programmed with view direction, focus, iris and BLC
- 4 Patterns : record and play back user preference of surveillance path up to 240 sec.
- 16 Scans : 8 speed steps(1 to 8) for Scan with two speed steps for Diagonal Scan(Slow/Medium)
- 8 Tours : each tour consists up to 64 Presets, Patterns, Scans and other Tours
- 8 Alarm inputs with 0~8 priority / 2 Auxiliary outputs programmable NC/NO
- 8 Privacy Zones : video off or up to masked block with selectable 8 colors
- 64 steps of variable speed for panning from 0.1°/sec. to 90°/sec.
- Maximum manual speed 360°/sec. with Turbo key pressed, Preset speed: 380°/sec.
- Minimum adjustable angle is 0.0375° with Single Step move function
- programmable user preferences of speed (Slow / Medium / Fast)
- Addressable up to 999 camera IDs (Extend up to 3999 setting at factory menu)
- Built-in RS-485/RS-422 receiver driver
- On-site software upgrade and upload/download of programmed data into the Keyboard / Dome
- Built-in power-line surge protection and lightning protection
- Capable of fail-safe hot swap
- Supporting multiple protocol
 - Smooth 180 ° tilting with digital flip function

1.3.3 Outdoor Box Camera with 1/3" CCD, 580TVL, 0.1lux, Color, WDR, SDN, DC12V with 1/3" CS-Mount, DC Auto Iris, 2.7-13.5mm Varifocal Lens F1.3, Long Lead, IR Corrected for D/N camera

Video Standards NTSC PAL

| | | |
|-------------------------|-----------------------------|----------------------|
| Image sensor | 1/3" Interline Transfer CCD | |
| Effective Pixels | 768(H) x 494(V) | 752(H) x 582(V) |
| Horizontal Resolution | 580 TV lines | |
| Minimum illumination | 1 lx (50IRE) | 1 lx (50IRE) |
| | 0.1 lx (TDN) | 0.1 lx (TDN) |
| | 0.01 lx (DSS) | 0.01 lx (DSS) |
| | 0.001 lx (TDN ,DSS) | 0.001 lx (TDN ,DSS) |
| Video Output | 1.0 V p-p, 75ohms | |
| Synchronization | Internal | |
| S/N Ratio (dB) | >50dB | |
| Auto Gain control (AGC) | 0-36dB | |
| AES (sec) | 1/60 – 1/100.000 sec | 1/50 – 1/100.000 sec |
| Lens Control | DC / VSD | |
| White Balance | AWC/ATW/MANUAL/IN/OUT | |
| Power source | 12 VDC (10 – 14VDC) | |
| | 12VDC/24VAC (Dual Power) | |
| Power Consumption | Approx. 2.5W | |
| Operation Temperature | -10°C to 55°C | |
| Dimensions (WxHxL) | 67mm x 62 mm x 95.5 mm | |
| Weight | 192g (Camera Only) | |
| Lens Mount | CS mount | |
| Listing & Approval | U L/CE/ FCC | |

1.4 DIGITAL VIDEO RECORDER

The DVR shall have following specifications:

- 16 channel real-time recording and playback in genuine D1 resolution
- **Advanced H.264 compression technology**
- 4 hot-swappable hard disk supports up to 8TB
- HDMI, VGA support 1080P high definition video output on 16:9 LCD monitor
- Dual stream, multicast supported
- Embedded operation system
- Video record anti-tamper
- Backup through USB or network
- 16 alarm inputs, 4 alarm outputs
- Supports multi PTZ protocols
- Support scheduled remote backup using remote access software
- UL/FCC/CE, approved

Video/Audio Input

| | |
|---------------------|--|
| Video compression | Advanced H.264 |
| Analog video Input | 16 channel, BNC (1.0 V Vp-p, 75 Ohm), PAL/NTSC |
| Digital video input | 4 channels High – Definition IP Camera |
| Audio Compression | Standard G.711 |
| Audio Input | 16 Channel , RCA |
| Intercom Input | 1 Channel , RCA |

Video / Audio Output

| | |
|----------------------|---|
| Recording Resolution | D1/4 CIF /HD ½ CIF /CIF /QCIF |
| BNC Output | PAL : 704x576 Pixels NTSC : 704x480 Pixels |
| VGA Output | 1920x1080 Pixels |
| HDMI Output | 1920x1080 Pixels |
| Spot Video Output | 2 Channel , BNC (10.Vp-p, 75Ω) |
| Frame Rate | PAL : Up to 500fps (Total Encoding) NTSC: UP to 600fps (Total Encoding) |
| Video Bit Rate | 64Kbps~5M bps |
| Audio Output | 2 Channel , RCA |
| Audio Bit Rate | 64Kbps |

Hard Disk Drive

| | |
|-----------|------------------------------|
| Interface | Hot swappable SATA (Up to 4) |
| Capacity | Each HDD Supports Up to 2TB |

SYSTEM

| | |
|--------------------------|---|
| Event Trigger | External inputs, video loss, Camera Covered, Motion Detection Video Buffer 5S pre – and 50S post – alarm per channel |
| PTZ | Wide range of analog PTZ supported : Scandome ,Diamond , VCL , Pelco – P/D |
| Network Failure Recovery | Automatic local record upload to center storage |
| Dual Streaming | 16 Channel individually configurable second stream |
| Multicast | 16 Channel individually configurable multicast |
| Network Protocols | RTSP/RTP, HTTP, TF TP, SMTP, DHCP, SSL/TLS, NTP |

External Interface

| | |
|-------------------|--------------------------------|
| Network Interface | 1, RJ45 10M/100M Ethernet Port |
| Serial Interface | 1xRS-232 , 1xRS-485 (PTZ) |
| USB Interface | 2x USB2.0 |
| Alarm Input | 16 (Terminal Block) |

Alarm Output 4 (Terminal Block)

General

Power Supply 100~240VAC ,50~60HZ

Operating Temperature 0°C~ 50°C

Humidity 30% ~ 80%

Chassis Standard 2U

1.5 CENTRAL MONITORING SYSTEM:

The Central Monitoring System should have the following features:

- Multi-DVR management, should support up to 960 video channel connection
- Should support up to 36 live view windows at one single screen and maximum 144 windows extension viewing
- Video recording and playback management
- Local recording
- Devices management, auto search configuration and status monitoring
- Alarm management and inter linkage control
- PTZ control
- Video Snap-shot
- E-map

| | |
|--------------------------------|--|
| Max. Video Channels Connection | 960 Channels |
| Video Display Split | 1/4/9/16/25/36 |
| PTZ Controls | Pan/Tilt/Zoom/Focus/Iris/Preset/Tour/Pattern |
| Video Playback | Should be provided |
| Snapshot | Should be provided |
| Local Recording | Should be provided |
| Alarm Management | Should be provided |
| Sound Management | Auto sound when alarm triggering |
| E-map | Support with 64 layouts |
| E-map Format | JPEG/BMP |
| Alarm Trigger | Recording/PTZ control/Relay out |
| Minimum PC Specs | |
| CPU | Intel Core2Duo E6750, RAM : 2GB above |
| Memory | 512MB |
| HDD | 80GB above |
| OS | Window XP/Vista, DirectX 9.0 above |
| Screen Resolution | 1024 x 768 or above |

1.6 LCD COLOR MONITOR – 21 INCH

- a. The monitor shall be suitable for the highest level of quality control. These shall provide reliable, high resolution video viewing in the most demanding security applications. Under scan shall be available, brightness, contrast, and power ON/OFF shall be to standards.
- b. The minimal equipment specification for alarm monitor is as follows, Color
- | | | | |
|-------|----------------|---|---|
| i) | Size | : | 21" |
| ii) | Picture tube | : | Flat square, 53 cm measured diagonally |
| iii) | Deflection | : | 90° |
| iv) | Resolution | : | Equal to or More than 550 lines |
| v) | Viewing area | : | 20", Diagonal |
| xii) | Input voltage | : | 220-230 V AC, 50 Hz, single phase |
| xiii) | Power Max. | : | 30 W |
| xiv) | Linearity | | |
| | - Horizontal | : | 3 % typical |
| | - Vertical | : | 3 % typical |
| xv) | Humidity | : | 20%-80% non-condensing |
| xvi) | Operating temp | : | 0 to 40°C |
| xvii) | Controls | : | Front: On-off, LED, , Sharpness, Color, Brightness, Contrast, Volume/Data (2) |

1.7 LCD COLOR MONITOR – 32 INCH

- a. The monitor shall be suitable for the highest level of quality control. These shall provide reliable, high resolution video viewing in the most demanding security applications. Under scan shall be available, brightness, contrast, and power ON/OFF shall be to standards.
- b. The minimal equipment specification for alarm monitor is as follows, Color
- | | | | |
|-------|----------------|---|--|
| i) | Size | : | 32" |
| ii) | Picture tube | : | Flat square, 80 cm measured Diagonally |
| iii) | Deflection | : | 90° |
| iv) | Resolution | : | Equal to or More than 700 lines |
| v) | Input voltage | : | 220-230 V AC, 50 Hz, single phase |
| vi) | Power Max. | : | 30 W |
| vii) | Linearity | : | 2 to 3% typical 7% maximum |
| viii) | Humidity | : | 20%-80% non-condensing |
| ix) | Operating temp | : | 0 to 55°C |

x) Controls : Front: On-off, LED, , Sharpness, Color, Brightness, Contrast, Volume/Data

1.8. ACCESSORIES

A. Weather proof housing for outdoor application

The Housing should be made of extruded aluminum and should be weather proof. The minimum internal dimensions of the housing should be capable of housing the camera and the Verifocal lens.

The camera housing should be:

- Compatible to camera
- Suitable for the make and model no of cameras offered and as specified by the manufacturer
- Should be compact and indoor / outdoor type as required.
- Suitable for operation in upright and inverted position'
- Should be weather proof in case of outdoor mounting.
- Should be Vandal proof

B. Camera mount

The camera mount should be:

- Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer.
- Should be compact and indoor / outdoor type as required.
- Should support the weight of camera. Camera accessories such as housing pan & tilt head in any vertical or horizontal position.
- Should be weatherproof in case of outdoor mounting.

C. Speed dome controller/PTZ controller

Speed Dome Controller should have variable speed joystick, LCD for programming and it should be able to control the Encoders as well as speed dome for PAN / TILT / Zoom functions.

D. Video Wall Rack

The video wall mountings should be of powder coated MS frames/supports and should be strong enough to take care weight of all Monitors. It should be suitably fabricated in such a way that only screens of monitors should be visible outside. Power supply wiring with suitable capacity sockets /earthing should be neatly installed on the rack. Video wall computers should also be enclosed in the rack. The supporting frames of monitors should not sag due to its weight.

2. VIDEO CO-AXIAL CABLES

- 2.1 The Co-axial cable is of wideband type with operation capability up to 2400 MHz.
- 2.2 The ageing resistance of the co-axial cable complies with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz. measured by artificial ageing (14 days at 80 deg. C)
- 2.3 Cables meets or exceed the following specifications.

Construction RG-6 CATV

| | |
|---------------------|---|
| a. Center Conductor | 18 AWG tinned copper |
| b. Dielectric | Foam Polyethylene Nom. dia 0.180 |
| c. Shield | Foil - 0.003 Al. Tape Braid - 34 AWG 4 end AL. 60% coverage dia 0.212 |
| d. Jacket | Black PVC flame retardant dia over jacket 0.272 + 0.008 Min. spot 0.023 |

Electrical Properties

| | |
|----------------------------|--|
| a. Dielectric Strength | Conductor to shield 2000 VDC |
| b. Capacitance | 16.2 PF / FT, Nom |
| c. Impedance | 75.0 + 3.0 ohms |
| d. Attenuation | DB/100 ft. 0.65 DB @ 5 MHZ 0.76 DB @ 10 MHZ 0.96 DB @ 20 MHZ 1.98 DB @ 100 MHZ 4.21 DB @ 450 MHZ 4.80 DB @ 550 MHZ 6.49 DB @ 1000 MHZ |
| e. Velocity of propagation | 82.0% Nom |
| f. DCR | 35.47 ohms / 1000 ft. |
| g. SRL | 30 DB (10 MHZ to 300 MHZ) |

3. POWER/ COMMUNICATION CABLING SYSTEM

The system shall consist of video, power serial data combined cable and Cat6 cable in metallic conduits and shall be concealed as called for.

