

**CENTRAL GOVERNMENT HEALTH SCHEME (CGHS)
MINISTRY OF HEALTH & FAMILY WELFARE
GOVERNMENT OF INDIA, NEW DELHI**

Tender No. CGHS/RKP-DELHI/HLL/ID/2013

Request for Proposal (RFP)
for

**Construction of CGHS Wellness Centre and Administrative Building
at Sector 13, R.K. Puram, New Delhi**

VOLUME - III

TECHNICAL SPECIFICATIONS



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INDEX

TECHNICAL SPECIFICATIONS

Chapter	TITLE	Page No.
Chapter	TITLE	Page No.
A.	A Brief of Requirement of the Work	1
B.	Technical Specifications and Conditions- Civil Works	3
C.	Technical Specifications - Plumbing & Sanitary Works	33
D.	Technical Specifications - Horticulture Works	65
E.	Special Conditions -Electrical Services	68
F.	Technical Specifications For Electrical Services- General Requirements	78
G.	Technical Specifications -Electrification	85
H.	Technical Specifications - D.G.Sets	142
I.	Technical Specifications - Fire Alarm System	160
J.	Technical Specifications - Closed Circuit Television System & Pa System	183
K.	Technical Specifications - HVAC System	187
L.	Technical Specification For IBMS	251
M.	Technical Specifications For Lifts	292
N.	Technical Specifications For Fire Fighting	319
O.	Technical Specifications for Solar Power Plant	339
	List of Approved Makes	352

Construction of CGHS Wellness Centre and Administrative Building at Sector 13, R.K. Puram, New Delhi

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 CGHS Wellness Centre and Administrative Building at Sector 13, R.K. Puram, New Delhi. The building consists of two basements, Ground plus three floors with infrastructure facilities including External Development Works.

The work includes a number of specialized Civil /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, BMS, UPS
- k. Solar energy Systems

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

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

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

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

follows. In the case of discrepancy between the Schedule of Quantities, the Specifications and /or the Drawings, the following order of preference shall be observed –

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

CHAPTER B

TECHNICAL SPECIFICATIONS AND CONDITIONS- CIVIL WORKS

1. EARTH WORK: As per relevant CPWD specifications.

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

2. PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:

a. STONE AGGREGATE:

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

b. SAND

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

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

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

c. FLYASH

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

d. CENTERING SHUTTERING AND SCAFFOLDING:

- i. All Scaffolding centering for RCC shall be with properly designed system and brought to site well in advance so that the progress of the work is not hampered for non-availability of the same.
- ii. All shuttering for RCC work except soffits of slab shall be in water proof shuttering Ply. Shuttering for slab and soffits shall be in water proof shuttering ply or in good quality

mild steel plates free of dents, bends or warping and rusting as approved by the Engineer in charge.

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

e. REINFORCEMENT:

- i. TMT reinforcement steel shall be used shall be as per design and conforming to IS: 1786 pertaining to Fe 500D OR Fe 500D grade of steel.
- ii. TMT steel bars manufactured by main producers, as per list of makes, shall be allowed in the work. Contractor shall produce manufacturer Test Report for each dia and each lot Tests. Nothing extra will be paid for "straightening of bars" received from market in coils or with bends. All incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.
- iii. The actual average sectional weight for dia up to 10 mm shall be arrived at from one meter long samples (minimum 3 from each dia) taken from each lot of steel. The discretion of the Engineer – in – charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute the single lot for this purpose.
- iv. The weight of each lot of a particular diameter of 10mm and below shall be reckoned as the weight as per actual 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 within a period of 30 days from award of work. The contractor shall install batching plants (within 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfill the following requirements.
 - 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 concerting 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 reserves the right to exercise 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. In this work, wooden door frames and shutters are specified.
 - v. **Shop drawing:-** The contractor shall submit including required designing shop drawing for doorframes, shutters complete with
 - 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. Door Frames:** - Door frame shall be manufactured from 2nd class teakwood (Ivory Coast) door frame of section as per BOQ. It shall have heat activated intumescent fire seal strip of section 10mm x 4mm 2 No. of approved make. The frame shall be coated with one coat anti-termite fire retardant primer of approved brand.
- c. Door Shutter:-**
- i. The Door shutter shall be of thickness 50 mm minimum but not more than 55mm or as per BOQ, suitable for mounting on the door frame. It shall comprise of two non-combustible boards 12mm to 18 mm thick sandwiching 20 mm to 25 mm fire resistant insulation filler veneered with 3mm thick commercial ply on both faces and pasting of minimum 1 mm thick laminate over wooden fire of approved brand a 100% without Asbestos, Bructile and merschaum, having density not more than 1150 kg/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.
 - ii. The intumescent sealant shall be used to fill the gaps between board and internal wooden lipping.
 - iii. **Vision Panel:-** Vision Panel shall be rated vision panels with 6mm thick clear glass (2 hours fire rating) made from Spin turned Rings (380mm dia circular vision panel) or press formed (300mm Square vision panel). Glass shall be fixed with glazing gasket of self-sticking ceramic glass fibre having a classification temperature of 1260° C.
 - iv. **Finish:** - The door frame and door shutter shall be finished with thermo setting acrylic paint for scratch resistance and durability. The paint shall be of approved brand and quality.
 - v. **Ironmongry Hinges:** - Stainless steel ball bearing butt hinges, 3mm thick shall be fixed flushed to the frame and shutter.

- d. **Lock:** - Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.
- e. **Flush Bolts (For Double Door):-** 300mm concealed extended lever action flush bolts satin finish, fixed to top and bottom of the inactive blade shall be provided.
- f. **Automatic Door Closer:** - Dual adjustable speed automatic door closer with rack and pinion method shall be provided.
- g. **Smoke Seals:** - Heavy duty smoke seals for smoke check doors shall be provided.
- h. **Acoustic Seals:** - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.
- i. **Opening Width:** - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.
- j. **Measurement:** - Frames and shutters shall be measured in square meter out to out.
- k. **Testing:** - The Engineer – in - charge holds the right to get the door tested for fire rating at the cost of the contractor/vendor. In case the Engineer-in-charge desires to get the doors tested, then one door shall be selected at random out of the entire lot and shall be tested for two hour fire rating. The testing shall be got done from either CBRI, Roorkee or from any other laboratory approved by the Engineer-in-charge. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet the requirement, the entire lot shall be rejected.
- l. **Rates:** - The rates shall be inclusive of all material, T&P, Labour, etc. complete including the cost of fittings, testing etc. as described above.

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	
	ii. Moisture Absorption	2.0% Max	
f	Incombustibility	Incombustible When Tested As Per Is 818 / 3144	
g	Recovery after Compression	90% Min. (Tested As Per Is -8183)	
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 synchronous with the basic structural glazing/curtain wall structure and also make the system air tight and watertight. The fixing details should be got approved by the Engineer-in-charge. The peel off foil should be removed at the time of handing over as may be required by the Engineer-in-charge.
- k. Any joint provided between cladding elements to cater for individual panel installation and shall be sealed off with extruded EPDM gasket or silicon sealant.

I. 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 ± 2.0 mm Length ± 4.0 mm Thickness ± 0.02 mm
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 ≥ 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 Client/ 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. Fastners 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. **STUCTURAL 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 client.

g. EXECUTION Performance Testing

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

i. General Requirements

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

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

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

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

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

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

ii. Test of Wind Pressure

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

the Test Unit is fixed.

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

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

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

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

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

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

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

iii. Test of Lateral Deflection Per Floor Height

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

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

The dynamic deflection shall be applied upto + 13mm.

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

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

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

iv. Test of Water-tightness

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

The volume of the sprinkling water in one minute shall be 5 litres/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 Client.

vi. Cost of Performance Test

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

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

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

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

vii. Shop Drawings and Calculations for the Performance Testing

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

viii. Record Drawings

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

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

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

ix. Contractor's Representatives

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

h. PERFORMANCE GUARANTEE

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

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. **Wall Guard Grab Rail /Hand Rail System**

- a. The scope of work includes providing & fixing Wall Guard Grab Rail /Hand Rail System of approved make consisting of Continuous aluminum retainer, adjustable Rail mounting base (HRAM) adaptable to uneven wall surface, impact absorbing strip (B-ABS), end cap, corner joint, high impact vinyl acrylic snap- on cover desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.
- b. The Wall Guard Grab Rail/Hand Rail System shall be developed to assist building users when ambulating along corridors and ascending or descending stairs. It is also suitable for helping physically handicapped persons to move within a building.
- c. Handrail System is applicable in the following circumstances:-
 - i. Ramp- Rail System – along the sides of a ramp
 - ii. Stair- Rail System- along the sides of a stairway and landing
 - iii. Transfer- Rail System- to support and allow transfer of body weight in locations such as toilets, shower and bathtub enclosures.
- d. The Wall Guard Grab Rail/Hand Rail System shall be made from a special, high impact vinyl acrylic material, the Handrail System has the following qualities:
 - i. Able to withstand abrasion
 - ii. Weather resistant and fire retardant
 - iii. Textured to provide an anti- slip surface
 - iv. Fitting and anchorages that can withstand corrosion when exposed to normal environment conditions
 - v. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance
- e. The Wall Guard Grab Rail/Hand Rail System shall be designed and shall comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.
 - i. Continuous Aluminum Retainer
 - ii. Adjustable Rail Mounting Base (HRAM)- adaptable to uneven wall surface
 - iii. Impact Absorbing Strip (B-ABS)
 - iv. End Cap
 - v. Corner Joint
 - vi. High Impact Vinyl Acrylic Snap- On Cover as per approved colour and shade.

21. 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.

22. SAMPLES OF MATERIALS:

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

23. 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.

24. 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.

25. 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.

26. 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:
- ii. Wall hung wash down or single or double siphon type
- iii. 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.
- iv. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- v. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

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

6. Cleanout Plugs

a. Cleanout Plug on soil pipes

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

b. Cleanout Plug on Drainage Pipes

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

7. Waste pipe from appliances

a. General

- i. Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of heavy galvanized steel /CPVC as given in the Schedule of Quantities or shown on the drawings.
- ii. All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per good engineering practice approved by the 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 chromate with etch coating primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. Colour shall be as per the approved colour code.

8. Cast iron pipes for drainage

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

9. Encasing pipe in Cement Concrete

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

10. Painting

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

11. Cutting and making good

- a. Pipes shall be fixed and tested as building proceeds.

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

12. Testing

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

13. Measurements

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

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

SECTION 4 Water Supply Systems

1. Scope of work

- a. Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

- b. Without restricting to the generality of the foregoing, the water supply system shall include the following:-
 - i. Rising main from water supply pumps to all overhead tanks.
 - ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.
 - iii. Insulation to hot water pipes within toilets.
 - iv. Connections to all plumbing fixtures, and appliances.

2. General requirements

- a. All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.
- e. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the 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 Clients mains line (water report enclosed).
 - ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank located in basement.
- c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

4. G.I/ CPVC Pipes & Fittings

- a. All pipe inside the building and where specified, outside the building shall be galvanized / 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±2kg/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/cm² 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.
 - 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 in the following order:

3. Rising Mains & level control system

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

4. Level Controllers

- a. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:-
 - i. Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location
- b. Overhead tank level controller cum indicators
 - i. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:
 - ii. To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.
 - iii. Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.
 - iv. Indicate the water level in each OHT in the level indicating panel installed in the pump room

- v. Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.

c. Control & Indicating Panel (For overhead and underground water tanks)

- i. A centralized indicating stand-alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ($\frac{1}{4}$ th, $\frac{1}{2}$, $\frac{3}{4}$ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:
 - ii. Digital level indicator panel meter for each water tank.
 - iii. Etched plate identification plates.
 - iv. Control cabling from MCC to the panel installed in the control room as directed by the Project Manager.
 - v. Cabling from PHT sensing probes to the panel

5. Pressure filters for Water Supply System

a. Specification shall apply for water filtration system

- i. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media, G.I. face piping, accessories testing and commissioning complete, Working Pressure 2.4 kg/cm² (Test pressure 3.75 kg/cm²). 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/cm² 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/m² 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 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 42/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 1/2 /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

- i. 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.
- ii. 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 drying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly 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 swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, staving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shovled.
- 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.

IS-732:	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-3043:	Earthing.
IS-2309:	Code of practice for the protection of buildings and allied structure against Lightning
IS-7689:	Guide for control of undesirable static electricity.
IS-3716:	Insulation co-ordination application guide.
IS-8130:	Conductors for insulated electrical cables and flexible cords.
IS-5831:	PVC insulation and sheath of electric cables.
IS-3975:	Mild steel wire, strips & tapes for armouring cable.
IS-3961:	Current rating of cables
IS-694:	PVC insulated (heavy duty) electric cables for working. Voltage up to and including 1100 volts.
IS-424- 1475 (F-3):	Power cable flexibility test.
IEC-439/IS-7098:	Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage up to 1.1 KV.
IS-1554:	PVC insulated cables up to 1100 volts.
IS-10810:	Test procedures for cables.
IS-6121:	Cable glands.
IS-10418:	Cable drums.
IEC-754(1):	FRLS PVC insulated cable.
ASTM-D-2863:	Standard method for measuring minimum oxygen concentration to support candle-like combustion of plastic (oxygen index).
ASTM-D-2843:	Standard test method for measuring the density of smoke from burning or decomposition.
ASTM E-662/IEC 754(A)	Standard test method for specific optical density of smoke generated by solid materials.
IEEE-383:	Standard for type test class-IE, electric cables, field splicers and connections for power generation station.

IS 13947/IEC 947:	Air circuit breaker/moulded case circuit breaker.
IS-8623:	Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000vac/1200vdc
IS 1018:	Switchgear and control gear selection/installation and maintenance
IS-1248:	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS-13779:	Digital measuring instruments and testing accessories.
IS-3156:	Voltage transformer
IS-2705:	Current transformer for metering and protection with classification burden and insulation.
IS -2147:	Degree of protection provided by enclosures for low voltage. PART 1, 11,111 Switchgear and control gear
IS-3427:	Metal enclosed switchgear and controlgear
BS-162:	Safety clearance
IS-3202:	Code of practise for climate proofing of electrical equipment.
IS-375:	Marking and arrangement for switchgear, busbars, main connections and auxiliary wiring.
IS-722:	Ac electric meters
IS-3231 /IEC-255:	Electrical relays for power system protection.
IS-5082:	Electrolytic copper/aluminium bus bars
IS-2834:	Capacitors
IS-2713:	Steel tubular pole
IS-335:	Specification for insulating oil
IS-3837:	Specifications for accessories for rigid steel conduit for electrical wiring.
IS-2026& 335:	Distribution transformer (PART I, II, III) GI/STEEL /PVC conduit pipe for electrical wiring.
IS-2274:	Code of practise for electrical wiring installation system voltages exceeding 650 volts.
IS-6665:	Code of practise for industrial lighting
IS-3646:	Interior insulation part 1&2
IS-1944:	Code of practise for lighting of public through fares.
IS-7752:	Guide for improvement of power factor consumers installation.
IS-13346:	General requirement for electrical for explosive gas atmosphere.
IS-13408:	Code of practise for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
IS-12360:	Voltage and frequency for ac transmission & distribution system.
IS-5572:	Classification of hazardous area for electrical installations.

IS-5571:	Guide for selection of electrical equipment for hazardous area.
IS-4201:	Application guide for Current Transformer
IS-4146:	Application guide for Voltage Transformer
IS-10028:	Code of practise for installation and maintenance of transformer
IS-8478:	Application guide for on load tap changer
IS-10561:	Application guide for power transformer
IS-1646:	Code of practise for fire safety of buildings electrical installation
IS-3034:	Code of practise for fire safety of industrial building-electrical generating and distribution station
IP-30:	National electrical code (NEC) BIS publication.
IS-4722:	Rotating electrical machines.
IS-4889:	Method of determination of efficiency of rotating electrical machines.
IS-325:	Three phase induction motors.
IS-4729:	Measurement and evaluation of vibration of rotating electrical machines.
IS-900:	Installation and maintenance of induction motors.
IS-4029:	Air break switches.
IS-2208-9224:	HRC cartridge fuses.
IS-2959:	Contactors.
IS-9537:	Rigid steel conduit.
IS-1030-1982:	Specification for carbon steel castings for general engineering purpose.
IS-1601/ BS-649:	Performance & testing of Internal Combustion (IC) engines for general purpose.
AIEE-606(1959):	Recommended specification for speed governing of I.C. engine generator units.

BS-5514/IS-3046 8528(Part-2): Reciprocating IC engine driven A.C. generators.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern.

- a) Specification, particular specification if any, and drawings.
- b) Indian regulations/codes and standards.

4 SITE CONDITIONS

i)	Design ambient	50 Deg.C. Maximum, 2 Deg. C. minimum
ii)	Relative Humidity	85% maximum
iii)	Site environment	Normal

5 DESIGN CRITERIA

I Electrical Details of Incoming Supply

a	Supply Voltage	11 KV as per SEB approved.
b	Fault level (sym.) at supply of point (designed)	350 MVA (to be confirmed from State Electricity Board by Tenderer).
c	Neutral Earthing	Solid Earthing
d	Voltage Regulation	$\pm 10\%$
e	Frequency Regulations	$\pm 3\%$
f	Combined	$\pm 10\%$

II L.T. Power Distribution Systems

a	Voltage	415 V / 240 V
b	Frequency	50 Hz
c	Neutral Earthing	Grounded
d	Short Circuit Fault withstand Capacity	10 KA - 50 KA (1 Sec.) as per B.O.Q. and specification.

III Emergency Lighting (Battery Operated With Self Charger)

a	Voltage	12 V, DC
b	Source	Mains/D.G. Set

IV Control Supply for Electrical System :- The various supply voltage to be used in the control panels for main equipment are

a	Spring Charge Motor	230 Volt A/C
b	Closing/Trip Coil	24 V DC / 230V AC
c	Alarm/ Indication/ Relay	24 V DC/ 230 V AC
d	Heaters	230 V AC
v	Power Supply Load Control / Distribution Panel.	433 V TPN / 240 V 1 phase A.C. (other supply if required shall be derived by package vendor
VI	Painting of Panel.	Powder coating of approved shade

VII Painting of Cable Tray & Structure Steel.

Powder coated of approved shade

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

1.0 11 KV H.T. SWITCHBOARD

This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type high voltage switch boards upto 11 KV including necessary termination, cabling, bus work required for satisfactory operation .

Specific requirements shall be in accordance with single line diagram/specification/data sheet. In case of conflicting requirement between the Technical Data and General Specification the former shall prevail.

The technical parameters of switchgear equipment, transformers etc. shall be submitted by the Contractor for approval by the consultant/ client.

This specification shall cover both Single Panel as well as 3 Panel Board.

1.1. STANDARDS

All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.

Some of the relevant Indian and British Standards are listed below:

- IS 13947 - A.C. Circuit Breakers (Relevant Parts/SCC)
- IS 13941 - High voltage Circuit Breaker (Relevant Parts/SCC)
- IS 3427 - Metal enclosed Switchgear & Control Gear
- BS 162 - Safety Clearances
- IS 2705 - Current Transformers (Parts 1 to 4)
- IS 3156 - Voltage Transformers (Parts 1 to 4)
- IS 3202 - Code of Practice for climate proofing of electrical equipment
- IS 375** - Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.
- IS 722 - A.C. Electric Meters
- IS 1248 - Direct acting Electrical Indicating Instruments
- IS 3231 - Electrical Relays for Power System Protection
- IS 2544 - Epoxy Cast Resin Insulators
- IS 5082 - Electrolytic Copper and Aluminium
- IS 5792 - High Voltage HRC fuses
- IEC 60694- High Voltage Switchgear

IEC 60947- High voltage Circuit Breaker

IEC 60298- Metal Enclosed High Voltage Switchgear

1.2 DETAIL OF DESIGN

CONSTRUCTION

The switch boards shall be cubicle type, suitable for indoor/outdoor installation, floor mounting and free standing. The design shall be totally enclosed, dust - tight, dam proof and vermin proof offering degree of protection not less than IP-42 for Indoor Application & IP-54 for Outdoor application.

Separate segregated compartments shall be provided for circuit breakers, bus bars, cable box, voltage transformers, wire ways, relays, and instrument and control devices. Switchgear cubicles/ modules shall be provided with hinged doors in front with facility for padlocking door handles.

Vent openings shall be covered with grills so arranged that hot gases cannot be discharged through them in a manner that can injure the operating personnel. These vent openings shall be vermin proof.

All the High Voltage compartments i.e. Circuit Breaker, Bus Bar, and Cable Compartments shall be separated from each other by metallic partitions in line with IEC-600298. These compartments must have pressure relief flaps for exit of gas due to internal arc to ensure operators safety. All the HV design must ensure conformity to IEC-600298 and must be Type tested for Internal Arc Test. The supplier shall submit Type Test report from CPRI or other independent agency to prove the above.

All panels shall be of same height, width and depth. Panels shall be bolted together to form a continuous flush front switch board, suitable for front of board operation.

The switchgear cubicles shall be rigid and robust in design and construction, fabricated out of CRCA sheet steel. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed/formed sheet steel of not less than 2mm thickness. The frames shall be enclosed by sheet steel of at least 2mm thickness, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary. Height of the operating handle, push button etc. shall be restricted between 300 mm to 2000 mm from the finish floor level. Fixing screws and nuts shall be used. Self-tapping screws shall not be used in the construction.

All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.

All doors shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.

Floor mounted cubicles with minimum 75 mm high channel and 5 mm thick channel base frame. Approx 200 mm-blank space between the floor of the switchboard and bottom most unit shall be provided. The total height of the cubicle shall not exceed 2400mm.

BUSBARS & BUSBAR CHAMBER

Three phase bus bars shall be of high conductivity electrolytic copper as stated in B.O.Q. The bus bars shall be air insulated and housed in a separate compartment, which segregated from all other compartments, in case of Vacuum Circuit Breaker. Current density of **Cu.Bus-Bar** shall not exceed 1.5 Amps / mm²

Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. The bus bars connections shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified. Normal operating temperature for bus bars shall be 85 Deg.C. Short circuit rating of the bus bars shall be 35 KA for 1 sec.

All bus bar joints and bus tap joints shall be silver or tin plated. Joints shall be bolted type and shall be insulated. Spring/Lock washers shall be provided to ensure good contact the joints.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental shorting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.

CIRCUIT BREAKERS

The circuit breakers shall be Triple Pole double break type and the Insulation and Arc interruption medium shall be Vacuum. The Breaker shall be enclosed in a sealed Vacuum Tank.

The circuit breakers shall be of horizontal draw out construction with horizontal/vertical isolation. The circuit breaker including its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement on the circuit breaker. There shall be three discrete positions viz. Service, Test and Isolated. Locking facility in all three positions shall be available. Position indicator shall be provided on the panel to indicate the position of the circuit breaker. Test position shall offer testing of circuit breaker operation/interlocks without energizing the power circuit.

Circuit breakers shall have stored energy spring mechanism charged by manually operated handle as well as electrically operated mechanism. The closing mechanism of the circuit breakers shall be Motor operated, spring charged with a provision for manual charging.

The operating mechanism shall be mechanically and electrically trip free and non-pumping. Anti-pumping feature may be built in or separate anti-pumping relay may be provided. In case spring charged mechanism, spring charged indication shall be provided.

Local manual trip device shall be provided on the operating mechanism. The trip device shall be suitable for front operation and positive mechanical 'ON-OFF' indication shall be provided.

Main contacts of circuit breaker shall have ample area and adequate contact pressure to carry the rated and short time current without excessive temperature rise. The contacts shall be adjustable for wear and easily replaceable. Main contacts shall open before and close after the arcing contacts when these are provided. Arcing contacts shall be easily accessible for inspection and replacement in case of VCB.

Each breaker shall normally be provided with auxiliary contacts of 6 NO+6NC directly operated from breaker operating mechanism. These contacts shall be in addition to these used in circuit breaker internal wiring. These contacts shall be rated for 10 Amps at 240V AC and 20 Amp (inductive breaking) at 220V D.C. If more breaker auxiliary contacts are required latching relay shall be used to multiply the contacts.

Shunt trip coil as called for shall be provided for tripping the circuit breaker. The trip coil/s shall operate satisfactorily between 50% - 110% of rated control voltage. Wattage of trip coils will be sufficiently high to prevent it from picking up or holding on with specified number of trip circuit supervisory indicating lamps wired in series.

It shall be possible to trip the breaker, in case of failure of control supply

Circuit breaker type duty and rating shall be submitted in Data Sheet by the Contractor.

Circuit breakers of similar rating shall be interchangeable.