3.1 GENERAL

Prior to laying and fixing of conduits, the contractor shall carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor shall be gotten approved before the actual laying of conduits is commenced.

3.2 MATERIALS (METAL CONDUITS & ACCESSORIES)

CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. 16/14 (16 gauge up to 32mm & 14 gauge above 32 mm) gauge screwed MS conduits as specified on BOQ shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note. : Whatever materials required to be billed by the Contractor should come on site with proper challan no. and quantity mention on it.

JOINTS

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil, Connections between screwed conduit and GI boxes shall be by means of hexagon brass check nut, fixed outside and brass bush from inside the box. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

RECESSED OR EXPOSED CONDUITS

All conduits shall be as per Schedule of Quantities.

FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron 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 the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits.

FIXING OF CONDUITS

All conduits, shall be installed so as to avoid steam and hot water pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, insects or another foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 600 mm, but on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface.

4.0 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 K**LIFT & ELEVATORS****A. BRIEF SPECIFICATION OF PASSENGER LIFTS PROPOSED FOR HLL OFFICE (2B+S+4)**

| | | |
|---|--------------------------|---|
| 1. | Type | Passenger Lift |
| 2. | Capacity / Load | 13 Passenger/884 Kg. |
| 3. | Speed | 1.5 Meter / Sec. |
| 4. | No. of Stops | 7 |
| 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(Scratch proof) |
| 12. | Type of Door | Centre opening sliding door, one hour fire rated landing doors, Stainless steel Hairline finish(Scratch proof). |
| 13. | Car enclosure | Stainless steel Hairline finish, toughened glass Enclosure. The ceiling panel shall be with 4 down lights (LED Type) in stainless steel panel, Ceiling cabin fan. |
| 14. | Car Floor | 25mm thick stone flooring by HLL. |
| 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**

- 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 HLL'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 i981, 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 electr1c 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 exceed 90% contract load of the lifts, the lifts shall ignore all landing calls and only responds 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 present 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 passes 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 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 of 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/mm² or 1770 N/mm² for ropes of single tensile
 - 1370 N/mm² for outer wires and 1770 N/mm² 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 $\frac{1}{4}$ of the clear platform entering/leaving onto the entrance edge of the platform.

Compensating ropes shall be provided for lift travels over 30 m:

Rated lift speed (m/s) Compensation means

| | |
|----------------------------|--|
| < 2.5 | Quiet operating chains |
| ³ 2.5 and < 2.5 | Steel wire rope with an idle tension pulley in lift pit |
| ³ 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 L**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 Building. 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 required 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 radiographic ally 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 mm | 4 mm | 8 mm | 8 mm | 12 mm |

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.
- c. Pipe passing through structural members will be provided with M.S. pipes.

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 on top of each wet riser piping shall be installed before execution for approval fabricated out of at least 8 mm thick steel to withstand the pressure, with dished ends and supporting legs. 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.

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 1.6 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 6mm 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 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, equipments 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

These shall comply with the IS codes as specified.

3. SUBMISSIONS

- a. Product Manuals
- b. Hydraulic Details

4. STORAGE

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 2000 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.

4. VIBRATION ELIMINATORS

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 Architect 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 150 mm dia pressure, 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, equipments 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 | | 10.0 Kg/ sq.cm | |
| Jockey pump | | 9.0 Kg/ sq.cm | 7.0 Kg/sq.cm |
| Fire Electrical Pump | 1 | 6.5 Kg/ sq.cm | automatically |
| Fire Electrical Pump | 2 | 5.5 Kg/ sq.cm | automatically |
| Diesel Engine driven pump | 3 | 4.50 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 1.6 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 suitably 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 25 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 equipments 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. Incoming 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, lugs 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 annunciator facility as specified.
- v. Inter- connection control and power cable work, cable glands, lugs, 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 glands 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 audiovisual alarm. This should indicate the level of water at different stages in 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 wet 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.

11. 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 carrier 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 or 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 no strong enough to support the pipes, thereby likely to case 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 specifies.
- 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 with in 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 12 kg/cm². 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 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.

Spacing between vertical supports shall not exceed 1.5m and horizontally at 2m up to 50mm and 1.5m for higher diameters. 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 pypkote 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 trickle operating from 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 earthing 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 M**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 8 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, I_m , V_m 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 31st March, the RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions. **However from 1st 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 HLL.
- 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 M15 (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 08KWp, 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

- 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.
- 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.
- Wind Speed: An integrated wind speed measurement unit to be provided.
- 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:
- 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.
- 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.
- 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.
- 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
- 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 lightening 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 of HLL 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.

CHAPTER N**HVAC SYSTEMS****SECTION 1: - SYSTEM DESIGN DATA****1. GENERAL**

- 1.1 The system design, basis of design, estimated requirements and other relevant data are outlined in this section. The detailed specifications and specific requirements are out lined in the subsequent sections.

2. LOCATION

- 2.1 The Proposed Office Building for HLL Lifecare India Limited at Sec-62, Noida.

3. SCOPE OF WORK

- 3.1 The work proposed under this tender includes providing and fixing Variable Refrigerant Volume system, Refrigerant piping, drain piping, insulation, electrical wiring etc. for the above project.

4. BASIS OF DESIGN

- 4.1 Outside Conditions Summer : 43.33°C DB, 23.8°C WB,
20%RH
- 4.2 Inside Conditions Summer : 24°C + 1.0°C DB RH not
exceeding 60%

5. SYSTEM DESIGN

- 5.1. VRV System has been proposed. It is a system in which we can get flexibility to connect several number of indoors unit with a single Outdoor unit.
- 5.2 Areas shall be provided with Ductable indoor units, Cassette & Hi wall type units.
- 5.3 The Outdoor units shall be placed on terrace level of the Building.
- 5.4 The Outdoor & Indoor units shall be interconnected with copper refrigerant piping duly Insulated.

6. LOAD SUMMARY

| S. No. | Floor | Floor Area (Sq.ft.) | Calculated Cooling Load (TR) | Selected Outdoor (HP) |
|--------|---------------------------------|------------------------|---------------------------------|--|
| 1. | Ground Floor | 550 | 1.61 | 34 HP |
| 2. | First Floor (Excluding Labs) | 4824 | 18.13 | |
| 3. | First Floor (Only Labs) | 1395 | 11 | 10 HP (For Clinical Histo Pathology Lab & Molecular Biology Lab) & 8 HP (Microbiology Lab & Microbiology-TB Testing) |
| 4. | Second Floor | 7315 | 33.68 | 22+30=52HP |
| 5. | Third Floor | 7315 | 33.68 | 22+30=52HP |
| 6. | Fourth Floor | 6775 | 34.47 | 26+26=52HP |

| | Future Expansion | | | |
|-----|-------------------------------|--------------|---------------|---------------|
| 7. | Fifth Floor | 6685 | 45 | 52 HP |
| 8. | Sixth Floor | 6685 | 45 | 52 HP |
| 9. | Seventh Floor | 6635 | 60.15 | 70 HP |
| 10. | Outdoor Unit for TFA- DX Type | | | 28 HP |
| | Total | 48179 | 282.72 | 410 HP |

- 6.1 Air shall be distributed through Indoor units i.e. Ductable type, Hi wall Type units.
- 6.2 Corded remote control shall be provided with each unit to control the system.

| S.No | Design Parameters | References |
|------|-------------------------|-------------------------|
| 1. | Outside Conditions | ISHRAE-2007 |
| 2. | Lighting Load | ECBC-2009 |
| 3. | Roof Assembly U-factor | ECBC-2007 Table-4.3.1 |
| 4. | Wall Assembly U-factor | ECBC-2007 Table-4.3.2 |
| 5. | Glass U-factor | ECBC-2007 Table-4.3.3-1 |
| 6. | SHGC | ECBC-2007 Table-4.3.3-1 |
| 7. | Fresh Air | ASHRAE-62.1-2010 |
| 8. | Ventilation rate (ACPH) | NBC-2005 |

7. ITEMS TO BE PROVIDED BY OTHER AGENCIES

The following items of works shall be provided by other agencies. The HVAC contractor shall be responsible for the adequacy and accuracy of these works and shall ensure that these are completed as per the required time schedule.

- 7.1 Provision of 415 v / 3 PH / 50 Hz electric supply .

8. DRAWINGS

Tender drawings are diagrammatic only and indicate arrangement of system and the extent of work covered in the contract. These drawings indicate point of supply and point of termination and suggest the route to be followed. The architectural drawings and details shall be examined for exact location of equipment, cutouts etc. Contractor shall follow the tender drawings in preparation of shop drawings and for subsequent installation work and will coordinate with other services also.

9. TEST DATA

The whole system shall be tested as per specifications given elsewhere and complete test data shall be furnished on prescribed data sheet.

10. DEVIATION FROM SPECIFICATIONS

Deviation from specifications may be accepted, provided such deviations are found necessary and appropriate, in order to meet the design of established foreign collaborators/manufacturers.

11. COMPLETENESS OF ITEMS

The prices of each equipment shall include the cost of all accessories or miscellaneous items listed in the respective section, except for the items where "Price Separately" is indicated. The item shall be complete regardless of whether or not it is listed in the BOQ.

12. TECHNICAL DATA

Each Tenderer's must submitted along with the tender the technical data for all items listed herein in the indicated format. Failure to furnish technical data with tenders may reject in summary rejection of the tender.

13. PERFORMANCE GUARANTEE

- 13.1 The contractor shall guarantee that the air conditioning system shall maintain the design inside temperature within $\pm 1^\circ \text{C}$ tolerance and the relative humidity shall not exceed the specified limit.
- 13.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- 13.3 The contractor shall ensure that the system shall be free of all objectionable vibrations and disturbing sounds under all conditions of operation.

14. FOREIGN EXCHANGE

The contractor shall make his own arrangements to procure the necessary, specified controls for which no foreign exchange shall be made available.

15. CODES & STANDARDS

The Split system shall conform to the latest edition of following standards:-

| | |
|-------------|--|
| ASHRAE 15 | Safety code for Mechanical refrigeration |
| ASHRAE 23 | Methods of testing and rating positive displacement refrigerant compressors and condensing units |
| ANSI B 31.5 | Code for refrigeration piping |
| ARI 575 | Standard for method of measuring machinery sound within an equipment space |
| ISO 1940 | Mechanical vibration – Balance quality requirements of rigid rotors |
| ISO 10816-1 | Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines |

SECTION 2:- VRV SYSTEM

1. GENERAL

- 1.1 Unit shall be air cooled, split type multi-system air conditioner with Variable Refrigerant Flow technology consisting of one outdoor unit and multiple indoor units, each suitable to cool and heat independently for the requirements of the rooms.
- 1.2 The refrigerant piping shall be extendable up to 200m with 50m level difference without any oil traps.

2. OUTDOOR UNIT

- 2.1 The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- 2.1.1 The outdoor unit shall have multiple scroll compressors and be able to operate even in case of breakdown of one of compressors.
- 2.1.2 The connectable range of indoor units shall be from 0.65 HP to 10HP with all outdoor units.
- 2.1.3 The noise level shall not be more than 55 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground.
- 2.2 The outdoor unit shall be modular in design and shall be allowed for side by side installation.

3. COMPRESSOR

- 3.1 The compressor shall be of highly efficient hermetic scroll type and equipped with capacity control technology capable of changing the speed in accordance to the cooling load requirement.
- 4. HEAT EXCHANGER**
- 4.1 The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be covered by anti-corrosion resin film.
- 5. REFRIGERANT CIRCUIT**
- 5.1 The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves.
- 5.2 All necessary safety devices shall be provided to ensure the safety operation of the system.
- 6. SAFETY DEVICES**
- 6.1 The following safety devices shall be part of the outdoor unit:
High Pressure Switch, Low Pressure Switch, Fan Motor Safety Thermostat, Inverter Overload Protector, Over Current Relay, Fusible Plugs, Fuses.
- 7. OIL RECOVERY SYSTEM**
- 7.1 Each unit shall be equipped, with an oil recovery system to ensure stable operation with long refrigerant piping.
- 8. INDOOR UNIT**
- 8.1 Each Indoor unit shall be ceiling mounted duct type/cassette type/Hi-Wall split type, as specified in scope of work. It shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.
- 8.2 The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by liquid crystal remote controller.
- 9. CONTROL UNIT**
- 9.1 Computerized PID control shall be used to maintain room temperature.
- 9.2 Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.
- 9.3 The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance.
- 9.4 It shall be able to control up to 16 indoor units and change fan speed and angle of swing flap individually in the group.
- 10. CENTRALIZED INTELLIGENT TOUCH REMOTE CONTROLLER**
- 10.1 A multifunctional compact centralized controller shall be provided with the system.
- 10.2 The Graphic Controller shall act as an advanced air conditioning management system to give complete control of VRV air conditioning equipment. It shall have ease of use for the user through its touch screen, icon display and colour LCD display.
- 10.2.1 It shall be able to control up to 64 groups of indoor units with the following functions:
- 10.2.2 Starting/stopping of Air conditioners as a zone or group or individual unit.
- 10.2.3 Temperature setting for each indoor unit or zone.
- 10.2.4 Switching between temperature controls modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
- 10.2.5 Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, and troubleshooting information.
- 10.2.6 Display of air conditioner operation history.

- 10.2.7 Daily management automation through yearly schedule function with possibility of various schedules.
- 10.3 The controller shall have wide screen user friendly colour LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

11. REFRIGERANT PIPING

- 11.1 All refrigerant piping for the air conditioning system shall be constructed from hard drawn seamless copper refrigerant pipes with copper fittings Y- joints, headers etc. and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include expansion valves, charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.
- 11.2 The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturer's specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, slotted angle tray, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.
- 11.3 The OD wall thickness & wall thickness size of copper refrigerant piping shall be as follows:

| | <u>Outside Dia (mm)</u> | <u>Wall Thickness (mm)</u> |
|----|-------------------------|----------------------------|
| a) | 41.3, 38.1, 34.9 | 1.3 |
| b) | 31.8, 28.6, 25.4, 22.2 | 1.2 |
| c) | 19.1, 15.9 | 1.0 |
| d) | 12.7, 9.5, 6.4 | 0.8 |

12. DRAIN PIPING

- 12.1 The indoor units shall be connected to drain pipe made of High density PVC pipe of 40 mm, 32 mm, 25 mm dia.
- 12.1.1 The pipes shall be laid in proper slope for efficient drainage of condensate water.
- 12.2 Drain Pipe Insulation
- 12.2.1 Drain pipes carrying condensate water shall be insulated with 6 mm Nitrile rubber having density 55 Kg/m³ and K factor 0.37 w/mk at a mean temp. of 20°C.
- 12.2.2 The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

13. PIPE INSULATION

- 13.1 Refrigerant Pipe Insulation
- 13.1.1 The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm /13 mm thick Nitrile close cell rubber having density 55 Kg/m³ and K factor 0.37 w/mk at a mean temp. of 20°C.
- 13.1.2 The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

14. Y joint is used to increase the piping size between indoor units. When more than one indoor units are to be connected through a common pipe Y joints are used.

15. Each indoor units are provided with remote controller flat display type for controlling. These are connected to indoor units by means of transmission wiring.

SECTION - 3.0:- HORIZONTAL FLOOR MOUNTED DX TYPE AIR HANDLING UNITS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction air handling units along with its accessories, conforming to these specifications and in accordance with requirement of the 'Schedule of Quantities', Drawings and 'Technical Schedule of Equipment'.

2. TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R .AIR and F.AIR are ducted.), pre filter section, fine filter and HEPA filter wherever required, DX type coil, fan section supply air plenum as per details given in Drawings and Schedule of Equipment.

3. CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as indicated in 'Schedule of Quantities'.

4. CONSTRUCTION

4.1 AHU HOUSING / CASING:

4.1.1 The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type with 0.8mm pre painted GSS/ pre-plasticized on the outside and 0.6 mm galvanized sheet inside with 25 mm thick PUF insulation material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

4.1.2 Framework for each section shall be joined together with soft Neoprene rubber gasket in between to make the joints airtight. Suitable airtight access doors /panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on roller-formed GSS channel framework having pressure die cast aluminum jointers.

4.2 DRAIN PAN

The drain pan shall be of 18 G aluminum/stainless steel with necessary slope to facilitate fast removal of condensate. It shall be provided with drain connection of suitable size complete with 25 mm rigid insulation. Necessary arrangement will be provided to slide the coil in the drain pan. The drain pan shall be insulated with 12 mm thick close cell Nitrile insulation (self adhesive) or equivalent.

4.3 DX TYPE COOLING COIL

The refrigerant coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 10to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 38-kg/sq. cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be complete with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

4.4 FAN SECTION WITH FAN

The fan shall be backward curved, double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a

solid shaft supported to housing with angle iron frame & pillow block heavy-duty ball bearings. The fan shall be selected for a speed not exceeding 1000 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM. Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the air handling housing on anti vibration spring mounts or cushy foot mounts of at least 90% vibration isolation efficiency. The fan outlet shall be connected to casing with the help of fire retardant double canvas or Neoprene rubber of imported Origin. The fan shall be selected for a noise level of less than 70 DB (A) at one meter distance.

4.5 **FILTER SECTION**

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Fine-filter shall be selected for minimum filtration efficiency of 5 micron particles and 20 micron particles respectively. HEPA filters shall be provided in the AHU. These shall be with minimum efficiency 99.97% down to 0.3 microns required. Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

The AHU contractor shall select the AHU blower capacity in away which shall be able to take care of pressure drop expected to be encountered in all three filtration levels in the labs mentioned in Schedule of Quantities.

5. **FRESH AIR INTAKES**

Extruded aluminum construction duly anodized fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear opening in masonry walls of the air handling unit room having at least one external wall. Fresh air louver, damper, pre filters, ducts and fresh air fan with speed regulator (wherever specified in 'Schedule of Quantities') shall be provided. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be rattle free. Damper shall be similar to those specified in 'air distribution'. Fresh air fans and fresh air intakes shall be as per the requirements of 'Schedule of Quantities'.

6. **ACCESSORIES**

Each air handling unit shall be provided with manual air vent at highest point in the cooling /heating coil. In addition, the following accessories may be required at air handling units. Their detailed specifications are indicated in individual sections and quantities separately identified in 'Schedule of Quantities'.

- (a) Stem type thermometer at each AHU coil inlet and outlet with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'
- (b) Pressure gauge with globe valves at inlet and outlet of each AHU coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.
- (c) Butterfly valves at inlet and outlet of the each coil.
- (d) Balancing valve at the outlet of each coil.
- (e) Y strainer at inlet of each coil.
- (f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.
- (g) Motorized three way mixing valves located connected to the coil. This valve shall be operated by the cooling/heating thermostat and shall control the flow'.
- (h) Cooling /heating thermostat as per section
'Automatic Controls and Instruments' shall be located in return air stream.
- (i) Flexible connection between the fan outlet and duct.

- (j) Vibration isolators of at least 90% efficiency.

7. SAFETY FEATURES

Each handling unit must have safety features as under:-

- (a) The fan access door must have micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.
The access door shall further have wire mesh screen as an added feature, bolted on to the unit frame.
- (b) Fan and motor base shall be properly earthed from the factory.
- (c) All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

8. DRIVE

Fan drive shall be 3phase-squirrel cage totally enclosed fan cooled motor suitable for $415 \pm 10\%V$, 50 HZ AC supply. Motor shall be specially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement or Plug Fans. If it is belt driven then belts shall be of oil resistant type of approved make only.

9. DESIGN DATA FOR AIR HANDLING UNITS

- (a) Fan outlet velocity shall not exceed 500 MPM.
- (b) The air velocity across coil shall not exceed 150 MPM.
- (c) The air velocity across air pre filter shall not exceed 150 MPM.

Motor ratings are only tentative and shall be suitable for the duty but not less than the specified HP. The motor shall be selected with a safety factor of at least 20% over and above the brake power.

The AHU fan shall be selected for a total static pressure as indicated in 'Schedule of Quantities'.

10. INSTALLATION

Air Handling Unit shall be installed inside the AHU room to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation and mounted on serrated rubber pads. The serrated rubber pads shall be in two layers with 16G GI sheet sandwiched in between.

11.1 PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation.

12. TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

HORIZONTAL FLOOR MOUNTED AIR HANDING UNITS – DATA SHEET B

| | | |
|------------|--|--|
| 1.0 | <u>GENERAL</u> | |
| 1.1 | Manufacturer | |
| 1.2 | Type of Unit | |
| 1.3 | Over All Dimensions (L x W x H) (mm) | |
| 1.4 | Weight (Including Water in circulation) Kg. | |
| 1.5 | Approximate Noise Level (DBA) | |
| 1.6 | Fan Discharge Position | |
| 2.0 | <u>FAN SECTION</u> | |
| 2.1 | Air Quantity (CFM) | |
| 2.2 | Total Static Pressure (mm of WG) | |
| 2.3 | Fan Speed (RPM) | |
| 2.4 | Fan Diameter (INCH) and no. Of fans | |
| 2.5 | Balancing (Static and / or dynamic) | |
| 2.6 | BHP | |
| 2.7 | Motor HP, RPM, Make & Type | |
| 3.0 | <u>COOLING COIL</u> | |
| 3.1 | Coil Fin Material (Aluminum or copper) | |
| 3.2 | Tube Diameter (INCH) and material | |
| 3.3 | Water through coil (USGPM) and no. of circuits | |
| 3.4 | Fin Size (INCH) | |
| 3.5 | No of Fins / INCH | |
| 3.6 | Water velocity through Coil (FPS) | |
| 3.7 | Water Coil Pressure Drop (ft of WG) | |
| 3.8 | Outside Coil Surface (SQFT) | |
| 3.9 | Face Area (SQFT) of Coil | |
| 3.10 | Rows Deep | |
| 3.11 | Water Temperature IN & OUT (DEG F) | |
| 3.12 | Air In and Out DB& WB Temp (DEG F) | |

SECTION – 4:- VENTILATION FAN- INLINE & PROPELLER FANS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of inline and propeller fans conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2. TYPE

Inline fans and Propeller Fans shall be of type as indicated in drawings and 'Schedule of Quantities'

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 equipment 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.

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 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 preventers for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

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.

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.

SECTION – 5:- FAN SECTIONS – SPECIFICATIONS

1. **SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of ventilation fan sections conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2. **TYPE**

Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.

3. **UNIT CONSTRUCTION**

3.1 **Housing**

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be

weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas.

3.2 Fan

Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.

3.3 Motor

Motors shall be suitable for $415 \pm 10\%$ volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class 'F' insulation. Motor shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be through belts.

3.4 Back draft Damper

Where called for in schedule of quantities the ventilation fan section shall be provided with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatter-proof under all conditions.

4. **VIBRATION ISOLATION**

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.

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.

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.

SECTION 6:- AXIAL FLOW FANS – SPECIFICATIONS

1. **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

2. **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

3. DESIGN & MANUFACTURING

Fan and Components

- 3.1 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.
- 3.2 The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quiet, stable and vibration free operation at the prescribed conditions of flow, static and speed.
- 3.3 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.

3.4 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 $415 \pm 10\%$ 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.

4. TECHNICAL SPECIFICATIONS

- 4.1.1 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.

5. GENERAL REQUIREMENTS

- 5.1 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.
- 5.2 **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.

6. PAINTING

All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

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.

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

SECTION 7:- PRE-INSULATED DUCTWORK

PRE-INSULATED GLASS WOOL DUCT WORK FOR THERMAL/ ACOUSTIC APPLICATION

Duct thermal

Pre-insulated duct board (Plus -R) shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft+ glass veil and inner facing foil - Aluminum + Kraft + glass veil.

Duct Acoustic

Pre-insulated duct board-(Neto) shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft+ glass veil and inner facing - Black glass textile.