RING MAIN UNIT/ LOAD BREAK SWITCHES (If Applicable)

All the live parts of the Load break switches, Copper Bus Bars of the RMU shall be enclosed in SF6 gas medium sealed in stainless steel tank. All connection for Bus-bars shall be capable for short time rating of 21 KA for 3 seconds and shall also be capable of breaking full load current and having fault making capacity of 52 KA.

The RMU shall be equipped with following mechanical Mechanical Interlocks:

1. Between Load break switch & earth switch, i.e., load break switch only can be turned on when the earth switch is in OFF position and vice versa.
2. Between breaker, off load break switch (disconnecter) & earth switch: The breaker must be in OFF position to operate the off load break switch & earth switch. When the earthing switch is in closed position it will be impossible to operate the disconnecter.
3. Between Earth switch & Cable compartment doors, i.e., doors are accessible only when the earth switch is ON; further the main isolator switch/ breaker disconnectors cannot be switched ON unless the doors are closed-

CURRENT TRANSFORMERS

Current transformers shall be of ratio, burden (shall be worked out by panel supplier), class/accuracy as specified in Single Line Diagram/BOQ.

Current transformers shall conform to latest edition to relevant standards. Current transformers shall be epoxy resin cast with bar Primary or ring type.

CT core laminations shall be of high grade silicon steel. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full load current, without overheating or damage. Short time current rating and rated withstand time shall be same as corresponding C.B.

Secondary terminals of CT shall be brought out to a terminal block which will be easily accessible for testing and external connections. Facility shall be provided for short circuiting and earthing of CT secondary leads through a removable and accessible link with provision for attaching test link.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Current transformers (core) shall be used for metering and protection. Each CT shall be provided with rating plate indicating: Name and Make, Serial number, Transformer Ratio, Rated burden, Rated voltage and Accuracy class.

POTENTIAL TRANSFORMERS

Potential Transformers shall conform to latest edition of "IS-3156 (Part I, II & III) as applicable relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.

The PT shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg.C above an ambient of 45 Deg.C.

The PT's shall be fixed at rear bottom / top of the panel as called for. An interlock or automatic shutters shall be provided to prevent access to live HV parts when PT is withdrawn.

HRC Fuses shall be provided both primary & secondary side. It shall be possible to replace PT fuses easily without having to de-energize the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the BOQ and shall be stated in data sheet by the Vendor/Contractor. Nameplate as per relevant standards shall be provided on the PT.

PROTECTIVE RELAYS

Relays type and numbers shall be in accordance with the protective scheme required or as per drawings and B.O.Q.

Relays shall be digital microprocessor based or analogue type, as called for in BoQ. It shall be enclosed in rectangular shaped cases, suitable for flush mounting only, dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicalized. The relays shall be either self-powered or a 24V DC Power-pack of suitable capacity with charging device shall be provided within the HT panel.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be drawing out type. Where it is not possible to provide protective relays of the drawout pattern, fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self reset type with indicator. The indicator/s shall be visible from the front.

Relays conform to relevant standards in all respects. Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as required and shall be in data sheet by the Vendor / Contractor.

SAFETY/PROTECTION INTERLOCKS/FEATURES

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe, positive and full-proof.

- a) It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless

it is in Service or Test position.

- b) Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.
- c) Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.
- d) Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.
- e) 1 no. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB.
- f) Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.
- g) Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.
- h) Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.
- i) Annunciation window shall be provided for winding temperature trip / alarm as required.
- j) Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.
- k) All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.
- l) Components within cubicles shall be properly labelled to facilitate testing.

EARTHING

The switch board shall be provided at the bottom throughout its entire length with a earth bus of copper of adequate size to carry the fault current for the duration same as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.

All non-current carrying metal parts, frames and equipment mounted in the switchboard shall be bonded to earth bus.

Earthing of moving carriage of drawout equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables or bus bars and common for all circuit breakers of the same type/rating shall be provided.

INSTRUMENT & METERS

Electrical indicating instruments shall be digital type with zero adjustment, probe from outside the cover.

Multi function meter of CL 1.0 accuracy with RS 485 port shall be provided.

Instruments/meters shall be suitable for flush mounting on the panel with flanges protecting outside the panel.

All meters shall be industrial grade with accuracy of class 1.0 unless specifically indicated.

CONTROL WIRING

All wiring for control, protection, alarm, indicating circuits and remote tripping mechanism on all equipment shall be carried out with at least 650V grade, PVC insulated, stranded, copper, 2.5 Sq.mm conductors.

All wiring shall be run on the sides of the panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel. Where wiring enters or passes through compartments containing HT apparatus then they shall be in earthed metallic conduits or ducts.

All wiring shall be taken to terminal blocks without joints or tees in their run.

All wiring shall be colour coded as follows:

Instrument Transformer AC circuit with which the wire is associated.	-	Red, Yellow & Blue determined by the phase
AC Phase Wire	-	White
AC Neutral	-	Black
DC Circuits	-	Grey
Earth connections	-	Green

Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire. Ferrules shall fit tightly on the wires, without falling off when wire is removed. Ferrules shall be of white colour with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.

All unused auxiliary contacts of the circuit breaker and relays shall be wired upto terminal block.

FITTINGS AND ACCESSORIES

Indicating Lamps:

Neon type indicating lamps or LED indicators shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.

Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	-	Circuit Breaker 'ON'
Green	-	Circuit Breaker 'OFF'
White	-	Continuous trip supply supervision
Amber	-	Auto trip
Blue	-	Spring charged

R.Y.B	-	Potential indication
Green	-	Earth

Push Buttons:

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

Control & Selector Switches:

Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in colour. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

All other instruments and selector switches shall have stay put contacts.

Circuit breaker control switches shall normally have three positions close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

Contacts of all control and selector switches shall be rated for 10 Amps at 240V AC or 20 Amps at 220V dc (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.

Control Terminal Blocks:

Box - clamp type, 650V grade line up terminals of minimum 2.5 Sq.mm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated. Terminal blocks at different voltage shall be segregated into groups and distinctly labelled. Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminal stems shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate undrilled removable gland plate shall be provided for the control cables at the bottom of each panel.

Minimum 10% of total number spare terminals shall be provided for future use.

NAME PLATES AND LABELS

One Name plate giving designation of the HV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels giving following details shall be affixed on each feeder panel:

- i) Feeder Name.
- ii) Equipment reference no. & Description
- iii) Rating (KVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labelled with reference number/letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plate, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

SPACE HEATERS:

Adequately rated anti-condensation space heaters shall be provided in each cubicle.

Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.

Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature.

CUBICLE LIGHTING:

Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from a 240V single phase, 50 Hz. A.C. supply.

AUXILIARY SUPPLY:

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

FUSES:

All fuses in control, indication and metering circuit shall be HRC link type of approved make. Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

CABLE TERMINATION:

The switch board panel shall be provided with separate compartment for cable termination complete with suitable cable end termination for XLPE insulated cables suitable for bottom entry. Cable and sealing box shall preferably be mounted inside the panel. Cable compartment doors shall be self-locking type, interlocked and shall have Arc withstand capability due to short circuit. The compartment shall be provided with cable testing facility in case of gas insulated medium. For XLPE cables adequate space and clearances shall be made for heat/cold shrinkable termination e.g. Reychem or cold flowing stress grading joints.

Two earthing terminals shall be provided in each panel in cable box/cabling chamber for earthing armour/screen.

Where more than one core is terminated on each phase, links suitably designed and properly supported shall be provided to avoid unnecessary bending of cable cores without decreasing the length of insulated cable tail. Electrical clearances which would normally be required when using one core per phase shall be maintained.

Where core balance type current transformers are provided on switchgear feeder circuit cable/s for earth fault protection sufficient space, clearance and support, mounting arrangement shall be provided for the CT.

PAINING:

All steel work shall be pretreated in tanks and finally powder coated of approved shade of the levels not less than 100 microns.

TESTING & INSPECTION

Four copies of all test certificates and certificates from sub-vendor shall be furnished. After completion of all work at the manufacturers works the switchboards shall be inspected and tested in presence of Purchaser's/Consultant's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.
- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.
- xi) Power frequency voltage withstand test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switch boards.

DRAWINGS AND INFORMATION

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) Equipment List.
- vii) Bus bar sizing calculations.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

- i) Technical literature giving complete information of the equipment.
- ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii) A comprehensive spare parts catalogue.

TOOLS

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

SPARES

Contractor shall also quote separately for the maintenance spares for 2 years normal operation for owner to decide for placement of order at a later date. The quote shall remain valid at least for 6 months. The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

QUALITY ASSURANCE

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

DEVIATIONS

Clause wise deviation for the specification must be stated in writing at the quotation stage. In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

2.0 DRY TYPE DISTRIBUTION TRANSFORMER

PART 1 – GENERAL

1.1 WORK DESCRIPTION

- A. This section of Specification defines the technical requirements for 3 phase 50Hz 11000/433V (no-load) cast resin, dry type Distribution Transformers.
- B. The works shall comprise design, manufacture, routine testing at the factory, supply, delivery to site, installation, testing and commissioning at site of the indoor type, cast resin, dry type distribution transformers specified herein.
- C. All items of accessories, fittings, and protective devices/relays shall be incorporated.

1.2 PARTICULAR REQUIREMENTS ON QUALITY ASSURANCE

- A. All items shall be designed, manufactured and type tested generally in accordance with the latest revision of the following standards except where specifically directed otherwise:
 - 1. IS 11171(Part 0/Sec 0):1985 / IEC 60726(1982) : Dry type power transformers
 - 2. IS 2026(Part 1/Sec 0):1977 : Power transformers: Part 1 General (first revision) / IEC 60076(1977)
 - 3. IS 2026(Part 2/Sec 0):1977 : Power transformers: Part 2 Temperature-rise / IEC 60076(1977)
 - 4. IS 2026(Part 3/Sec 0):1981 : Power transformers: Part 3 Insulation level and dielectric tests (Second revision) / IEC 60076(1977)
 - 5. IS 2026(Part 4/Sec 0):1977 : Power transformers: Part 4 Terminal marking, tapping and connections (first revision) / IEC 60076(1977)
 - 6. IS 2026(Part 5/Sec 0):1994 : Power Transformer: Part 5 Transformer/Reactor bushings minimum external clearance in air - Specification
 - 7. IS 3639(Part 0/Sec 0):1966 : Fittings and accessories for power transformers
 - 8. IS 8478(Part 0/Sec 0):1977 : Application guide for on-load tap changers
 - 9. IS 13964(Part 0/Sec 0):1994 : Methods of measurement of transformer and reactor sound levels
 - 10. IS 13956(Part 0/Sec 0):1994 : Testing transformers
 - 11. ISS-2099-1973 : Specification for High voltage Porcelain Bushing
 - 12. IS-7421/1976 : Specification for Low voltage Porcelain Bushing
 - 13. IS-12444/ASTM B – 49 : Specification for Cu Wire rods
 - 14. IS-5484/ ASTM B – 233 : Specification for Al Wire rods
 - 15. ISS-5/1961 No. 632 : Specification for Colors for ready mixed paints
- B. If the specifications conflict in any way with any or all of the above standards, the above specifications shall have precedence and shall govern.
- C. Material conforming to other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above would also be acceptable. In case the Bidders who wish to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English Translations shall be furnished along with the offer.

1.3 SUBMITTAL

- A. Type tested transformers shall be provided.

- B. Upon the request of the Engineer, the Sub-Contractor shall submit type test certificates issued by a National or International Testing Authority. Certificates from NEMA, ASTA will be accepted. Located Test Certificate recognized by Local Supply Authority is also required.
- C. The Type Test Certificates shall show evidence of the following tests:
 - a. Routine tests at the manufacturer's works in accordance with IS: 2026 and IS: 1180 (Part I).
 - b. Calculations in accordance with IS: 2026 to demonstrate the thermal ability of the transformers to withstand short-circuit.
- D. Should modifications be made to the design on the transformer that may affect any or all of the performance obtained from type tests already carried out, the relevant type tests shall be repeated at the expense of the Sub-Contractor.

PART 2 – PRODUCT

2.1 FREQUENCY

- A. The frequency of the transformer shall be rated at 50Hz.

2.2 POWER

- A. The rated power of the transformer is shown on the single line drawings. This being related to the continuous maximum rating (CMR) under the climatic condition specified in this Section for cast resin dry type distribution transformer.

2.3 RATED VOLTAGE RATIO AND TAPPING RANGE

- A. The rated voltage ratio of the transformer at no load shall be 11,000/433V, this being related to the principal tapping of the transformer. Tappings shall be provided on the high voltage winding to provide variation of transformer ratio by +5.0%, +2.5%, -2.5%, -5.0%, -7.5%, -10.0%.