Density of above both pre insulated glass wool duct board shall be 75-80Kg/m³ and at the edge of panels shall have density of 150Kg/m³. Size of panels for duct construction as below.

| Thickness(mm) | Length(m) | Width(m) |
|---------------|-----------|----------|
| 25 | 2.9 | 1.19 |

The thermal conductivity of duct board shall not be exceeding 0.033 W/m K at 10 deg C means temperature and thermal resistance should be more than 0.6 m²K/W.

Glass wool duct panels shall be tested as per EN 13403

Vapour permeance of duct panels should be approximate value: 0.013 g/m². day mm Hg (outer facing) Mechanical stiffness: R5 rigidity, according to EN 13403 (European Standard for non metallic ducts) this rigidity is the maximum level of the ones established by this standard.

Duct board should withstand pressure under 800 Pa with no evidence of fissures or swelling (test according to EN 13403)

Fire test: Panels shall be tested as Euroclass: Euro class C-s1, d0

- s1: null smoke emission
- d0: non flaming droplets / particles.

Joint System: Duct boards should have exclusive design with male / female edges, in order to provide greater strength for joints, easy installation and shall reduce the number of cutting operation & exceptional inside finish.

Tools and Accessories for Installation of Duct Boards shall be followed as per recommendation of manufacturer's manual.

Duct Support: Duct board shall be installed, using support as described in installation manual of manufacturers. Maximum distance between hangers / support shall not exceed for horizontal ducts as

- 900 mm inner dimension maximum distance of hanger 2.4 m
- 900-1500 mm inner dimension maximum distance of hanger 1.8mm
- Above 1500 mm inner dimension maximum distance of hanger 1.2 m

INSPECTION AND TESTING

Duct dimensions shall be checked based on the duct dimension / layout drawings duly approved by the Architects/ Consultants.

The ducts, branches elbows etc. shall be inspected and the joints and connection shall be checked properly before these are assembled in position. After assembly the system shall be checked for tightness of male/ female joints to avoid the leakage

Climaver Al. tape of 75mm thickness shall be applied on each male / female joint to avoid the leakage of air

Full sized standard dimension sheet as specified are to be used and any patched or made-up pieces of duct work are liable to be rejected. Joints between male/ female connections shall be fitted properly and Al. tape of 75 mm thickness shall be applied on joints.

Test points shall be provide at the discharge of each air handling unit and at each individual zone of the duct work system. Test points shall consist of 25mm diameter sockets fitted with sealing plugs which can be removed for the fitting of measuring devices. Test points shall be insulated as for the duct work and shall be provided with identification labels.

Rectangular risers should be free supported by angles or channels secured to the sides of the duct flanges with bolts or sheet metal screws or blind rivets. The supporting angle or channel should be freely resting over the slab cut-out. Riser support intervals should be limited to one storey height.

To ensure the air tightness, all ducts shall be checked with Leak Test after completion of duct fabrication but before installation of duct system.

SECTION 8:- SHEET METAL WORKS - (FACTORY FABRICATED)

1. GENERAL

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. DUCT MATERIALS

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).
- 2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

Governing Standards

- 2.3 Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

3. RAW MATERIAL

- 3.1 Ducting
 - 3.1.1 All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. row material furnished with accompanying Mill test Certificates.
 - 3.1.2 Galvanizing shall be of 120gms/sq.m. (total coating on both sides).
 - 3.1.3 In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.
 - 3.1.4 The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.
- 3.2 Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized)/

4. FABRICATION STANDARDS

- 4.1 All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be Rolastar factory-fabricated or Techno Fabriduct. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.
- 4.2 Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
- 4.3 All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- 4.4 All edges to be machine treated using lock formers, flanges and roller for fuming up edges.
- 4.5 Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5. SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with 1" (250 Pa)w.g. static norms as per SMACNA.

All transverse connectors shall be the Rolamate 4-bolt slip-on flange system or Techno Fabriduct imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

The specific class of transverse connector and duct gauge for a given duct dimensions will be 1"(250 Pa) pressure class.

Non-toxic, AC-applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

6. DUCT CONSTRUCTION

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

- 7 DIMENSIONAL TOLERANCES:** All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.

- 7.1 Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.
- 7.2 Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
- 7.3 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.
- 7.4 Plenums shall be shop/factory fabricated panel type and assembled at site.
- 7.5 Factory Fabricated ducts shall have the thickness of the sheet shall be as follows

| S.No. | Size of Duct | Sheet Thickness | Fastener Size | Type of Joints | | Bracing with GI tie rods of following sizes | Support Angle |
|-------|--------------------|-----------------|---------------|--|---|---|---------------------------------------|
| | | | | For Rolastar duct & Rolamate flanges | For Techno Fabriduct and flanges | | |
| 7.5.1 | Upto 750 mm | 0.63 mm | 3/8" | Fabricated out of G.I. sheet of 24 gauge at every 1.2 m internal. | The flanges shall be made out of the same duct sheet | Cross tie rods to be fitted of suitable dia GI rod for each piece of duct | 25x25x3 mm |
| 7.5.2 | 751 mm to 1000 mm | 0.80 mm | 3/8" | E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal. | and all the four corner shall be fitted for fitting the bolt | | 25x25x3 mm |
| 7.5.3 | 1001 mm to 1500 mm | 0.80 mm | 5/8" | E-22 type flange shall be fabricated out of 22 G sheet at every 1.2 m internal. | The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt | Cross tie rods to be fitted of suitable dia GI rod for each piece of duct | 40x40x5 mm |
| 7.5.4 | 1501 mm to 2250 mm | 1.00 mm | 5/8" | J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal. | | | 40x40x6 mm angle |
| 7.5.5 | 2251 mm and above | 1.25 mm | 5/8" | J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal. | | | 50x50x6 mm with MS rods of 12 mm dia. |

- 7.6 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.
- 7.7 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.
- 7.8 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.
- 7.9 All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

8. INSTALLATIONS

- 8.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.
- 8.2 Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

- 8.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.
- 8.4 The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
- 8.5 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.
The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.
- 8.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- 8.7 Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 8.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- 8.9 Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- 8.10 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 8.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.
- 8.12 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- 8.13 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

9 GRILLS / DIFFUSERS

SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be made of extruded aluminum section as specified in BOQ. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed blade volume control devices of extruded aluminum in black anodized finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Architect/Consultant.

The diffusers shall be provided with removable central core.

All diffusers shall be selected as per selection curves and in consultation with Architect / Consultant. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

LINEAR GRILLS:

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 15° inclination with flanges on both sides. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in black anodized finish shall be provided in S.A. duct collars.

DOUBLE ADJUSTABLE LOUVERED SUPPLY / RETURN AIR GRILLS WITH HORIZONTAL/VERTICAL OR VERTICAL/ HORIZONTAL LOUVER ARRANGEMENT:

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plus or minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade.

Volume control device of extruded aluminum construction with black anodized finish shall be provided in S.A. grills.

EXHAUST AIR REGISTER:

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminum construction with black anodized finish shall be provided.

MULTI SLOT CEILING DIFFUSERS:

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation. Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

LINEAR CEILING MOUNTED DIFFUSERS:

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. diffuser.

FRESH AIR INTAKE LOUVERS:

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 45° on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted. Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

All supply and return air ducts at AHU room crossings (or ducts as applicable) and at all floor crossings shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI ROORKEE as per UL 555:1973

Fire damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be provided on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 g galvanized sheet steel. For preventing smoke leakage side seals will be provided.

In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room/R.A. duct/damper. The A/C Contractor shall also provide smoke detector. The fire damper shall also close due to Temp. rise in S.A. ducts thru the electric temp. sensor factory set at 165 Deg. F micro switches with bake lite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorized actuator.

Each dampers in case of motorized smoke-cum-fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/temp. sensor & reset button. Additional terminal will be provided to have signal (sound beep or visual) in central control room.

Damper actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

Spring return action of the actuator shall be an in-built mechanism and shall not be mounted externally.

The damper shall be installed in accordance with the installation method recommended by the manufacturer.

10 PAINTING

All grills and diffusers shall be powder coated in color as approved by Architect/Consultant before installation.

All ducts immediately behind the grills/diffusers etc. Are to be given two coats of black paint in Matt finish.

11 TESTING

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

12. DOCUMENTATION TO MEASUREMENTS

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

13. TESTING

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA- "HVAC Air Duct Leakage Test Manual: (First Edition).

QUALITY CHECKS ON DUCTING

| S.No. | DESCRIPTION | YES - OK NO - X | REMARKS |
|-------|--|--------------------|---------|
| 1 | Whether material adheres to Fabrication Standards as specified (Lock form Quality Sheets) | | |
| 2 | Valid for construction Drawings. at site. | | |
| 3 | Cross breaking, bracings / reinforcements are as per standard. | | |
| 4 | Air tightness of transverse / Longitudinal Joints ensured. | | |
| 5 | Grease and heat resistant sealant for kitchen exhaust duct. | | |
| 6 | Neoprene gaskets for pharmaceutical and clean room projects used | | |
| 7 | Check following aspects of duct supporting system | | |
| 7.1 | Hanger spacing | | |
| 7.2 | Anchor bolts size and quality | | |
| 7.3 | Primer painting of supports | | |
| 7.4 | Check allowable load on trapeze angle for bigger ducts | | |
| 8 | Check whether contractor has provided | | |
| 8.1 | Vanes in elbows | | |
| 8.2 | Clinched collar at take Offs | | |
| 8.3 | Splitters | | |
| 9 | Check transitions & offsets slopes & fabrication. | | |
| 10 | Whether the installed ducting is as per layout approved, check locations, headroom etc. | | |
| 11 | Whether grilles / diffusers are as per approved shade. | | |
| 12 | Check the method of installation for Grilles / Diffusers | | |
| 13 | Repair / paint damaged surfaces. | | |
| 14 | Check the coordination of following activities as per the given sequence:- | | |
| 14.1 | Main Ducts Cut for taking collars | | |
| 14.2 | Match / Fabricate collar taking false ceiling framework for diffuser into account | | |

| S.No. | DESCRIPTION | YES - OK NO - X | REMARKS |
|-------|---|--------------------|---------|
| 14.3 | Fix grilles / diffuser framework in false ceiling | | |
| 14.4 | Install the collar | | |
| 14.5 | Install diffuser | | |
| 15 | All elbows / turning points and branches to be properly supported | | |
| 16 | Access door is provided at serviceable position for fan and fire damper | | |
| 17 | Air balancing for room is studied | | |
| 18 | Air replacement is considered for air exhausted from room. | | |
| 19 | PVC or stainless steel material is used for corrosive fume exhaust system. | | |
| 20 | Anti vermin netting installed for louvers removable and serviceable. | | |
| 21 | Water or gas vent outlet is not installed near air intake louver. | | |
| 22 | Kitchen exhaust is not short circuited to outdoor air intake louver. | | |
| 23 | Kitchen room pressure is slightly below the surrounding area. | | |
| 24 | Sound level of fan is studied. | | |
| 25 | Face velocity for louvers / grills / diffusers is studied. | | |
| 26 | Air distribution of the room is studied. | | |
| 27 | Cross break all flat surfaces to prevent vibrations or buckling due to air flow. | | |
| 28 | Sides of ducts having collar for grills should not be cross broken to facilitate alignment of grills. | | |
| 29 | All bends and collars should have vanes. | | |
| 30 | If duct passes through fire chamber increase sheet thickness. | | |
| 31 | Kitchen exhaust ducts to be tapered at bottom for oil / grease collection. | | |
| 32 | Avoid flanged joints in kitchen exhaust duct above false ceiling. | | |
| 33 | When aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint | | |
| 34 | Provide check nuts with duct hangers | | |
| 35 | Ducts below 250 mm should not be more than 1 m long to facilitate proper joining. | | |
| 36 | Plenums should have flanged and bolted ends for rigidity and easy maintenance. | | |
| 37 | Avoid 'U' bends in ducts | | |

| S.No. | DESCRIPTION | YES - OK NO - X | REMARKS |
|-------|--|--------------------|---------|
| 38 | Provide long radius bends and offsets. | | |
| 39 | No collars to be taken from top. | | |
| 40 | Install duct spool pieces near equipment for easy removal. | | |

SECTION 9:- INSULATION – SPECIFICATIONS

1 SCOPE

The scope of this section comprises supply and fixing of acoustic lining conforming to these specifications.