- B. Tap changing shall be carried out by means of an off circuit externally operated self-positioning switch and when the transformer is in de-energised condition. Switch Position No. 1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5 percent in voltage. Provision shall be made for locking the tap changing switch handle in position.

2.4 INSULATION LEVELS

- A. The insulation levels of the transformer windings shall be rated as follows:

Voltage	Impulse Voltage (kV Peak)	Power Frequency Voltage(kV)
433	-	3
11000	75	28
33000	170	70

2.5 LOSSES AND IMPEDANCE

- A. Transformer Losses are to be as per ECBC. The manufacturer can offer losses less than as mentioned in IS: 2026/ECBC. The offer will be evaluated as per the loss evaluation formula given in REC, K-5 Standard – as amended up to date.

2.6 LIMITS OF TEMPERATURE RISE

- A. The transformers shall be designed for continuous operation at their rated power without exceeding 90°C corresponding to Class-‘F’.

2.7 WINDING CONNECTION

- A. The transformers shall have three high voltage windings and three low voltage windings per transformer.
- B. The High Voltage Windings shall be connected in Delta and the Low Voltage Windings shall be connected in Star with the neutral point brought out.

2.8 VECTOR GROUP SYMBOL

- A. The vector group symbol shall be Dyn11 in accordance to IEC76.

2.9 OVERFLUXING

- A. The transformer shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5 percent on any tapping without injurious heating at full load conditions.
- B. The maximum flux density in any part of the core under such condition shall not exceed 1.9 Tesla. The supplier shall furnish necessary design data in support of this stipulation.

2.10 CORE MATERIAL :

- A. Core is to be built up from Cold Rolled Grain Oriented (CRGO) Electrical Grade steel sheets. Corner Losses are to be reduced by using mitered joints, staggered in alternate layers. Core surface is to be applied a resin coating to protect it from atmospheric pollutants.

2.11 WINDING CONDUCTOR MATERIAL

- A. Winding conductor material shall be Copper, statutory directives prohibiting use of copper shall also be taken into account. The Copper used shall be double paper covered with 50% percent overlap.

2.12 TERMINALS

- A. The terminals shall be provided as required for 433 volt may be with 1.1 kV bushing as per IS: 3747 for normally polluted atmosphere suitable for bus duct connections.

2.13 LOADING

- A. In accordance with IS: 6600 - 1972, the transformer shall be capable of being overloaded as per guidance given in IS: 6600 - 1972.

2.14 FITTINGS & ACCESSORIES

- A. The dry type transformer shall have the following fittings..
 - 1. Base channels suitable for mounting on floor and plinth.
 - 2. Winding temperature indicator with Alarm and Trip Contacts.
 - 3. Earthing terminals.
 - 4. Lifting Hooks.
 - 5. Diagram & rating plates
 - 6. Plain rollers
 - 7. Platform lugs.
 - 8. Inspection cover.

- B. Surface preparation and painting of enclosure shall be done as per clause of painting elsewhere.

PART 3 – SCHEDULE OF TESTS FOR POWER TRANSFORMER

3.1 GENERAL

A. The following tests shall be carried out by the contractor to determine whether the plant items and materials comply with the specification and to provide the necessary operating data.

B. Not less than twenty-one days notice of all tests shall be given to the Owner/ Consultant in order that he or his representative may be present if he so desires. As many tests as in the opinion of the Owner/ Consultant are possible shall be arranged together. The plant items selected for type tests shall be identical to those to be supplied by the Sub-contractor in all details likely to be encountered in service. Details of testing equipment and measurement and recording instruments shall be submitted to the Owner/ Consultant as required. All instruments shall be to approval and if necessary shall be calibrated at the expense of the Sub-contractor at a recognized national laboratory.

- A. Notwithstanding reference to British Standards referred to in this specification the Sub-contractor may submit for approval plant tested to technically equivalent National Standards of the Country of Origin. Test certificates and reports shall be furnished to the Owner/ Consultant. The tests shall be classified under following categories.

1. Routine Tests (at works)
2. Site Tests

B. The Sub-contractor shall submit any reports on Type Tests which have been successfully performed on the plant items tendered. If in the opinion of the Owner/ Consultant these reports are acceptable as evidence of the plant items having been satisfactorily tested, the Owner/ Consultant may exempt the Sub-contractor from carrying out the tests.

C. In the event that modification are made to the design of any plant items which may affect any or all of the performance obtained from Type Tests already completed, the relevant Type Tests shall be repeated at the expense of the Sub-contractor.

3.2 APPROVAL OF TEST REPORTS

- A. All test reports other than those for site tests shall be submitted to the Owner/ Consultant for approval at least six weeks before shipment of the plant items.
- B. It shall be the responsibility of the Sub-contractor to ensure that written approval obtained for the items prior to shipment. Failure to comply with this requirement may result in the rejection of the plant items.

3.3 FACTORY ROUTINE TEST

- A. Prior to despatch the transformer out of the factory, each transformer shall be routine tested (in presence of representatives of the Purchaser if so required).
- B. The routine tests to be performed shall be:
1. Measurement of winding resistance.
 2. Measurement of voltage ratio and check of voltage vector relationship
 3. Measurement of impedance voltage/short circuit impedance and load-loss

4. Measurement of no-load loss and current
5. Measurement of insulation resistance
6. Induced over-voltage withstand test
7. Separate-source voltage withstand test.
8. Partial Discharge test to IEC 270.
9. Transformer noise measurement.

3.4 Type Tests:

A. In addition to the routine tests, the following type tests may be made as per details in IS 2026.

1. Lightning impulse-test.
2. Temperature rise test.
3. Short-circuit test
4. Air pressure test
5. Unbalanced current test: the value of unbalance current shall not be more than 2% of the full load current.

3.5 SITE TESTS

- A. The transformers shall be fully tested on site prior into putting into service to ensure that all items are in proper working condition, correctly installed and free from damage.
- B. An authorised testing Professional Engineer shall be engaged by the contractor to perform the site testing and commissioning.
- C. The following tests shall be made on the plant item together with any other tests which the Sub-contractor deems necessary.

3.6 SEPARATE SOURCE POWER FREQUENCY WITHSTAND VOLTAGE TEST

A. The windings of each power transformer shall be power frequency voltage tested in accordance with BS 171.

3.7 OPERATION TESTS

- A. Transformer tap-changers, cooling equipment, emergency stop, door interlocks, temperature relays, their controls and all other auxiliary equipment shall be operated to prove that they are functioning satisfactorily before the transformers are put into service.

3.8 SECONDARY WIRING TEST

- A. The insulation of all secondary wiring shall be tested with injection test and megger test after installation.
- B. Measurement of voltage ratio at every tap position and check of voltage sector.

3.9 INSPECTION

- A. All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge to satisfy him that the material is being furnished in accordance with this specification.

- B. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

3.10 SEPARATE SOURCE POWER FREQUENCY WITHSTAND VOLTAGE TEST (As Applicable)

The windings of each power transformer shall be power frequency voltage tested in accordance with BS 171.

3.11 OPERATION TESTS

- A. Transformer tap-changers, cooling equipment, emergency stop, door interlocks, temperature relays, their controls and all other auxiliary equipment shall be operated to prove that they are functioning satisfactorily before the transformers are put into service.

3.12 SECONDARY WIRING TEST

- A. The insulation of all secondary wiring shall be tested with injection test and megger test after installation.
- B. Measurement of voltage ratio at every tap position and check of voltage sector.

3.13 INSPECTION

- A. All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge to satisfy him that the material is being furnished in accordance with this specification.
- B. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

Outdoor type step-down transformer shall be **11 KV to 0.415 KV**, three phase 50 cycles copper wound of rating **1250 KVA** respectively. Transformer shall be having high efficiency, low magnetic field and impedance shall not exceed 6.25 %. Transformer shall not exceed 3.6 and 12 KW at 50% and 100% loading respectively. It shall be double wound core type with ONAN cooling having delta connection on HT side and star on secondary side having automatic On load tap changing device on high tension side for tapping –10% to +5% in step of 1.25%. The transformer shall be complete with the following accessories.

- On Load tap changer with Remote tap changing control panel with Automatic Voltage Regulating relay.
- OLTC conservator with drain valve, filling hole with cover and silica gel breather and oil level indicator.
- Oil conservator with sump and drain valve with cover plate.
- Dehydrating breather with silica gel and oil seal.
- Oil filling valve 32mm dia with cover plate.
- Thermometer pockets with thermometer.
- 150mm dia magnetic oil level indicator with low-level alarm and trip contacts and minimum filling and maximum level markings. Plain oil level gauge with minimum level marking.
- Diagram, rating plate, terminal-marking plate.
- Two earthing terminals.
- Lifting lugs for active part only.

- Four bi-directional plain rollers.
- First filling of oil.
- Double diaphragm explosion vent pipe with sight glass.
- 150mm dial type winding temperature indicator with maximum reading pointer and alarm and trip contacts. Pocket for above item.
- 150mm dia magnetic oil level indicator with low level alarm and trip contacts and minimum filling and maximum level markings
- Double float Buchholz relay with testing sampling cocks, alarm and trip contacts.
- Marshaling Box for contacts for alarm & trip for OTI, WTI, OSR, MOG & Bucholtz relay.
- Air release plug on tank cover.
- Isolation valve on both sides of bucholtz relay.
- W.P. thermo / plastic junction box.
- Detachable radiator with top and bottom stop valves and drain and air release plugs.
- Jacking pads with haulage holes.
- Oil surge relay for OLTC.
- Shut off valve for OLTC oil surge relay.
- Access windows for OLTC connections.
- Drain cum bottom filter valve 32mm with cover plate.
- Vector group – Dyn11
- Cable end box suitable for 1 No. 3 core x **240 Sq.mm** XLPE cable, **11 KV (E)**
- Cable end box suitable for 8 Nos. **3.5 core x 300 Sq.mm** XLPE cable, for connection in L.T. side (1100 Volt grade).
- Extra neutral bushing for solid earthing.
- Pressure equalizer pipe.
- Provision of terminals & Space for mounting Neutral CT for REF relay.

The transformer shall be rated for a maximum temperature rise of 50 Deg. C for oil and 55 Deg. C for winding over 45 Deg. C ambient temperatures.

The transformer shall conform to the IS: 335 and 2026/1977.

WINDINGS

Windings shall be subjected to shirking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent lighteners of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

All low voltage windings for use in the circular coil concentric winding shall be wound on a preformed insulating cylinder for mechanical protection of the winding in handling and placing around the core.

Windings shall not contain sharp bends, which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or be otherwise affected under the operating conditions.

Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

All threaded connections shall be locked. Leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Windings and connections shall be braced to withstand shocks during transport or short circuits.

Coil clamping rings shall be of steel or of a suitable insulating material.

Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistance material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

Terminate of all windings, also of stabilizing windings, shall be brought out of the tank for external connections.

Windings shall be of copper, the conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along with the windings.

The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over tank or in the transformer tank. Vapor phase dry-out shall be preferred.

TANK

Tank shall be made from good commercial grade low carbon steel and shall be of welded construction.

Tank shall be designed to permit lifting, by crane or jacks or the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

Tank together with radiators, coolers, conservator, bushings, vessel and other fittings shall be designed to withstand without permanent distortion the following conditions:

- a) Full vacuum of 760mm of Hg. for filling with oil by vacuum.
- b) Internal gas pressure of 0.35 Kg/cm² (5 lbs/sq.in) with oil at operating level.

The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rain water.

Manholes with bolted covers shall be provided in the top or sides of transformer for easy access to the lower ends of bushings, tap changers and to permit replacement auxiliaries without removing tank cover.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

The transformer base shall be designed to permit skidding of the complete transformer unit in any direction, when using plates or rails. The under base shall be detachable unless transport facilities permit a fixed base. Pulling eyes shall be provided for moving the transformer in either direction.

The material used for gaskets shall be cork-neoprene or approved equivalent. Gasketed joints for tank and manhole covers, bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather. Spare gaskets shall be provided for all openings as shipping gaskets will not be reused.

Tank shall be provided with valves etc. as required.

Tank shall be provided with a pressure release device which shall be operated at a pressure below the test pressure for the tank and radiators. The device shall be rain-proof after blowing and shall be provided with a device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied. Explosion vent shall be equipped with remote monitoring/alarm contracts with oil indicator.

The transformer be rated for a maximum temperature rise of 50 Deg. C by thermometer in oil and 55 Deg. C by resistance at CTR with a daily average ambient temperature of 45 Deg. C and peak ambient temperature of 50 Deg. C. poxy paint shade of IS: 631.

The external surface of transformer shall be painted with e

ON LOAD TAP CHANGING (OLTC)

The diverter switch contacts shall be housing in separate oil chamber not communicating with oil of the main transformer tank. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

The OLTC oil chamber shall have oil filling and drain plug, relief vent and level glass. It shall also be fitted with a separate oil surge relay. The outlet of this relay shall be connected to a separate conservator tank or a totally partitioned compartment of the main conservator. A magnetic oil level gauge with separate potential free contacts for alarm and trip shall be provided.

The equipment shall be suitable for local and remote electrical control and local manual control. The features to be provided with these controls are detailed below:

i) Manual Control

The cranking device for manual operation of OLTC gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:

- a) Mechanical tap position indicator which shall be clearly visible from near the transformer.
- b) Mechanical operation counter.
- c) Mechanical stoppers to prevent over cranking of the mechanism beyond the extreme position.
- d) The manual control considered as backup to the motor operated tap control shall be interlocked with the motor to block motor start up during manual operation. The manual operating mechanism shall be labeled to show the direction of operations for raising the secondary voltage and vice-versa.

ii) Electrical Control

This includes the following:

- a) Electrical local control from transformer marshal box.
- b) Electrical remote control from remote control (RTCC Panel).
- c) The control scheme shall have the following features:
 - i) An interlock to cut off electrical control automatically upon recourse being taken to manual control.
 - ii) Selection of point of control local or remote, it shall not be possible for any two electrical controls to be in operation at same time.
- d) Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated.
- e) Step by step operation, ensuring only one tap change for each tap changing command.
- f) An interlock to cutoff the electrical control when it tends to perate the gear beyond either of the extreme tap positions.
- g) An interlock to block a counter command for reverse tap change during a tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

The equipment shall be so arranged so as to ensure that when a tap change has commenced it shall be completed independent of the control relays and switches. If a failure of auxiliary supply during a tap change or any other contingency would result in the movement not being completed adequate means shall be provided to safeguard the transformers and its auxiliary equipment. A supply monitoring relay with alarm contacts shall be provided for the tap changer.

The auxiliary device for electrical controls of the OLTC shall be housed either in the OLTC driving mechanism box or in Transformers marshalling box. It shall be provided with a circuit breaker with magnetic and thermal O/L devices for controlling the auxiliary supply of the OLTC motor.

Tap position indicator shall be supplied loose for mounting on the RTCC.

On the RTCC there shall be following components also:

- i) Raise/Lower switch for manual operation.
- ii) Lamp indicating ON LOAD TAP CHANGE in progress.

RTCC panel shall have automatic tap changing feature i.e. whenever voltage fluctuations occur the tap switch shall change automatically to set net output voltage of $0.415 \text{ KV} \pm 1\%$. For this purpose, an Auto/ Manual selector switch shall be provided in RTCC.

OLTC shall have separate breather.

Erection & Installation

The installation, testing and commissioning shall conform to IS Code of Practice IS: 1886-1967 with latest amendment and regulations of local authorities.

When lifting a transformer core shall be taken to see that lifting chain will not interfere with any part of the transformer. Never fix the sling to any other part of the transformer except the lifting lugs. Lifting lugs and jacking pads shall be used for lifting of the transformer. While using jacking pads utmost care shall be taken in proper application of jacks. Where transformer is dragged or pulled on sleeper or rollers the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles. Tank cover should always be fitted lifting the tank.

The transformer shall be lifted by lugs or shackles or by any other suitable means (such as dragging on rollers) and mounted on MS channel embedded in cement concrete. Care shall be taken to see that transformer is not tilted during lifting and erection of transformer. The rollers shall be choked to prevent movement of the transformer after being positioned on the plinth. Adequate and necessary clearances from wall etc.. shall be provided as required as per IS: 1886 - 1967.

Before energizing the transformer the oil must be got tested and approved from any of the Government Test House or from approved appropriate authority. The oil shall be tested in accordance with the requirement of IS - 335/1970. In case the results obtained are substandard the entire quantity of oil is replaced with the approved quality of oil and test taken again. The process shall be repeated till satisfactory results are achieved. In case of presence of foreign matter/moisture etc., in the oil, the oil may be got filtered through oil filtration plant. The temperature of oil in the spray tank shall not exceed 80 Deg. C. during the purification process. The minimum IR value by the end of purification process shall be at least 20 Mega-ohm at an oil temperature of 60 Deg. C. Topping up of oil if required shall be done with tested oil.

The insulation resistance of the winding shall be measured with 2500 V DC meggar and results shall correspond to the factory test results. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained.

- a) Transformers will be delivered without oil, filled with inert gas and without externally mounted accessories.
- b) The Contractor shall place the transformer on its foundation assemble parts, erect the separate cooler banks where provided, erect the supporting structure for detachable type cable chamber, conduit and wiring connecting and filling of transformer with oil.
- c) The Contractor shall arrange to fill transformer oil and also arrange for oil filtration before filling. H.V. Test/Breakdown strength of transformer oil shall be carried out taking a sample from individual transformer and till the result is not found to satisfaction of Engineer, oil conditioning shall have to be carried out.
- d) Jack for the above transformers shall have to be provided by the Contractor.
- e) If vacuum oil filling in transformer is envisaged the Contractor shall arrange the necessary equipment.
- f) All the cable terminations and control wiring is to be carried out by Contractor.

TESTING OF TRANSFORMER

The transformers shall be subjected to the following routine tests at the manufacturer's works before dispatch.

- a) Measurement of winding resistance.
- b) Voltage ratio, polarity and phase relationship
- c) Measurement of impedance voltage
- d) Excitation Current Measurement
- e) Load losses
- f) No load losses and no load current
- g) Induced over voltage withstand
- h) Separate source voltage withstand

- i) Partial discharges tests.
- j) Insulation resistance measurement test.

The insulation resistance of the winding shall be measured with 2500 V DC meggar and results shall correspond to the factory test results. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained.

The power frequency test voltage for the secondary winding shall be 2.5 KV R.M.S. The transformer shall be charged only after the tests are conducted and approval of local authorities is obtained.

CONTROL WIRING

All the cable terminations and control wiring is to be carried out by Contractor.

The Contractor shall supply, install, test and commission all control/instruments wiring as found necessary. The job is turnkey and shall remain the responsibility of Contractor to ensure its functioning in useful and defined manner.

All the indoor control wiring shall have copper conductor and PVC insulated.

The indoor control wiring shall conform to IS: 694 for voltage grade of 1.1 KV for A.C./230 V for D.C.

The conductor cross sectional area shall not be less than 2.5 Sq.mm.

The indoor wiring shall be in surface conduit neatly placed on wall or ceiling either in horizontal or vertical run.

The control wiring which are to be placed outdoor or which are to run in cable trench shall be of 650/1100 voltage grade and shall conform to IS: 1554. The cable shall have minimum dia of conductor to 2.5 sq.mm.

TESTING AND INSPECTION

- a) The Contractor shall draw up and carry out a comprehensive inspection and testing programme during manufacture and commissioning of the transformer. The programme shall be duly approved by the Consultant/Client.
- b) Contractor shall ensure that type tested equipment only is offered and routine tests shall be conducted as per relevant standards. Type test certificates shall be submitted along with the bid.**

DRAWING AND INFORMATION

The vendor shall furnish following drawings/documents in accordance with enclosed requirement.

- a) General arrangement of transformer.
- b) General arrangement of HV cable box with connection diagram.
- c) General arrangement of LV Bus duct flange/Cable box and connection arrangement.
- d) General arrangement of marshalling box and wiring diagram.
- e) Rating and diagram plate indicating % impedance etc.
- f) Type test and guaranteed technical parameters.

QUALITY ASSURANCE PROGRAMME

Quality Assurance Programme shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance Programme involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

3.0 L.T. PANELS & SWITCHGEARS

Medium voltage switch boards/distribution boards, the combination of both these and components shall conform to the equipments of the latest revision including amendments of the following codes and standards.

The drawings, specification and BOQ complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

CODES & STANDARDS

The design, manufacture and performance of equipment shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (B.S.), International Distro 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 in case bus bar rating exceeds 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 stress 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-hygroscopic non-combustible track resistant and high strength SMC or polyester fiberglass moulded material.

All bus bars shall be colour coded as per IS: 375.

Copper /G.I./Aluminium earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly suitable size of strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

Sheet steel hinged lockable doors shall be interlocked with MCCB to prevent opening of the panel when MCCB is on position. Safety interlock with operating handle shall be provided.

Contactors shall be electromagnetic type with interrupted duty as per IS: 2959. The main contacts shall be of silver or silver alloy, provided with minimum 2 NO and 2 NC auxiliary contacts. The push button should be of shrouded type and each should be provided with 1 NO and 1 NC contact. Colour coding shall be as per IS: 6875 (Part-II).

ACB (IEC 60947-2; IS 13947)

The circuit breaker shall be of air break type in order to eliminate fire and explosion risk and shall comply with the IEC with a rupturing capacity of not less than 35 MVA at 415 volts or as specified elsewhere (The service short circuit breaking capacity shall be as specified and equal to the short circuit with stand value $I_{cs} = I_{cu}$). The breaker shall be provided with variable microprocessor based releases within built fault differentiation for integral over load, short circuit and earth fault & other protection as called for in BOQ, LED indication for type of fault, CT's for protection and measurement class as called for in BOQ, and LCD display of curves and parameters. Electrical endurance without maintenance shall be greater than 2000 cycles.

Mechanical & electrical anti pumping devices shall be provided in breaker, as required.

The breaker shall have memory for logging history for type of fault, load, time & date and the Vendor shall mention in the data sheet for no. of loggings available in the breaker memory.

The breaker shall consist of a horizontal draw out pattern triple/four pole, fully interlocked, independent manual/motorized spring operated mechanism. The mechanism should be such that the circuit breaker is at all times free to open immediately. The trip coil is energized. Current carrying parts should be silver plated and suitable arcing contacts shall be provided to protect the main contact arc-chutes for each pole shall be provided and shall be lifted out for the inspection of main and arcing contact.

Self-aligning cluster type isolating contacts shall be provided on breaker for interlocking protection metering and for any other purposes. The breaker should have 3 distinct positions - SERVICE/TEST/ISOLATED within the cubicle.

The ACB shall be with molded housing class II front fuse and shall be suitable for Isolation as per the annexure 7.1.2 in the standard.

Breaker shall be provided with automatic safety shutters to screen the main live contact when the breaker is withdrawn. The frame of the circuit breaker could be positively earthed when the breaker is racked into the cubicle.

The following safety arrangements shall be provided for the safety of the personnel to prevent mal-operation.

- i) Interlock to prevent the truck from being withdrawn or replaced except in the fully isolated position.
- ii) Interlock to prevent earth connection from being made by the earthing device except breaker is open.
- iii) Interlock to prevent the breaker being closed unless it is fully raised.
- iv) Interlock to prevent the breaker from being made alive without its rack in position.

Protection Releases

Self-powered & true RMS sensing microprocessor based release with following features.

a) Incomer ACB of Panels:

Long time short circuit protection with time delay. Instantaneous and earth fault protection with LCD display to show RMS current in all three phases, neutral (for 4pole) simultaneously. The other features of the release to be as under.

- The release should display distinct fault indication for each type of tripping for faster fault diagnosis and reduce down time & should protect ACB from over temperature and Phase unbalance.
- Release should provide contact wear indication in display no. of operation seen by the breaker for case of maintenance.
- The release shall be self-diagnosis & should provide fault history including cause of fault as well as level of fault current. It should be possible to store minimum 20 last trip data with nonvolatile memory.
- The protection setting of release should be accessible to change locally.
- LCD display should be at least 4 line display and should be able to display current in all the 3 phases and neutral (4 pole) simultaneously.

b)For Outgoing ACB feeder:

Long time Short circuit protection with time delay (for discrimination), instantaneous. The other features of the release to be as under.

The release should have distinct fault indication for each type of tripping for faster fault diagnosis and reduced down time and shall protect ACB from over temperature and phase unbalance.

- Operation counter
- Alarm and warning indication

Type test certificate : The ACB's shall be type tested and certified for compliance to IS 13947/equivalent / EC standard from Indian / International testing authority, supplier to submit certificate of the same.