2. DUCT ACCOUSTIC LINING

The ducts so identified and marked on drawings and in 'Schedule of Quantities' shall be provided with acoustic lining of thermal insulation material as follows: -

2.1 Material for Duct Lining

The material to be used for duct lining shall be 25 mm thick resin bonded glass wool having a density of 32 kg/cu.mt and covered with 26 gauge thick perforated aluminum sheet with at least 20% perforation. The value at 32°C shall not be less than 0.034 KCAL / HR / MTR / Deg C

2.2 Application

- Clean inside surface of the duct
- Apply a coat of CPRX compound
- Fix the board inside the duct provided with GI channel 25 x 25 mm screwed on duct surface with self-tapping screws to make grid of 600 x 600 mm.
- The inner surface should now be covered with fiberglass RP tissue.
- Cover the insulation boards with 26 G perforated aluminum sheet with at least 20% perforation.
- Secure the insulation board and aluminum sheet with cadmium plated bolts and washers.
- Seal the ends completely so that no insulation material is exposed.

3. UNDER DECK INSULATION

Supply of extruded polystyrene closed cell rigid insulation material for under – deck application. Light and easy to handle the boards have a density of 30-32 Kg/m³ and available in standard size of 1250 x 600 mm in various thicknesses.

Normally for roof, thickness of under deck insulation required is 50mm i.e. 'R' value of 1.78 or 'U' value of 0.56 in metric units.

Insulation is laid with its shiplapped joints tightly butted in single or multiple layers depending upon the specific 'U' value requirements.

'U' factor is the transfer of energy through the building assembly per unit time, per unit area and temperature difference.

It offers a compressive strength of 250kPa, water absorption of < 1% (V/V) and a thermal conductivity of 0.028 W/m²K at a mean temperature of 25°C

SECTION 10:- HEPA FILTER & HEPA FILTER MODULE**DESCRIPTION**

It shall be Single Skin 18G CRCA Powder coated Housings complete with Aluminium powder coated perforated grill (thickness 1.6 mm). The housing is suitable for High Flow Hepa Filter having size 2'x2'x1'. The Housing is complete with Measurement Ports (DOP & Pressure Drop). Housing as quoted is without Hepa Filters but with flexible canvass connection. Volume Control Damper shall be provided. S.S. Hardware for filter mounting and zinc plated hardware for back cover and Volume Control Damper shall be provided. Housing is designed for removing filter from corridor. Offered Housings are suitable for fixing Flange type High Flow Hepa Filters

1. D.O.P. tested point to point scanned **HIGH FLOW HEPA FILTERS** having following technical specifications :-

- | | | |
|---------------------|---|--|
| a) Frame | - | Aluminium. |
| b) Type | - | Flange Type. |
| c) Media | - | Micro Fibre Glass (Imported). |
| d) Sealing of media | - | By means of epoxy. |
| e) Efficiency | - | ≥ 99.97% down to 0.3 micron particle size. |
| f) I.P.D. | - | < 25 mm WG |
| g) F.P.D. | - | 75 mm WG |
| h) Separators | - | Aluminium |

Specification – HEPA FILTER

| Sr.No. | Description | Specification |
|--------|---------------------------------------|--|
| 1 | Filter grade | H-13 |
| 2 | Applicable | Final filter for Unclassified Controlled area. |
| 3 | Type | Box type |
| 4 | Filter frame and box construction MOC | Aluminum Anodized – 3mm Thick. |
| 5 | Filter Efficiency | 99.97 % down to 0.3μ |
| 6 | Filter Media | Fiber glass filter media |
| 1 | Filtration | Shall protect the product from small size dust particle equal to & larger than 0.3 μ |

HEPA filter Housing/Module specification

| Sr.No | Description | Specification |
|-------|---------------------------------------|---|
| 1 | Type of HEPA filter housing | Ceiling mounted, suitable for bottom filter loading |
| 2 | Provision for duct connection | Top connection |
| 3 | MOC | G I powder coated |
| 4 | Thickness | 1.6 mm |
| 5 | Housing surface finishing from inside | G I powder coated |
| 6 | Filter fixing arrangement | Loading from bottom side Pressure plates - One (top) shall fixed and other (bottom) will lose and tightens with clites and bolts |

| | | |
|----|---|--|
| 7 | Pressure plate size | 25 mm x 5 mm |
| 8 | Pressure plate MOC | SS 304 |
| 9 | Grill MOC | SS 304 Capsule perforated with 75% perforation |
| 10 | DOP test and on line pressure measurement | Vendor shall provide the port with nipple for DOP test and online pressure measurement |
| 11 | External volume control damper and MOC | External damper at housing inlet For MOC and specification of volume control damper pl ref specification of "Volume control damper" |

SECTION 11:- MODES OF MEASUREMENTS

1. UNIT PRICES IN THE SCHEDULE OF QUANTITIES

- 1.1 The item description in the 'Schedule of Quantities' is in the form of a condensed resume. The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
- 1.2 The Unit price of the various items shall include the following:
- 1.2.1 All equipment's, machinery, apparatus and materials required as well as the cost of any tests which the Consultant may request in addition to the tests generally required to prove quality and performance of the equipment's.
 - 1.2.2 All the labour required supplying and installing the complete installation in accordance with the specifications.
 - 1.2.3 Use of any tools, equipments, machinery, lifting tackle, scaffolding, ladders etc. Required by the Contractor to carry out his work.
 - 1.2.4 All the necessary measures to prevent the transmission of vibration.
 - 1.2.5 The necessary material to isolate equipments foundations from the building structure, wherever necessary.
 - 1.2.6 Storage and insurance of all equipments apparatus and materials.
- 1.3 The Contractor's unit price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2 MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.

2.1 Sheet Metal Ducts

- 2.1.1 Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface areas shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.
- 2.1.2 For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway large and small diameter shall be adopted, the length of tapered duct section shall be the center line distance between the flanges of the duct section. or special pieces like bends,

tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

- 2.1.3 The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel. Splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

2.2 Grilles/Diffusers

- a. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.
- b. Diffusers - cross section area for airflow at discharge areas, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.
- c. Linear diffusers - shall be measured by cross - sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.
- d. Fire dampers - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel No special allowance shall be payable for extension of cross section outside the air stream.
- e. Flexible connection - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.
- f. Exhaust Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipments. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

2.3 Dampers

Measurement of dampers shall be as per internal cross sectional area of the damper

SECTION 12:- SAFETY CODES - SPECIFICATIONS

1. SCOPE

The scope of this sub-section is the minimum safety requirements to be observed during manufacture and erection of the HVAC system as specified herein in addition to the safety norms generally followed:-

2. I.S. STANDARDS

The safety code for mechanical refrigeration IS: 660 and safety code for air conditioning IS: 659 shall be observed.

3. SAFETY REQUIREMENTS

Some of the important safety requirements are as under but not limited to the same:-

- a) There shall be maintained in a readily accessible place, first aid appliances including adequate supply of sterilized dressings and cotton wool.
- b) The injured person shall be taken to a public hospital without loss of time.
- c) Suitable and strong scaffolds shall be provided for workmen for all works that cannot be safely done from ground.
- d) No portable single ladder shall be over 8 meters in length. The width between side rails shall not be less than 30 cm (clear) and the distance between two adjacent rings shall not be more than 30 cms, when a ladder is used, an extra mazdoor shall be engaged for holding the ladder.
- e) The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.
- f) Every opening in the floor of a building or in a working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.
- g) No. Floor, roof or other part of the structure shall be so overloaded with debris or material as to render it unsafe.
- h) Workers employed on mixing and handling materials such as asphalt, cement mortar or concrete & lime mortar shall be provided with protective footwear and rubber hand gloves.

Those engaged in welding works shall be provided with protective eye shields and glove.

No paint containing lead or lead products to be used except in the form of paste or readymade paint.

Suitable facemasks shall be supplied for use of workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.

Overalls shall be supplied by the Contractor to the painter and adequate facilities shall be provided to enable the working painter to wash during cessation of the work.

The ropes used in hoisting or lowering material or as a means of suspension, shall be of adequate quality and adequate strength and free from defects.

All site personnel shall wear safety helmets whenever they are in the construction/erection areas.

GRILLES AND DIFFUSERS TEST REPORT

PROJECT _____

SYSTEM _____

OUTLET MANUFACTURER _____

TEST APPARATUS _____

| AREA | | OUT LET | | | DESIGN | | INITIAL | | FINAL | |
|--------|----|---------|------|-----|--------|-----|---------|-----|-------|-----|
| SERVED | NO | TYP | SIZE | VEL | CFM | VEL | CFM | VEL | CFM | VEL |

TEST DATE _____ READINGS BY _____

Tender No. HLL/HQ/NOIDA/2015

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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 | American society of heating, refrigeration and air conditioning books - Applications 1999 - Fundamentals 1997 - System and equipments 1996 - Indoor air quality 62 – 1999 |

**Construction of HLL Office Building (Phase II) at
B-14A, Sector 62, NOIDA**

List of Approved Makes of Materials

1. List of Approved Makes- CIVIL & Plumbing Services

| S.No | Details of equipment/ material | Make/manufacturer |
|------|--|---|
| 1. | Adhesive for Door Work | Fevicol/Vamicol/Dunlop |
| 2. | Air Release Valve | Azud/ API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto |
| 3. | Aluminium Accessories and Hardware | Classic/Argent/Oxford /Newlite /Crown /EBCO /Earl Bihari |
| 4. | Aluminium Cladding Sheets | Aludecor / Armstrong / Alucobond / Alupan / Alstone |
| 5. | Aluminium Die-Cast handles & two point locking kit | Giesse / Securistyle / Alu – alpha |
| 6. | Aluminium Extrusion | Hindalco / Jindal / Indal/ Mahavir |
| 7. | Aluminium Fabricator | To be approved by the Engineer-in-Charge |
| 8. | Anchor Fastner | Hilti / Faischer /Bosch |
| 9. | Anti – Termite Treatment | It should be done by permanent members of IPCA as approved by Engineer-in-Charge. |
| 10. | Automatic variable temperature control / fixed temperature control faucets | Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics |
| 11. | Back up rod | Supreme Industry or equivalent |
| 12. | Ball Cock | Sant / L&T/Audco/ Gpa |
| 13. | Ball valves with floats | Zoloto / Leader / Sant / Jayco /GPA /Audco /AIP |
| 14. | 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. |
| 15. | Brass stop & Bib Cock | Zoloto / Sant / Jaquar |
| 16. | Butterfly valves | Zoloto/Audco / AIP /Sant/ KSB |
| 17. | C. I Fitting | Electrosteel/ Kesoram/ Neco/ RIF |
| 18. | C.I Sluice Valve & Non Return Valve | Kirloskar / IVC/ Leader /Zoloto/ Audco/ Sant/ AIP |
| 19. | C.I Valves (Full way, Check and Globe Valves) | Leader / Kirloskar / SKF / Zolto / Sant / Upadhyay / Castle / Kartar |
| 20. | C.I. Manhole Covers | Neco/R.I.F./B.C./Hepco/SKF/Kajeco |
| 21. | C.P. Fittings Mixer / Pillar taps/ C.P brass angle valve/ Valves Washers, C.P. brass accessories | Parko /Jaquar /Marc/ Sanitaryware (ARK) Parry/ Orient/ Kohler |
| 22. | C.P. Waste, Spreaders, Urinal | Jaquar/Parko/ Parryware |
| 23. | Carpet Flooring & Skirting (Floatax) | Forbo/ Polyflor/ Tarket |
| 24. | Cement | ACC / Ultra tech / JK Cement / Jaypee-Rewa / Ambuja / Lafarge / Bangur/ Shree |