MOULDED CASE CIRCUIT BREAKER (MCCB)

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 use 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 override 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 Ie
- Breaking Capacity equal to or more than 8 Ie

For AC4 Duty

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

The contactors should be capable of frequent switching and should operate without derating at 600C for AC3 applications. They should be climate proof as standard. The coil of the contactor should have class H insulation to support frequent switching.

The rated voltage of the contactor shall be equal or superior at 690 V, and rated insulation voltage shall be 690 V. The rated impulse voltage of the contactor should be 8 KV.

The contactor should be modular in design with minimum inventory requirements and built in mechanically interlocked 1NO 1NC auxiliary contact up to 32A. They should be suitable for the addition of auxiliary contacts and other electrical auxiliaries without any compromise on the performance or the operation of the contactors. The contactors from 4 KW to 400 KW will be associated with the same auxiliary contact block range.

Wherever D.C control is required, the contactor should have wide range (0.7 to 1.25Uc) D.C coil with built in interference suppression as standard.

The control and power terminals should be at separate **layers preferably with colour coding (black for power and white for control)**

All contactors power connection will be **finger safe (IP2X)** as standard.

They should be capable of being integrated into automated system (PLCs etc.) without any interposing components in minimum operating conditions.

The thermal over load relay if used will be directly mounting under the contactor without any specific connections.

NAME PLATES & LABELS

- i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
- ii) All nameplates shall be of non-rusting metal or 3-ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to Owner's approval.
- iii) Suitable stencilled paint marks shall be provided inside the panel/module identification of all equipments in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

PAINTING

All steel work shall be pretreated in tanks and finally powder coated of approved shade.

WIRING

Control and protective wiring shall be done with copper conductor PVC insulated 1100 volts grade multi-stranded flexible wire of 2.5sq.mm cross section. The colour coding shall be as per latest edition of IS: 375.

Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spliced between terminal points.

Terminal blocks shall preferably be grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than one wire shall be connected to any terminal block. All doorframe of L.T. switchboard shall be earthed with bare braided copper wire.

TESTING & INSPECTION

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of Purchaser's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by primary or secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test.
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)

- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.
- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out alongwith copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before despatch of switchboards.

DRAWINGS AND INFORMATION

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.
- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

- i) Technical literature giving complete information of the equipment.
- ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii) A comprehensive spare parts catalogue.

TOOLS

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools with his quotation.

SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

QUALITY ASSURANCE

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

4.0 BATTERY & BATTERY CHARGER

1. SCOPE

The specifications give details of the Battery Charger suitable for HT/ LT Panels. The batteries are housed in the Bottom Compartment of the Battery Charger. Sealed maintenance Free Batteries upto 24V – 200AH or Lead Acid Batteries upto 24V – 150AH can be housed in the Battery Compartment. The Battery Charger is a composite Battery Charger cum DC Distribution Board.

2. GENERAL

The Battery Charger shall be Float cum Boost type, Thyristor controlled. The Charger shall have selector switch for Auto Float – Boost/Manual Float/Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to Trickle charge.

Construction Feature

Float cum Boost Charger and DC Distribution Board shall be housed in Sheet Steel Cubicle with Panels of 1.6mm thickness, louvers for ventilation, gland plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens Grey Shade. The Battery Charger shall be divided into two Compartments. The Upper Compartment shall house the Battery Charger & DCDB with all the necessary controls. The Lower Compartment shall be suitable for housing the Batteries.

PERFORMANCE

- 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 overvolt.

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, riveted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

Conductors shall be securely attached to the building to be protected by fasteners, which shall be substantial in construction, not subject to breakage and shall be of steel. The conductors shall be secured at not more than 900mm apart for horizontal run and 750mm for vertical run.

Where tape are required to pass through roof asphaltting or other waterproofing membranes, 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 than 50V in 60 seconds of disconnection from supply.
- Testing shall be done as per applicable standards for shunt capacitors.

Capacitor Control Panel

The capacitor control panel shall general comprise of the following:

- a) Automatic power factor correction relay.
- b) Step controller with reversing motor.
- c) Time delay and no-volt relays.
- d) Protection MCCB / MCB.
- e) Contactor (AC-3 duty) for individual capacitors of suitable rating.
- f) Change over switch for either automatic operation or manual operation with push button control.
- g) C.T.s with ammeter and selector switch as asked for in BOQ.
- h) Voltmeter with selector switch.
- i) Indicating lights RYB.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar shall be provided in panel as required.

The above control gear, P.F. meter, Digital Microprocessor based P.F. correction relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, free standing front operated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed design completely dust tight and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

All sheet steel material used in the construction of capacitor control panel should have undergone a rigorous rust proofing process comprising Alkaline Degreasing, descaling in dilute sulphuric acid and recognised phosphating process. The steel work should then receive two coats of primer before applying final coat of epoxy paint of approved shade.

Quality Assurance

Quality Assurance shall follow the requirement of Client/ Consultant. Q.A. documents as applicable.

Q.A. involvement will commence at enquiry and follow through to composition and acceptable thus ensuring total conformity to purchaser's requirement.

Deviations

Deviations from the specification must be stated in writing at the quotation stage.

In the absence of such a statement it will be assumed that the requirements of the specifications are met without exception.

SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

8.0 H.T. CABLE (XLPE) (33 KV & 11 KV)

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 900mm for cable upto 33 KV (E) below the ground level in a trench 450mm wide.

Insulation tests shall be done before and after laying of cables.

After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

9.0 L.T. CABLES & WIRE

a) **Wires**

The design manufacture, testing and supply of single core **LEAD FREE FRLS PVC** insulated 1.1 KV grade multi-stranded twisted wires under this specification shall comply with latest edition of following standards.

IS : 3961 Current rating for cables.

IS: 5831 PVC insulation and sheath of electric cables.

IS : 694 PVC insulated cables for working voltage upto and including 1100 volts.

IEC: 754(i) FRLS PVC insulated cable.

Copper multi-stranded twisted conductor FRLS PVC insulated wires shall be used in conduit as per item of work.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of wire.

The material & insulation of wires shall be **ROHS compliant** (Reduction Of Hazardous Substance) and shall comply the following directives:

- EU Directive 2002/95/EC Issued Jan 2003
- EU Directive 94/62/EC and 2004/12/EC (amendment)
- EU Directive 91/338/EEC
- EU Directive 91/157/EEC & 98/101/EC (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 hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Metre on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

i) Testing of Cables

Cables shall be tested at factory as per requirement of IS: 7098 Part-I. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to laying of cables, following tests shall be carried out:

- i) Insulation test between phases and phase to earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Architect/Owner.

- ii) Insulation resistance test (Sectional and overall) 1000/5000V depending upon the voltage grade of cable.
- iii) Continuity resistance test.
- iv) Sheathing continuity test.
- v) Earth test.

j) Laying of Cable

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 12 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3-meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms. All around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion are provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms. Over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are to be laid in ducts (pucca trenches) in side 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 conductor. 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 adopter boxes shall be provided for crossing & nothing shall be paid extra.

Where conduits are used for non-air-conditioned space to air-conditioned space or into a fan chamber or duct, a junction box shall be installed to break the continuity of such conduit at the point of entry or just outside and conduit shall be sealed around the conductors.

Particular care shall be taken during the progress of the work to prevent the ingress of dirt and rubbish such as plaster droppings into erected conduits. Conduit which has become so clogged shall be entirely freed from these accumulations or will be replaced. Screwed plastic or metal caps or turned wooden plugs shall be employed to protect all open ends. Plugs of waste wood, paper, cotton or other fibrous matter shall not be used. All unused conduit entries shall be blanked off in an approved manner and where conduits terminate in adaptable boxes, all removable box covers shall be firmly secured to provide complete enclosure. If considered necessary by the Engineer-in-charge, the conduits shall be swabbed out by drawing swabs of rag through the conduit to remove moisture prior to any cables being drawn in.

All conduit installations must be completed and erected in their totality before they are wired and must be fully rewirable from outlets to distribution boards or trunking systems etc. to which they connect. No wiring of any part of the installation shall be commenced until instructions are received to do so by the Engineer-in-charge at such time as he is satisfied that the wiring will not be damaged due to building operations.

Conduits shall be installed so that they are self-draining in the event of ingress of moisture due to condensation or any other reason. A suitable drainage hole shall be drilled at the bottom of the lowest conduit box in every 9-meter of horizontal run.

PVC bush of good quality shall be used in each conduit termination in a switch box, draw box, lighting fixtures and circular junction boxes.

Exposed conduits running above false ceilings shall be suitably clamped independently along with the dropped ceiling. Perforated straphangers or twisted attachment shall not be acceptable. In no case shall raceways be supported or fastened to other pipe for repair and maintenance. They shall be arranged symmetrically and in the most compact design, in no way unduly criss-crossing each other. Proper spacing shall be maintained when two or more conduits run side by side. The layout of the pipes shall be co-ordinated with other services if any. The junction boxes and conduits used in hazardous areas shall be flameproof type with cast iron construction complete with threaded covers. The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements by means of special approved type of earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between the earth and conduit.

The conduit system shall be so laid out that it will obviate the use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two-quarter bends from

inlet to outlet. The conduit itself being given required smooth bend with radius of bends suiting to the site conditions but not less than 6 times overall diameter.

Outlet boxes shall be of heavy-duty sheet steel installed as to maintain continuity throughout. These shall be so protected at the time of laying that no mortar finds its way inside during concrete filling or plastering. For fluorescent fittings, the outlet boxes heavy duty shall be provided 300mm off centre for a 1200mm fitting and 150mm off centre for a 600mm fittings or as per B.O.Q.

Draw boxes of ample dimensions shall be provided at convenient points to facilitate pulling of long runs of cables. They shall be completely concealed with MS covers flush with plasterwork painted to match the wall. These boxes will be as few as possible and located where found suitable by the consultant.

Switch Boxes

The switch boxes shall be zinc passivated & shall not be less than **18 SWG** thick or shall be as called for in BOQ. It will be so designed that accessories could be mounted on integral pedestals or on adjustable flat iron mounting straps with tapped holes by brass machine screw. Leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on either side of their walls. These shall be completely concealed leaving edges flush with wall surfaces. Earthing terminal inside box shall be provided.

Moulded plate switches screw less as specified in item of work shall be provided. No timber shall be used for any supports. Boxes, which come within concrete, shall be installed at the time of casting. Care shall be taken to fix the box rigidly so that its position is not shifted while concreting.

Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 660/1100 volts grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used and shall be as per B.O.Q. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for submains sub-circuit wiring. The ferrules shall be provided at both end of each submain and sub-circuit.

Where single-phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single-phase switches connected to different phase shall be mounted within one box.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of moulded plastic BoQ and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Maximum number of PVC insulated 650/1100 V grade/copper conductor cable conforming to IS: 694-1990.

Conduit size	20mm		25mm		32mm		40mm		50mm		60mm	
Wire size in sq.mm.	S	B	S	B	S	B	S	B	S	B	S	B
1.50	7	5	12	10	20	14	-	-	-	-	-	-
2.50	6	5	10	8	18	12	-	-	-	-	-	-
4	4	3	7	6	12	10	-	-	-	-	-	-
6	3	2	6	5	10	8	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	-	4	3	7	6	-	-	-	-
25	-	-	-	-	3	2	5	4	8	6	9	7

Notes:

- 1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- 2) The columns heads 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- 3) Conduit sizes are the nominal external diametres.

12.0 TELEPHONE SYSTEM AND LAN WIRING

Enhanced Category 5 UTP specifications

- a) The UTP shall be 4-pair, with 24 SWG solid or standard copper conductors.
- b) The UTP-based cabling system shall have a 160 MHz channel bandwidth over a maximum distance of 100m (328 ft) and a channel power sum attenuation-to-crosstalk ratio (PSACR) of 9.6 dB@ 100 MHz using an interconnect or BIX cross connect configuration.
- c) The UTP-based cabling system shall use matched components from a single manufacturer, certified to deliver system performance over the lifetime of the application that the cabling system was originally designed to support.
- d) All component used in the UTP-based cabling system shall be warranted for a period of 25 years from date of installation against defects in materials and workmanship.
- e) The UTP-based cabling system shall comply with the following standards:

Enhanced Category 5 – TIA/EIA Addendum

Category 5 – ANSI/TIA/EIA-568, TIA/EIA TSB67

Class D – CENELEC EN50173

Class D – ISO/IEC 11801

UTP Outlets

- a) The outlet UTP connection module and its optional cover shall be available in the following colors: grey, almond, white, black, orange, red, yellow, green, blue, purple and brown.
- b) The outlet UTP connection module shall be Power Sum rated, with a power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 5 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
- c) The eight-position outlet UTP connection module shall accommodate six-position modular plug cords without damage to either the cord or the module.
- d) It shall be possible to inspect and/or re-terminate the UTP cable at the outlet through front access at the face plate.
- e) The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
- f) The faceplate housing the outlet UTP connection module in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubical) access points using manufacturer – supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.