| | | |
|-----|---|--|
| 25. | Cement: White | Birla White / JK |
| 26. | Central Control | Rain Bird, USA/Toro/Nelson, |
| 27. | Centrifugal Pump | Crompton /Kirloskar/ KSB/ |
| 28. | Centrifugally C.I Rainwater Intel fitting , Bronze gratings | Sages Metals, GMGR, Electro Steel , Kesoram, Neco , Neer |
| 29. | Centrifugally cast C.I Rainwater fitting / Bronze gratings etc. | Sages Metals/ GMGR/ Electro Steel / Kesoram Neco / Neer |
| 30. | Centrifugally casted C.I. Pipes | Neco / Hepco / Anand/ Kapilash |
| 31. | Ceramic tiles | Somany / Kajaria /Nitco/ Orient-Bell |
| 32. | Ceramic tiles Adhesive | Cico / Pidilite / BalEndura / Sika |
| 33. | Chlorinator | Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon/ Jesco / Prominent Heidelberg |
| 34. | Chlorine Dosing System | Toshcon / Chloromax |
| 35. | Clear Glass / Clear Float Glass / Toughened Glass | Modi / Saint Gobain (SG) / Asahi India Safety Glass Ltd / |
| 36. | Cockroach Trap | Chilly/ Player/ Camry |
| 37. | Compressed Chequered tiles | Somany / Kajaria / Nitco |
| 38. | Concrete Additive | Sika /CICO/Pidilite / Fosroc / Fairmate / MC Bauchemie |
| 39. | Copper Fittings (Capillary) | Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd. |
| 40. | Copper Pipes | Rajco Metal works, Mumbai / IBP Conex Ltd. |
| 41. | CPVC Pipes & Fittings | Flowguard/ Astral/ Ashrivad |
| 42. | Curtain Rod/Drapery Rod | Vista work / Mac Decor |
| 43. | Dash Fasteners | Hilti / Faischer /Bosch |
| 44. | Disc Filter | Azud, Spain/ Amaid / Arkal, |
| 45. | Door closer / Floor spring | Doorking / Everite / Hardwyn/ Master |
| 46. | Door Locks | Godrej / Harrison / Link |
| 47. | Door Seal – Woolpile Weather Strip | Anand Reddiplex/ Enviroseal |
| 48. | Doors & Windows Fixtures / Fitting. | Everite / Classic/ Crown / Earl Bihari |
| 49. | Drainage Pumps | Grundfos/ KSB/Salmson/Kirloskar/ DP Holland |
| 50. | Ductile Iron Fittings (IS:9523) | Electrosteel/Kesoram/Tisco/Jindal |
| 51. | Ductile Iron Pipes (IS:8329) | Electrosteel/Kesoram/Tisco/Jindal |
| 52. | E.P.D.M Gaskets | Anand Reddiplex / Enviro Seals |
| 53. | Epoxy Floor | Fosroc/ BASF/ Cico/ Sika Pidilite |
| 54. | Epoxy SLF Flooring | Sika/ /BASF / Pidilite |
| 55. | Extruded Polystyrene Board | Styrofoam by DOW Chemicals / Insulboard by Supreme Industries |
| 56. | False Ceiling - Calcium Silicate Boards & Tiles | India Gypsum/ Armstrong / Aerolite / Hilux / Saint Gobain (Gyproc) |
| 57. | False Ceiling - Metal | Armstrong / Unimet or equivalent |
| 58. | False Ceiling - Mineral fibre | Armstrong / Decosonic / AMF/ Saint Gobain (Gyproc) |
| 59. | Filtration Plant / Softening Plant | Bikon water / Ion exchange /Thermax/ Pentair/ Eureka Forbes/Fontus |
| 60. | Fire rated Doors & Frames | Navair / Shakti-Hormann / Promat / Godrej |
| 61. | Fire Rated Glass | Asahi India Safety Glass Ltd./ Modi/ Saint Gobin |
| 62. | Fire Retardant Paint | Viper FRS 881, Nullifire, Burger |

| | | |
|-----|---|---|
| 63. | Fire Seal | Sealz, Alstroflam, Abacus |
| 64. | Fire: Door Closures, Mortice Dead locks | Becker Fire Solution, Inersoll Rand LCN Series, Dorma TH Series. |
| 65. | Fire: D-Type Pull Handles | Becker Fire Solution, Dorma, Hardwin |
| 66. | Fire: Hinges, | Becker Fire Solution, Inersoll Rand, Dorma. |
| 67. | Fire: Panic Exit Devices | Becker Fire Solution, Inersoll Rand LCN Series, Dorma PHA Series/ D-line |
| 68. | Fire: Tower Bolts | Suzu, Nulite, Dorset |
| 69. | Flush Door Shutters | Duro / Greenlam / Century |
| 70. | Flush Valves | Gem/ Jaquar / Marc |
| 71. | Forged Steel Fittings & Flanges (For Welded joints) | Rohini /Kanwal/ Vijay Cycle & Steel (VS) |
| 72. | G.I. Fittings | R/Unik/Zoloto/K.S./Sun/Swastik |
| 73. | G.I. Pipes | Jindal / Tata / Prakash Surya / SAIL / Swastik |
| 74. | Geyser | Spherehot / Racold / Usha Lexus /Bajaj |
| 75. | Glass : Mirror | Modiguard / Atul / Saint Gobain/ Asahi India Safety / Modi Float |
| 76. | Glass for Aluminum Doors/ Windows/ Structural Glazing | Modiguard / Saint Gobain / Pilkington/ Asahi India Safety Glass Ltd. |
| 77. | Glass Wool / Insulation Boards | Rockwool / UP Twiga / Lioyd Insulation |
| 78. | Grab bars and Disabled Hardware | Dorma / D-line |
| 79. | Gunmetal Valves / C.P brass angle valve | Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco |
| 80. | Gypsum Board & Gypsum False Ceiling | Boral Gypsum / India Gypsum / Laffarge / Saint Gobain (Gyproc) |
| 81. | Hand Drier | Kopal / Utech Systems / Euronics Automat |
| 82. | HDPE Pipes / Moulded Fittings | Emco /Polyefins/Pioneer Plyfab/ Jain |
| 83. | HDPE Solution tank | Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd. |
| 84. | Heat Resistant Terrace Tiles | Thermatek or equivalent |
| 85. | Horizontal Centrifugal / Monoblock Pumps | Kirloskar / DP Holland / Wilo /Ground fos/ CR Pumps/Ebara/Wilo |
| 86. | Hydro-pneumatic System | HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar/ DP Holland / Wilo |
| 87. | Inbuilt Drip Line | Azud/ Rainbrid-USA/ Netafim |
| 88. | Insulation of Hot water pipes | Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex |
| 89. | Laminates | Century/Greenlam/Formica/Sunmica/ Merrino |
| 90. | Liquid Level Controllers / Indicators | Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer / 21 st Century |
| 91. | Liquid Soap Dispenser | Euronics/Utec/Kopal |
| 92. | M.S. Pipe | Jindal / Prakash – Surya /TATA |
| 93. | Mainline Isolation Valve | Sant /Leader /Zoloto, |
| 94. | Modular SS Railing System | Metallica India / D – Line International Denmark / Mobel Hardware |
| 95. | MS Saddle with G.I. Riser | Harvel/Alprene/Rain Bird, USA |
| 96. | Night Latch | Godrej /Harrison / Link |
| 97. | Non Return Valve | Sant/ Leader/ Zoloto / AIP / Kirloskar/ IVC/ Leader/ Audco |
| 98. | OT: Anti-bacterial paint | Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX |

| | | |
|------|---|--|
| 99. | OT: Conductive Tile Flooring: ESD-Control Tile Flooring | Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux |
| 100. | P.R.S. Dials | Rain Bird, USA/ Toro, USA/ Nelson, |
| 101. | P.T.M.T. Fitting | Prince India / Symet |
| 102. | R.C.C Pipes | Indian Hume Pipe / Pragati Concrete Udyog /ISI Marked Pipes/Daya/KK / JSP |
| 103. | Paints - Cement Based | Snowcem Plus/, Berger (Durocem Extra)/ Nerolac (Super Acrylic)/ TATA Cem |
| 104. | Paints - Epoxy paint | Nerolac / Cico / Sika / BASF / Berger / Pidilite |
| 105. | Paints - Oil Bound Distemper / Acrylic Washable Distemper | Asian (Tractor)/ Burger (Bison)/ Nerolac (Super Acrylic) |
| 106. | Paints - Other Paints / Primer | ICI Dulux/ Asian/ Berger/ Nerolac |
| 107. | Paints - Plastic Emulsion Paint | ICI Dulux/ Asian/ Berger/ Nerolac |
| 108. | Paints - Synthetic Enamel Paints | ICI Dulux (Gloss), Berger (Luxol Gold), Asian (Apcolite), Goodlas Nerolac (Full gloss hard drying) |
| 109. | Paints - Texture paint | Berger / Spectrum / Unilite Heritage /Asian |
| 110. | Paver blocks (All Types) | KK Manholes / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles |
| 111. | PE-AL-PE Pipe and Accessories | Kitec/ Jindal/ Kissan/Vista |
| 112. | Pipe coat material (pipe protection) | RPG Raychem/Pypkote/Makphalt/Lwl |
| 113. | Plastic seat cover of W.C | Commander/Hindware / Parryware |
| 114. | Plywood/Block board/Ply board | Duro/ Greenply/ Century/ Kitply/ Greenply / National / Anchor |
| 115. | Polycarbonate Sheets | Galina/ GE Plastic / Vergola / Skyarch/ Polytechno/ FlexyTuff |
| 116. | Poly-sulphide Sealant | Pidilite / Fosroc / Cico / Sika |
| 117. | Pop up Connecting Assembly | Rain Bird/Dura/Lasco, |
| 118. | Popup Spray Head | Rain Bird/Toro, USA/Nelson, |
| 119. | Powder Coating Material pure Polyester | Jotun / Berger / Goodlass Nerolac |
| 120. | PP-R Pipes (PN – 16) | Amitex Polymers Pvt. Ltd. / Prince/ Supreme |
| 121. | Pre-coated Galvanised Steel Sheet | Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals |
| 122. | Pre-Laminated Particle Board | Novapan /Century /Green Ply |
| 123. | Pressure Relief Valve | Omega/ Sant/Leader/ Zolato / Upadhyay / Audco |
| 124. | Pumps | DP Holland / Wilo/ Grundfoss |
| 125. | PVC continuous fillet for periphery packing of glazings / Structural/ Glazing | Roop / Anand / Forex Plastic/ Nagalia/Trading Company |
| 126. | PVC Doors | Sintex/ Polyex/ Rajshri |
| 127. | PVC Flooring | Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong |
| 128. | PVC flushing cistern | Commander / Parryware / Hindware |
| 129. | PVC Pipes & fitting SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes | Prince / Supreme / Finolex |
| 130. | PVC Water Stops | Prince /Supreme/ Finolex |
| 131. | Polyethylene Storage Tank | Sintex / Polycon/ Fusion |
| 132. | R.O. Water Purifier Unit | Eureka Forbes/ Kent/ Zero B/ Dr. RO |
| 133. | Reinforcement Steel | SAIL/RINL/TATA Steel Ltd./ Jindal Steel & Power |