UTP System Testing

- a) There are two primary field test parameters for an UTP-based end-to-end cabling system. These are continuity/wire mapping and a visual inspection, both to be performed by the vendor.
- b) Continuity/wire mapping is used to verify consistency pair-to-pin terminations at each end of a given cable. It also checks for faulty connections in the run. For each of the eight conductors in the cable, continuity/wire mapping indicates:
 - Continuity of the channel to the remote end.
 - Shorts between any two or more conductors.
 - Crossed pairs.
 - Reversed pairs.
 - Split pairs.
 - Any other mis-wiring.

TELEPHONE TAG BLACK (TTB / IDF)

CAT-5e (enhanced) unshielded twisted pair cable in MS conduit shall be used to have modern structured cabling network for telephone system, to have latest facilities for Internet and also data cabling. All the telephone Jack must 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 terminated on an 8 wire, 8-position Jack. Each RJ-45 Data Connection will be terminated with a **BLUE** Data Jack

Only conduit routing & wiring shall be provided by the Electrical contractor and the configuration & wiring shall be done by the Vendor for the IT Networking.

EPABX system, with latest technology will be provided by a separate Vendor to provide Voice Mail & Call Accounting by costing of all calls made by telephones.

A small cabinet for Low current services shall be provided at the false ceiling level at entrance of guest room, to locate all the terminal points like Tel.Tag block, tap-off box for MATV etc., for interconnecting all the low current outlets (jacks) provided in the guest room. Each tel. outlet in guest room shall be provided a separate wire from the room tag block.

Similarly one CAT-5e wire from the floor TTB/IDF shall be provided for each Tel. Outlet proposed.

A Multi pair box as per BOQ Tel. Cable shall be laid from the Service gate to the Telephone switch room MDF for Direct lines from the Service provider. Some of the lines shall be bypassed to EPABX and shall be directly provided to Top management's office & Telephone operators for direct communication to outside. Rest of the lines shall be routed through EPABX for the use of patrons & staff through extensions. The following area/desk shall have direct access to outside Tel. lines:

- a) Telephone Operator's room
- b) Telephone Switch room
- c) Security room
- d) Fire officer room

13.0 MATV SYSTEM

Co-Axial Cables

13.1 The co-axial cable shall be of wideband type with operation upto 860MHz capability, with PE dielectric and PVC jacket.

The cable shall meet or exceed the following specifications:

	RG-6	RG-11
IS Standard IS:14131	5CA4	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

14.0 UPS SYSTEM: SPECIFICATION FOR THE UPS.

Quality power Supply

The UPS shall be ON-LINE double conversion with filter, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops).

The battery cabinets used in the UPS shall be for longer runtime, The UPS shall have Optional filters, Isolation transformer module, LCD-based remote control panel, LED-based remote control panel & Communication software “professional” version.

The Operating mode of UPS

It should operate in on-line operating mode as follows.

- **Economy Mode:** The UPS should use Line Interactive technology, i.e. the load is powered from the mains; the energy consumption is reduced with a subsequent improvement in efficiency (98%).
- **Smart active mode:** The UPS should automatically selects On Line or Line Interactive operating mode according to the quality of the mains supply, by monitoring the number, frequency and type of disturbances at the mains power input.
- **Stand-by-off mode:** With the mains available the UPS should normally not powered and consequently the power consumption is almost nil. Only when the mains fails or falls outside a preset range, does the inverter take over in 200ms using power from the batteries. This mode shall be suitable for Emergency escape lighting as per standard **EN 50171**.

The UPS shall have Expandable feature. The units can be connected in parallel up to 8 units to increase power availability or redundancy. The system can be expanded at any time. For the expandability there shall be “Hot System Expansion” feature, the additional unit can be connected in parallel while the other units are on-line and supplying regular power to the load. The new UPS is on-line and will receive the updated information automatically.

High Reliability

The UPS should be connected in parallel up to 8 units to exponentially increase the reliability of the system.

Maximum battery care

In the UPS there shall be an automatic battery test which shall be able to periodically check the efficiency of the batteries. The batteries should not be used during micro-interruption (40ms), as the required energy is drawn from a group of capacitor. (Battery saving).

Maximum safety for personal

There should be a feedback protection device in the UPS to prevent any voltage back feed in the upstream distribution board, thus ensuring the maintenance personal.

For Advanced communication there shall be software system which displays the most important information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It should also be able to provide information even in the event of a failure, to support the fault diagnostics.

It should also contain the following hardware interfaces:

- RS232 serial port
- Dry contacts
- EPO (Emergency Power Off)
- Contact for UPS shutdown using the remote emergency button.

To allow easy and intuitive operation of the UPS There should be Mimic Panel. This helps in accessing the most important parameters: status and alarm, control and commands, input, output, battery measurements (power, current, voltage, frequency and temperature) and settings.

Low Input Harmonic Distortion, The UPS shall have The Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages so that it is ideal in conjunction with motor generator or in installation with other sensitive loads. There shall be built in Active Filter designed to reduce the level of THDi to less than 4% and to increase the input power factor up to 0.99.

This Active filter shall be based on the IGBT's Technologies controlled by the Digital Signal Processor (DSP). This DSP instantly monitors and controls the inputs current absorbed by the UPS in order to eliminate the unlike harmonics and maintain the THDi less than 4%. With the effect of Active Filter the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.

Less harmonics in the UPS input reduces the neutral cable size and consequently the installation cost. Also it gives maximum reliability as any failure of the optional Active Filter has no influence on the power supplied to the load; the only consequence is the increase of current harmonics level rejected to the mains, which gives maximum reliability for the load.

The input requirements of the UPS are as follows:

Voltage	:	400 V three-phase + N
Voltage tolerance	:	± 20%+
Frequency	:	45-65 Hz
Current distortion	:	<4% with active filter
Power factor	:	0.99 with active filter

The Bypass of the UPS are as follows:

Rated voltage	:	400 V three-phase + N
Phases number	:	3 + N
Voltage tolerance	:	± 15%
Rated frequency	:	50 Hz
Frequency tolerance	:	± 2%
By-pass	:	Static and manual for maintenance
Transfer time	:	nil

The Battery for the UPS are as follows:

Type of battery	:	maintenance-free sealed lead-acid
Battery blocks	:	12 V
Recharge time minimum	:	6 Hr

The Output of UPS are as follows:

Rated power	:	As per BOQ
Active power	:	As per BOQ
Phases number	:	3 + N
Waveform	:	Sinewave
Rated voltage	:	415V
Frequency	:	50 Hz
Dynamic stability	:	± 5%0.
Static stability	:	± 1% 00
Crest factor	:	3 : 1
Overload	:	110% for 5h, 125% for 10', 150% for 1

The System of UPS is as follows:

AC/AC efficiency:		92% in On-line mode, 98% in Economy Mode / Smart active mode/ Emergency mode.
Noise	:	50-56 Db a 1 m.
Operating temperature	:	-2° - 45°C
Relative humidity	:	95% non-condensing
Remote controls	:	EPO & Bypass
Remote signals	:	volt free contacts
Protection degree	:	IP20
Communication	:	Double RS232/C + slot for SNMP Adapter
Colour	:	Dark grey RAL 7024

The 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 nitch or if required mounted on the surface of the wall with necessary clamp bolts etc. The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification nameplate and danger sticker/plate as per requirements.

All the distribution boards shall be provided with engraved nameplates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have a separate neutral connection bar and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as specified in BOQ. These shall be suitable for manual closing and opening and automatic tripping under earth fault circuit of 30-300mA as specified in item of work. The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardent, anti-tracking, non-hygroscopic, impact resistant and shall stand high temperature. All parts of switching mechanism shall be non-greasing, self-lubricating material so as to provide consistent and trouble free operation. Operation of ELCB shall be independent of mounting position and shall be trip free type. The RCCB shall be protected against nuisance tripping by protective device.

Miniature Circuit Breaker

1. The MCB shall be current limiting type and suitable for manual closing and opening and automatic tripping under overcurrent and short circuit. The MCB shall also be trip free

type.

2. Single pole/three pole versions shall be furnished as required.
3. The MCB shall be rated for 10 KA/15 KA fault level.
4. The MCB shall be suitable for its housing in the distribution boards and shall be suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.
5. The terminal of the MCBs and the open and close conditions shall be clearly and indelibly marked.
6. The MCB shall generally conform to IS: 8828. -1996
7. The MCB shall have 20,000 electrical operation upto 63A.
8. The MCB shall have minimum powerloss (Watts) as per I.S./ IEC.

16.0 NURSE CALL SYSTEM(if Applicable)

Nurse Call System shall be designed for patient in the Hospital to call for assistance in case of emergency and reduce the critical time for receiving medical attention by pressing a button which shall be located on the bed side of the patient.

Individual Nurse Call System shall be installed for the following areas:

- Patients rooms (Separate system for each Nurse Station)
- Intensive Care Unit
- Coronary Care Unit
- Patients Wards

PATIENTS ROOMS

The system shall have patient bed side display control unit which shall consist of the following:

- i. Wired remote hand set at the patient bed side with a green indicating lamp which shall glow continuously indicating that the system is in working condition and this green lamp shall also help the patient to locate the remote hand set during night.
- ii. Push button for medical assistance required by the patient which when pressed shall put off the green light and a red light which shall be located near the call acknowledge push button shall start flashing light. Also, there will be an audible beep to indicate that a call has been made.
- iii. Calls acknowledge push button which shall be operated by the nurse from the patient bed side control console to call Ack mode. At this time, patient's bed side panels beeps twice & the red light turns amber.
- iv. Staff call button at the patient console shall be provided for calling of additional help by the nurse without leaving the patient unattended.
- v. There shall be an indicating light at the entrance of the patient room, towards the corridor to enable the nurse/ doctor to identify the patient requiring assistance without going back to the nurse station for confirmation.
- vi. In the patients toilet there shall also be an emergency call point and a indicating light at the entrance of the toilet towards the room.

CENTRAL DISPLAY AT THE NURSE STATION

At each nursing station the Central Display Unit shall indicate all the patient; bed numbers under the care of that nursing station in the form of one green light for each bed indicating that the system is functional. When a patient shall press the "Nurse Call" button at the bed side from his/ her room, the respective green light at the central display shall go off and the associated red light shall start flashing at the Nursing Station display, at the entrance of patient's room and at the toilet entrance. Audio alarm shall also start to attract attention of the Nursing Staff. This audio alarm shall have a volume control for adjustment of the sound level for the day (high level) and the night (low level) operation.

The system tests itself continuously and if any console is not working, it is indicated on the Nurse's Panel.

The system shall be digital and all console shall be aesthetically pleasing and shall blend with the interiors. All operations at the bed side shall be isolated low DC voltage and with very low current consumptions for the safety of the patient.

The nursing station console shall have the following features:

- Modular construction, table mount, main body to be made of non-corrosive metal or synthetic high grade polymeric materials.
- Versatile message display functions using 2 line LCD display with at least 16 digits per line.
- Program protection function in case of power failure
- Battery backup for protection of memory program
- Built in real time clock chip
- Audio visual indication for each patient call
- Provision for acknowledgement of patients call
- Auto revert to alarm condition on non-attending of patient within a fixed time

BEDSIDE INDICATION AND CALL MODULE

This shall consist of a recess wall mountable module having three colour indications, input jack for connecting hand module, reset button.

HAND MODULE

The hand module shall have an extension cord for being used by the patient lying on the bed. This module shall have a provision for call and reset/ cancel.

TOILET CALL MODULE

Toilet call modules shall comprise of recess mountable modules having provisions for emergency call from the toilets and provision for reset.

CORRIDOR INDICATION MODULE

Corridor indication module shall be three colour. (Red, Amber & Green) indication recess mountable plates to indicate the status of the patients calls to be fixed outside each room door in the corridor.