| | | |
|------|--|--|
| | | Ltd./ JSW Steel Ltd. |
| 134. | RQRC Hydrant | Harvel/Alprene/Rain Bird, USA |
| 135. | RQRC Key | Harvel/ Aqua/ Drip& Drip |
| 136. | Sensor Operated Auto Flushing System Urinals | Jaquar / AOS-Robo/U-tec/Angash/Euronics |
| 137. | SFRC / RCC Manhole Covers/ Perfect RCC Grating | KK Manholes /SK Precast Concrete/ Advent concreteovision / Daya concrete |
| 138. | Silicon sealants /Weather Sealant / Structural Glazing Sealant | GE- Silicon / Pidilite / Forsoc / Cico /Dow Corning / Sika/ |
| 139. | Sluice valve / NRV | Kirloskar/IVC/Kilburn /Zoloto/Castle/ Leader / L&T/Audco |
| 140. | Solar Hot water system | Tata BP Solar / EPL India Limited / Solahart (India), / Edwards (Australia)/ WBS Innovations |
| 141. | Solenoid valve | Rain Bird, USA/Toro/Nelson, |
| 142. | SS Gratings, Soap Dish Towel Rail etc. | Camry/Glacier/Gem |
| 143. | Stainless Steel | Salem Steel or as approved by EIC |
| 144. | Stainless Steel bolts, Washers & Nuts | Kundan / Puja / Atul |
| 145. | Stainless Steel Clamps | Hilti /Intellotech Konzept |
| 146. | Stainless steel CP Grating | Chilly / Camry |
| 147. | Stainless Steel D-handles | D-line / Giesse /Dorma |
| 148. | Stainless Steel Friction Stay | Earl Bihari / Securistyle / EBCO |
| 149. | Stainless Steel Pressure Plate Screws | Kundan/ Puja/ Atul |
| 150. | Stainless Steel Screw for Fabrication and fixing of Windows | Kundan / Puja / Atul |
| 151. | Stainless Steel Sink | Hindware / Neelkanth / Nirali |
| 152. | Stone ware pipes & Gully Traps | Perfect / SKF/ R.K/ Hind / Anand /Burn |
| 153. | Submersible Drainage pump | Jyoti / Crompton/ Kirloskar/ KSB /Grundfos/ Mather & Platt / JS/Wilo/ITT |
| 154. | Sunken Portion Treatment | Choksey / Sika / Cico, MC Bouchemie / MC Bouchemie / BASF |
| 155. | Super plasticizer | CICO, Roffes Construction Chemicals, Pidilite Industries |
| 156. | Tiles: Ceramic tiles | Somany / Kajaria / Nitco / Orient-Bell / Spartek/ HR Johnson |
| 157. | Tiles: Glass Mosaic Tiles | Mridul / Bisazza/ Italias |
| 158. | Tiles: Glazed tiles | Somany / Kajaria /Nitco/ Orient-Bell |
| 159. | Tiles: Vitrified Tiles (Double / Multy Charged)/ Germ free | Kajaria / Nitco /RAK /Hindware/ Orient-Bell |
| 160. | UPVC Pipes & fittings | Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral |
| 161. | Vacuum Dewatered Flooring | Tremix / Sun Build / Avcon technics |
| 162. | Valve Box | Rain Bird, USA/Carson Brook, USA/Dura, |
| 163. | Veneered Particle Board | Duro / Greenply / Century / Novapan / Action Tesa |
| 164. | VFD Pump | Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt |
| 165. | Vibration Eliminator Resisto-flex Pads & Connections | Relay Corpn./ Kanwal |
| 166. | Vitreous China/ Sanitary ware | Hindware / Parryware / Cera |
| 167. | Water Cooler | Blue Star/ Voltas/ Usha/ Godrej |
| 168. | Water Meter | Capstan / Kranti/ Anand/ Kant |

| | | |
|------|-----------------------------------|---|
| 169. | Water Proofing treatment Agencies | To be approved by the Engineer-in-Charge |
| 170. | Water Proofing Materials | BASF/ Fosroc / Sika / CICO |
| 171. | Water supply pumps | KSB/ Grunfos/ Kirloskar/ Crompton/ Mather & Platt |
| 172. | White Glazed Fire Clay Sink | Hindware / Parryware / Cera |
| 173. | Wooden Laminated Flooring | Nitco /Euro / Pergo |

2. SOLAR POWER

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|--------------------------------|---|
| a. | Solar PV system | Tata BP Solar / EPL India Limited / Solahart (India), ARYAV/EMVEE |

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. | Intelligent Addressable Fire Alarm System | Zicom, FirePro, Honeywell, Siemens, Schneider, Bosch, Notifier, GE Edwards, Tyco |
| 2. | Intelligent Addressable Fire Alarm Detectors, Hooters, Manual Call Point UL Listed, Talkback | Zicom, FirePro, Honeywell, Siemens, Schneider, Bosch, Notifier, GE Edwards, Tyco |
| 3. | Data Cables | Molex/ Awaya/ Delton/Hua-wei |
| 4. | Switches | Clipsal/ Crabtree/ Legrand/ Hua-wei/Havells |
| 5. | Cable TV Cables | Skytone/ Bonton/ Finolex/ Delton/ Hua-wei |
| 6. | Termination Control Cable | Dowell's/ Elemex/ Wago/ Phoenix |
| 7. | Cable Tray/Raceway | Pilco/ Slotco/ Needo/MEM |
| 8. | Control Cable | RR Cable/ Bonton/Havells/Polycab/Finolex/Harsh |
| 9. | Photo Chromatic Switch | Bajaj/ Wipro/Phillips/L&T |
| 10. | Splitter Box | Shyam Antenna/ CAT vision or equivalent |
| 11. | Panic Button | Eureka Forbes/Fire Pro or equivalent |
| 12. | Intelligent Addressable Response Indicator | Morlay/Seimens Finder/Notifier/ GE Edwards/Honeywell |
| 13. | Fibre Optic | Belden/Simone/ Sydstemax |
| 14. | Change Over Switch | HPL/ L&T or equivalent |
| 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. |

5. LV Package/PA System/CCTV

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|--------------------------------|-----------------------------------|
| 1. | PA Speaker | Bosch/ Ahuja/ Evacpro/ Ateis/Bose |
| 2. | Amplifier | Bosch/ Ahuja/ Evacpro/ Ateis/Bose |
| 3. | CD Player | Bosch/ Ahuja/ Evacpro/ Ateis/Bose |
| 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. | Speaker Wire | Belden / Canare /Extron /Leoni |
| 8. | CCTV Camera/ DVR/Central Monitoring Software , Other Items | Honeywell / Pelco / Vicon /Bosch/GE/Axis/Sony |

6. DRINKING WATER PUMPING SYSTEMS ETC.

| S. No. | Details of equipment/ material | Make |
|--------|---|---|
| 1. | Raw water pump set/ Treated water pump set/ Drainage pump set | Grundfos/ WILO/ Ebara/ Kirloskar/ITT/ArmStrong/Mather & Platt |
| 2. | Sodium hypochlorite dosing system | Asia LMI/ Grundfos/ Seiko/ E - Dose |
| 3. | Chain pulley block | Indef, Ardee, J.K. Morris |

7. HVAC

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|---|--|
| 1. | Accoustic Lining for ducts/AHU Rooms | UP Twiga/Owens Corning/Kimcco |
| 2. | Adhesives | Fevicol/Superlon or equivalent |
| 3. | Air Distribution/Ducting GI Sheets | Sail / Tata / Jindal |
| 4. | Axial Flow Fans | Kruger/Waves / Humidin/ Brightflow/ Systemair/ Airflow |
| 5. | Cable Lugs/Thimbles/Glands | Dowell/Combat/Raychem/Jainsons |
| 6. | Cable Tray | Pilco/slotco/ricco |
| 7. | Centrifugal Fans for Fan Sections | Kruger/Nicotra/Systemair/ Bright flow/ Humidin |
| 8. | Control Cables | Universal/Finolex/Polycab/Havells |
| 9. | Dash Fasteners | HILTI / Fischer / Cannon / Wurth |
| 10. | Duct/Pipe Supports | EASYFLEX/Resistoflex/Diamond |
| 11. | DX Type Air Handling Units | Edgetech/Waves/Brightflow/VTS/Zeco |
| 12. | Extended Polystyrene (EPS) for underdeck Insulation | Styrene Packing/ Perfect Pack or equivalent |
| 13. | Extruded Aluminium Grills/Diffusers | Air Track Concept/ Caryaire / Trox/Ravistar |
| 14. | Extruded Aluminium Sections | Mahavir / Jindal/ Hindalco/ Indal |
| 15. | Factory Fabricated Duct & Flanges | Rolastar / Zeco / Dynamic/GP Spiro |
| 16. | Fan Sections | Edgetech/Humidin / Waves/ Systemair |
| 17. | Filters(Prefilters,Fine filter & Hepa Filter) | Thermadyne/Anfilco/Sper cut/Mach mark |
| 18. | Fire / Smoke Dampers | Air Track Concept/ Caryaire / Trox/ Systemaire/ Ravistar |
| 19. | Fire Damper Actuator | Belimo/Danfoss/Siemens/Trox/Honeywell |
| 20. | Flexible Connection (N.U Matic Cloth) (Fire & Fungal Proof & Lint free) | Archana Chemicals/Airflow/Pyroguard |
| 21. | Header/ Separator/ Refrigerant pipes | Daikin/ Mitsubishi Heavy/ Samsung/Trane |
| 22. | HEPA Filter Modules | Allied concepts/Ravistar or equivalent |
| 23. | Inline Fans/Propeller Fans | Caryaire / Kanalfakt / Krugger/ Systemair |

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|-----|--|---|
| 24. | Insulation -Fibre Glass | UP Twiga / Owens Corning/ Styrene Packaging |
| 25. | Insulation - Nitrile rubber | Kflex/Armacell/Superlon |
| 26. | Paints | Shalimar/Asian/Burger/Nerolac |
| 27. | Power Cables | Universal/Finolex/Poly Cab//Havells |
| 28. | Pre Insulated Ducting | UP Twiga / Owens Corning/Kimcco |
| 29. | PVC Drain Pipe | Polypack/ Supreme |
| 30. | Red Oxide/Zinc Chromate Primer | ICI/Berger or equivalent |
| 31. | Refnet joints | Daikin/ Mitsubishi Heavy/ Samsung/Trane |
| 32. | Remote Controller (individual/ centralized) | Daikin/ Mitsubishi Heavy/ Samsung/Trane |
| 33. | Starters/ change over switch/ push buttons/ Rotary switches/ 1-phase preventor/ Soft starter | Siemens / Larsen & Turbo / Merlinergerin/ ABB/ Schneider/C&S Electric/Havells |
| 34. | VRV/VRF Outdoors/Indoor Units | Mitsubishi Electric/Daikin/ Samsung/Trane |

8. FIRE FIGHTING WORKS

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|--|---|
| 1. | Diesel engine driven pump | Kirloskar/ Ashok Leyland / Mather & Platt / Wilo |
| 2. | Air Break Contactors | Seimens / L&T / ABB/Schneider/GE |
| 3. | Air Release Valve | Rb / Tbs /Cimbrio/ Zoloto |
| 4. | Alarm valve & Hydraulic (Alarm motor with coupling) | HD fire protect/ Mather&Platt or Equivalent |
| 5. | Alternator | Stamford/ Lorey Somer/ kirloskar/ toyo denki/ AVK |
| 6. | Ammeter, Voltmeter, PF, kW, Hz, meter ,Energy Meter,Multimeter | AE/ Enercon/Conserve |
| 7. | Ball Valve | Rb / Zoloto / Leader / Danfoss / Sant /Rapid / Castel/ Emerald /Audco |
| 8. | Battery | Exide/ Amco/ Amaraja/ Statcon |
| 9. | Butt welded fitting (UL/EN Listed) | V.S.Forge /True Forge / DRP-M |
| 10. | Butterfly valves / C.I. Double flanged sluice Valves & check valves | Audco / Zoloto / Safex/ Intervale/ Leader/ Sant/ Kirloskar / Advance |
| 11. | Cable lugs and glands | Comet/Dowell/Lotus/Jainson/Baliga/ Stripwel/Havells |
| 12. | Cables | Universal / CCI /Gloster/ Elektron/ Polycab/ Finolex/Havells |
| 13. | Control / Potential / Current Transformer | Gillbert & Maxwell/ AE/ Kappa/Meher/L&T/Areva |
| 14. | Deluge valve | Eversafe / HD / Tyco |
| 15. | ELCB | MG/MDS Legrand – Lexic/ L&T Hager/ Siemens |
| 16. | Electrical Motors | Kirloskar / Seimens / Crompton / Wilo / Mather & Platt/ABB |
| 17. | Epoxy Paint | ICI / Berger/Asian/Nerolac |
| 18. | Fire Aid / Fire Hose Reels, GM short branch pipe, 2/3/4 FB inlet/draw off connection/Hose pipe | Ceasefire / Newage / Safex/ Minimax/ Usha fire/Omex |
| 19. | Fire Buckets | Safex / Minimax/Peter Autokit |
| 20. | Fire Extinguisher | Safex , Minimax , Peterautokit , Omex Padmini |

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| | | Fire. Ceasefire, Newage/Exflame |
| 21. | Fire Man's Axe | Ceasefire / Newage / Safex/Minimax/Exflame |
| 22. | Flow switch | Potter / System sensors/ Rapid flow/Danfoss/Viking/Exflame |
| 23. | Foot Valve (Cast iron/ Gunmetal) | Kirloskar/ Neta/ Leader/ Zoloto |
| 24. | Forged steel fitting | V.S.Forge/True Forge / DRP-M |
| 25. | Forged Steel Fittings & Flanges (For Welded joints) | Rohini / Kanwal or Equivalent |
| 26. | GI / MS Pipes | Tata / Jindal / SAIL |
| 27. | Gunmetal Branch Pipe | Newage / Ushafire / Winco / Kailash |
| 28. | Gunmetal Valves (fullway Check and Globe Valves) | Audco / Zoloto / Sant |
| 29. | Hydrant Valves | Newage / Minimax / Safex/ Ceasefire/Exflame/Omex |
| 30. | Non-Return Valve – Swing | Intervalve /Audco/ Zoloto/ Sant/Veeson/AIP |
| 31. | Nozzle | Newage , Winco , Ushafire , Kailash |
| 32. | Over Load Relays | GE / L&T / Siemens/ABB/Siemens/Areva |
| 33. | Pipe coat material (pipe protection) | Pypcoat / Makphalt / Safex |
| 34. | Pipe Hangers/ Clamps/Supports | Chilly/ GMGR /CAMRY/Hilti |
| 35. | Power/auxiliary Contactors | MG/ Siemens/ ABB/GE/L&T |
| 36. | Pressure guage | Feibig / Emerald / Waaree/H Guru |
| 37. | Pressure Switch | Danfoss / Indfoss / Switzer |
| 38. | Push Buttons, Indicating lamps LED | MG/ Larsen&Toubro/ Schneider/Rank/BCH |
| 39. | RRL Hose | Newage /Ushafire / Padmini Fire/ Ceasefire/ Safeguard /Superex /Omex/Exflame/Minimax |
| 40. | Single Phase Preventer | L&T , Minilac, Grinnel, Tyco, Yiking, Eversafe |
| 41. | Sluice Valves | Kirloskar / Audco /Unik / Leader/ Zoloto/ Sant |
| 42. | Solenoid valve, Spray nozzle | Eversafe / HD / Tyco |
| 43. | Sprinkler (ICV) | HD /Fireasfe / Reliable / Wormald/ Padmini Fire |
| 44. | Sprinkler Heads | Grinnel / Tyco / Viking / Eversafe/ Reliable/ HD/ Fireasfe / Padmini Fire/Newage/Omex |
| 45. | Steel flexible extension | Eversafe / Safex or equivalent |
| 46. | Suction "Y" Type Strainer | Kirloskar / Leader / Zoloto/ Sant |
| 47. | Vibration Eliminator | Resistoflex / D waren / Kanwal |
| 48. | Weld Electrodes | Advani/ ESAB/ L&T/Victor |
| 49. | Hose Box | Newage/ Minimax/Exflame/Omex |
| 50. | Hose Reel Drum | Newage/Minimax/Exflame |

9. EPABX & TELEPHONE SYSTEMS

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|--|--|
| 1. | EPABX | ALCATEL , MATRIX, AVAYA , CISCO , SIEMENS , NORTEL |
| 2. | Digital/ANALOG PHONES/Handsets | BEETEL , PANASONIC , SIEMENS , ALCATEL |
| 3. | VOICE BOX – RJII | KRONE , TVS , FINOLEX |
| 4. | MDF/IDF | KRONE, TVS , FINOLEX |
| 5. | Data/ Telephone cable (2 PAIR , 4 PAIR CABLE, 10 PAIR , 20 PAIR , 50 PAIR , 100 PAIR CABLES) | DELTON , FINOLEX , RR CABLE |

10. DATA NETWORKING

| S. No. | Details of equipment/ material | Make/ Manufacturer |
|--------|--|-----------------------------------|
| 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 |
| 4. | Server | IBM , Dell , HP |

11. Electrical Works

| S.No | Description | Make/manufacturer |
|------|--|---|
| 1. | 11 KV Panel/11KV VCB | L&T, GE,ABB , Areva , Schneider , Siemens,CG |
| 2. | 11KV, 433 V OLTC oil type transformer | GE , ABB, Siemens, Areva, kirloskar, CG. schneider |
| 3. | A/C outlet 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, GE, Siemens, 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, Statcon |
| 12. | Battery Charger-cum-DCDB | Amaraja, Volstat, Caldyne, Expo-Fyn, BCH, HBL |
| 13. | Brass compression gland (Heavy duty) | Commex, Gripwell ,Dowell or equivalent |
| 14. | Bus bar | Jindal/ Hindalco /Indal 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. | LED/CFL lamps | Philips, Crompton, Wipro, GE, Osram, Bajaj |
| 20. | Coaxial wires | Finolex, Delton, Skytone, Anchor, L&T, Beldon, |
| 21. | Colour Monitor | Samsung , LG,Sony |
| 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. | Copper control cable (FRLS) | Havell's, RR Cables, Harsh,Polycab |
| 26. | Crimping lugs/thimbles | Dowells, Hex, Commet |
| 27. | CT/PT's | Meher, CGL, Kappa, Maxwell, Areva, L&T, AE, Jyoti, |

| | | |
|-----|--|---|
| 28. | CT's (Cast resin) | L&T, AE, Kappa, Pragati, Gilbert |
| 29. | Cubical type Synchronizing & capacitor control panel (Bolted / Folded fabrication) | L&T, ABB, Schneider, GE, Siemens (Siepan), GE |
| 30. | Cubicle type fuse unit | Siemens, L&T, ABB, Schneider, GE |
| 31. | Data Outlets | SYSTEMAX, amp, clipsal |
| 32. | MCBs, RCCB & DBs | Legrand, Schneider, Siemens, GE, ABB, L&T (Hager) |
| 33. | DG Set- Alternator | Stamford, Lorey Somer, kirloskar, toyo denki, avk |
| 34. | DG sets package | Jakson Engineers, TIL, Caterpillar, Sterling generators Ltd., Perkins, Kirloskar |
| 35. | Diesel engine | Cummins, Mitsubishi, Perkins, Kirloskar, Volvo, Caterpillar |
| 36. | Digital lighting control system | Aura dimming, relux controls, lightolier control, effectron, Philips, Schneider. |
| 37. | Digital Numerical Relays | L&T, ABB, Siemens, Schneider, GE, Areva |
| 38. | DWC HDPE Pipe | DURA-LINE, REX, CARLON, EMTELLE |
| 39. | Energy / Digital meters | Enercon, L&T, Rishabh, Secure, Trinity, Schneider Electric, Havells, HPL, GE, Siemens, ABB, Conzerv |
| 40. | Exhaust fan | Usha, Crompton, Havells, GE, Bajaj, Alstom |
| 41. | Feeder pillars, Meter cubicle Panels, Floor panels for upto 400A i/c switchgear | ABB, L&T, GE, Siemens, Schneider |
| 42. | Fiber Optic Cable | Sterlite Industries, Finolex |
| 43. | Fire extinguisher | Ceasefire, Exflame, Minimax, Life Guard, Safex, Peter Autokit |
| 44. | FRLS - PVC/Aluminum / copper 1.1 KV grade /cables & wires | Havells, Polycab, Finolex, RR |
| 45. | G.I./Cu. Strip & earthing material) | Bharati, Indiana, Slotco |
| 46. | H.T. Cables | Cable corporation of India, Universal, KEI, Havells, Nicco, Polycab, Finolex, Rallison, Gloster |
| 47. | Hand gloves & rubber mat | Premierpolyfim Ltd, Polyelectrosafe, Challenger, Electromat, Safe Hold |
| 48. | Indicating Lamp(LED) | BCH/ L&T/ Rank/ MG |
| 49. | Indicating lamps | AE, Kaycee, Vaishnav, L&T, Siemens, Emco |
| 50. | Industrial socket outlets | GE, ABB, Hager, Legrand |
| 51. | Insulators | Jaya Shree, Modern, IEC, WSI. |
| 52. | Intelligent detectors & hooters & accessories | Notifire, Honeywell, Johnson Control, Schneider, edwards |
| 53. | Intelligent fire alarm panel | Notifire, Honeywell, Johnson Control, Schneider, edwards |
| 54. | Inverter | Microtek, Luminous, Su-Kam, Eton |
| 55. | Isolators | Siemens, L&T, ABB, GE |
| 56. | Jointing kit | Reychem, Xicon, Birla 3M |
| 57. | Light fittings | Philips, Wipro, Bajaj, Havells, Keslec, Pierlite |
| 58. | Lightning arrestor | Indelec, Gersom, Helitta, MDS, Hager, Duval Messin, L&P Electro, LPI |
| 59. | LT cables (XLPE, PVC) | Cable Corporation Of India, Universal, Havells Nicco, Polycab, Finolex, Rallison, Gloster, |

| | | |
|-----|--|--|
| | | Elektron,KEI |
| 60. | LT panels | ABB, L&T, GE, Siemens, Schneider |
| 61. | 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 |
| 62. | Measuring instruments (Digital/analog type) | L&T, Ducati, Konzerv, HPL, Siemens |
| 63. | 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) |
| 64. | MS Conduit | BEC, AKG, Steel Craft |
| 65. | MS Conduit accessories | Rama, Novel, BEC, AKG, steel craft |
| 66. | Multi-function Meter | L&T, ABB , Siemens, Schneider, Ducati, |
| 67. | Overload relay single phase preventer | ABB, L&T, GE, Siemens, Areva |
| 68. | Panel accessories | L&T, Rishab, Siemens, BCH |
| 69. | Street Light including Poles & Light Fixtures | Bajaj, Transrail ,Power control corp, National tubing co, sancube, Hilite |
| 70. | Power capacitor with batter than 14% harmonic filter at 525 V (long life mixed Dielectric) | L&T(Meher) , EPCOS (Siemens), DUCAT, GE, Schneider, ABB |
| 71. | Programmable timer (self-powered electronic digital)/Astronomer | L&T, Siemens, Hager, MDS, Legrand |
| 72. | Protective relays (Microprocessor based compatible with PC & PLC) | Siemens, L&T, ABB, GE, Areva |
| 73. | Push button, indicating lamps (led type) | Siemens, L&T, ABB, Schneider , C&S |
| 74. | PVC conduit | Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG |
| 75. | PVC conduit Accessories | Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG. |
| 76. | Race ways/ Cable Trays/ Floor trunking / wall channels | MEM, Legrand, Needo, Rico Steel, Pilco, Slotco |
| 77. | Relay and Control Panel | Siemens , L&T, GE, Schneider, ABB |
| 78. | Relays- Auxiliary / Numerical /Bi metal relay | L&T, GE, ABB, Alstom, Siemens, Areva. |
| 79. | Sandwiched bus-duct | Siemens, ABB, GE, Schneider, L&T, C&S |
| 80. | Selector switch | Salzer, Kaycee, Siemens, HPL, L&T, BCH |
| 81. | Starters | Siemens, L&T, GE, ABB, Schneider , Areva |
| 82. | Surge diverter | Tercel, ABB, Siemens, Emerson, Hager, Phoenix, Legrand |
| 83. | Tap-off, Splitter box | Zinwell, Novatron, Catvision |
| 84. | Telephone tag block | Krone, Tvs, R&M, Phoenix, Wago |
| 85. | Terminal strip | Connect well, Phoenix, WAGO |
| 86. | Termination Kits | Raychem, Birla, 3M |
| 87. | Trivector - Meter (Digital type) only for SEB supply. | L&T, Secure, Enercon, Siemens, |
| 88. | UPS | Emerson , A.P.C ,Socomec, GE, Mistubishi, Eaton |
| 89. | Voltmeter and ammeter | AE, Meco, Universal, Rishab, Yokins |
| 90. | 11 KV RMU | ABB, Crompton & Greaves, Schneider Electric, L&T |

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. Similar Makes for the same items may be used for all the subheads.