CHAPTER H

TECHNICAL SPECIFICATIONS FOR D.G.SETS

1.0 SPECIAL CONDITIONS OF CONTRACT FOR D.G.SETS

DRAWINGS

The drawings, specifications and bill of quantities shall be considered, as a part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice-versa, shall be executed as if specification called for in both. The contract drawings indicate the extent and general arrangement of various 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 Employer's / Consultants decision with regard to the quality of the material and workmanship will be final and binding, any material rejected by the Employer / Consultant shall be immediately removed by the Contractor from the site. The Employer / Consultant 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 form 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- 500 KVA/200KVA

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
500 KVA/200KVA	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) 500 KVA/200KVA
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 Client 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 client 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 client.

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)

- a. 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:

$$\text{Rated output voltage} + 1 \text{ Mega Ohms}$$

$$1000 + \text{Rated output in KVA}$$
- 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 EPDN 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) 500KVA/200KVA(As per BOQ)		Project: CGHS,RK Puram New Delhi.	
		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:
		Format no:	
		Page 1 of 2	

Technical Data Sheet Diesel Generator (Engine) 500KVA/200KVA(As per BOQ)		Project: CGHS, RK Puram New Delhi.	
		Date:	
S.No.	Item	Data	
1	Serial		
2	Make		
3	Model		
4	Manufacturer		
5	BHP	@ 1500 rpm	
6	Starting Torque		
7	Type of Cooling	Heat Exchanger	
8	Specific oil consumption	gm / BHP / HR & __ litres/hr.	
9	Lube oil consumption		
10	Efficiency & losses at 0.8 p.f.		
a)	1/4 th Full load		
b)	½ th Full load		
c)	¾ Full load		
d)	Full load		
11	Day oil tank	_____ LTR	
12	Lube oil tank	_____ LTR	
13	Temp. De-rating factor		
14	Altitude De-rating factor		
15	Noise level at 1 Mtrs.		
16	Vibration		
17	Emission Level		
18	Exhaust pipe diameter & Nos.	_____ mm dia.	
Prepared by:		Name :	Date:
		Format no:	
		Page 2 of 2	

CHAPTER 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 FACP's 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 2		5 4	4 3	8 6	7 5						
16	7 / 1.70					2		4	3	7	6				
25	7 / 2.24							3	2	5	4	8	6	9	7
35	7 / 2.50							2		4	3	7	5	8	6
50	7 / 3.0 Al 19 / 1.80									2		5	4	6	5

Note 1: Cu – applicable to only copper cable; Al – applicable to only Aluminium Cable.

Note 2: The table shows maximum capacity of conduits for the simultaneous drawing of cables. The columns headed 'S' apply to straight runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from straight by an angle more than 15°. The columns headed 'B' apply to bent runs of conduit, which deflect from the straight by an angle of more than 15°.

Note 3 : In case of inspection type draw in box has been provided and if the cable is first drawn through one straight conduit, then through the draw in box and then through the second straight conduit such system may be considered as that of straight conduit even if the conduit deflects through the straight by more than 15°.

Table 1/2

Maximum Number of single core 1.1 KV cables that can be drawn in Rigid Non-Metallic Conduits

Size of cable sq. mm 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		2	5	9	11	

	7/1.06 Cu						
10	11 /3.55 Al 7/1.40 Cu			4	7	9	
16	7/1.70			2	4	5	12
25	7/2.24				2	2	6
35	7/2.50					2	5
50	7/3.0 Al 19/1.80					2 2	5 3

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable.

Table No. 1/4

Colour Coding for Conduits in Wall entry

Conduit For	Colour
Light/ Power Circuit	Black
Security wiring	Blue
Fire Alarm wiring	Red
Low voltage circuits	Brown
UPS circuits	Green

Table 1/5

Colour code of Wires

Type	Colour
Phase	Red, yellow, Blue
Neutral	Black
Earthing	Green

B. Wire:

All fire alarm system wiring must be new, unless specified herein.

Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 1.5 sq.mm. for initiating device circuits and signaling line circuits for notification appliance circuits.

All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

Wiring used for the signaling line circuit (SLC) shall be twisted and shielded and installed in conduit unless specifically accepted by the fire alarm equipment manufacturer.

All field wiring shall be completely supervised.

2.3 FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:

2.3.1 The Fire Alarm Control Panel shall be as per Section 7.33 of IS: 2189.

2.3.2 Each network FACP shall contain a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices.

Each FACP on the network shall perform the following functions:

1. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
2. It shall supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.
3. It shall detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
4. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
5. When a any of the following condition is detected and reported by one of the system initiating devices or appliances:
 - i. Fire Alarm Conduits
 - ii. Trouble Confirmation
 - iii. Supervisory Card
 - iv. Security Alarm
 - v. Pre Alarm

Then the following functions shall immediately occur:

- a. The FACP alarm LED on the FACP shall flash.
- b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
- c. The 640-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
- d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

2.3.3 General FACP Configuration & Operation

- a. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit 640 character Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
- b. All programming or editing of the existing programming in the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
- c. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.
- d. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.
- e. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.
- f. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

The FACP shall be able to provide the following software and hardware features:

1. Pre- Signal and Positive Alarm Sequence: The system shall provide means to cause pre-alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-Second time period for acknowledge an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.
2. Smoke Detector Pre-Alarm indication at control panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-Alarm indication shall be available at the control.
 - i) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
 - ii) Action: if programmed for action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition, Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.
3. The system shall be integrated with P.A. System Car Calling system for Emergency evacuation under fire.
4. Each FACP node shall be capable of providing the following features:

- a) Block Acknowledge for Trouble Conditions.
- b) Rate Charger Control
- c) Control-By-Time (Delay, Pulse, time of day, etc.)
- d) Automatic Day/Night Sensitivity Adjust (high/low)
- e) Device Blink Control (turn of detector LED strobe)
- f) Environmental Drift Compensation (selectable ON or OFF)
- g) Smoke Detector Pre-alarm Indication at Control Panel
- h) NFPA 72 Smoke Detector Sensitivity Test
- i) System Status Reports
- j) Alarm Verification, by device, with tally
- k) Multiple Printer Interface
- l) Multiple CRT Display Interface
- m) Non-Fire Alarm Module Reporting
- n) Automatic NFPA 72 Detector Test
- o) Programmable Trouble Reminder
- p) Upload/Download System Database to BMS
- q) One-Man Walk Test
- r) Smoke Detector Maintenance Alert
- s) Security Monitor Points
- t) Alpha-numeric Pager Interface
- u) On-line or Off-line programming

The configuration features & peripherals of FACP shall be given below:-

Doc1	Standard Data Sheet
Item	Floor Fire Alarm Panel
Purpose	Automatic fire detection and alarm
Interconnection	Peer to peer networked floor Panels
Type	Solid state micro-processor based analogue addressable
Loop capacity	6 Loop card slots
	Loop cards as per floor requirement
Compatibility	Photo electric smoke sensors Loop isolators Loop sounders Loop manual call points Loop input monitoring cards RS 485 cards for networking & RS 232 cards for printer & CRT Convention devises
No of devices	Each loop shall be able to cater to minimum 127 devised upto 199 devices Zone 50
Operation Voltage	15 V to 28 V DC, 3 amps
Input Voltage	230 V AC, 1 Ph 50HZ, 0.75 amps.

Stand by battery charging	28 V DC, 1.5 A
Wiring	2 core 1.5 mm 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 membrance switch keyboard
	1 set control switches
	1 set operator push buttons
	Loop cards
	Remote terminal unit connection port
	LCD display & driver module
Connectivity	To proprietary protocol compatible to analogue addressable detectors of type

LCD display	4 X 160 character alpha numeric LCD auto back-lit with occurrence of event or manual override
Display Format	Alarm/pre-alarm/fault/isolation
	Alarm & event acknowledge
	Commands/report/programming
	Time/day/date
Power supply	SMPS
Back up power supply	As per clause 7.5 of IS 2189
Power pack	SMF lead acid / Nicd 24 V DC 30 AH
Test features	Panel self test
	LCD test
	Fault test
	Detector test
	Battery fault
	Internal hooter test
	External hooter test
Control facility	Scroll/next
	Alarm silence
	Fault silence
	Lamp evacuate
	System reset
	LCD back Lighting
	Trouble Silence
Indications	System normal
	Priority 1 Alarm
	Priority 2 Alarm
	Fault
	Alarm Silence
	Power ON
	Battery ON
Event report	Type
	Address
	Location
	Time/day/date
	Date
	Time
Zone recording	In order of occurrence regardless of alarm priority
	Print Interrupt of occurrence of fresh event & on its record resume print
Testing facility	Possible with digital and analogue input and output digital simulation from panel through software
	Under maintenance mode testing possible with balance system in normal operation
Fire pattern	No alarm issue for short duration
	Quick response for fast smoke build up
	Early detection and suitable modification for of alarm level for dirt accumulation
	Programmed output actuation
	Access protection through 4 levels of pass words

	Hardware security lock
	Detector sensitivity adjustment and display of set value
	Disable/isolate detectors/ interface units
	Single button operation front panels keys
Software facility	Individual detector
	Sensitivity setting
	Trending
	Adjustable dual alarm thresholds
	Pre alert warning
	Cross zoning
	Alarm verifications
	Input/ output assignment
	Event history indexing
Local Sounder	Yes
Panel Sounder output	1 no. rated for 1 Amp.
Surge withstand	As per IEEE 472 for mains, input/ output/loops, 7 kv discharge on panel electronics except LCD display
Ambient	From (-) 5 deg. C to (+) 45 deg C Max.
Humidity	15% to 95% non condensing
Mounting	Wall/ floor
Enclosure	1.6mm sheet steel, dust and vermin proof to IP 55
Enclosure treatment & painting	Degreased, de-rusted, pickled, rinsed, phosphattized, putty finished. Double primer and final epoxy painted FIRE RED shade
Front doors	Hinged and lockable with transparent visor for viewing LEDs etc.
Cable Entry	From both top & bottom, through 2 mm thick removable gland plate

2.4 Network Repeater Panel (NRP)

A network control annunciator shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all possible points on the network.

Network display devices which are only capable of displaying a subset of network points shall not be suitable substitutes.

The NRP shall include a minimum of 640 characters, backlit by a long life, solid state LCD display. It shall also include a keypad. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a back box designed for this use.

The NRP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NRP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

For time keeping purposes the NRP shall include a time of day clock.

The configuration, features & peripherals of the Repeater panel shall be given below:-

Doc 2	STANDARD DATA SHEET
Item	Network Repeater Panel
Purpose	Repeat indication
Compatibility	With networked analogue addressable floor fire alarm panel through proprietary communication protocol
Type	Solid state micro-processor based
Communication	By 2 core RS 485 twisted pair screened with networked floor fire alarm analogue addressable panels
Distance maximum	Up to 2 Km from nearest networked floor addressable fire alarm panel. Connection to system by tee off / spur / daisy chained
Power Supply	From power supply unit or from nearest floor addressable fire alarm panel.
Operating Voltage	15 V to 28 V DC
Monitoring	Panel power disconnection
	Floor / Loop / Zone indication LEDs (50 nos)
	Select keys for point addresses in display zone
	Fire
	Fault
	Disabled
	Accept / Reset / Silence / Sound alarm
Power consumption	Control key for current Fire / Fault / Disabled status
	100 mA mains fail state
	250 mA nominal
	350 mA max. draw
LCD display	Back lit, Alphanumeric, 4 line 160 character display
Data interface	RS 485 serial bus driver board
Mounting	Suitable for both surface & recess mounting
Enclosure	1.8 mm sheet steel, dust and vermin proof
	Hinged lockable double door
Ambient	From(-) 5° C to (+) 45° C Max
Humidity	15 % to 95 % non condensing
Paint	Degreased, de - rusted, pickled, rinsed, phosphatized epoxy painted in FIRE RED paint
Local sounder	Yes

2.5 Network Control Station (As required)

The NCS shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.

The PC for NCS (Network Control Station) shall be provided by the client/other Vendor.

The NCS shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400MHz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200 watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.

The NCS shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.

The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)

The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.

The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu:

- a) An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles.
- b) A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable.
- c) A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed.
- d) A Disabled Device window that shall contain all disabled devices in the system.

The NCS shall have the option, from a Windows pull down menu, to connect to a third party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.

The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in.

The NCS shall include help screens, available to aid the user without leaving the selected application screen and shall have a table top hardware configuration.

The NCS shall include an industry-standard EIA-232 port for a UL864 listed printer.

The NCS shall meet FCC regulations (Part-15, subpart-J) regardless of its connection means to the network and shall be UL-Listed for fire protection (UL864) and burglary (UL1076).

2.6 Water flow Indicators:

Water flow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.

Water flow Switches shall have an alarm transmission delay time, which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.

All water flow switches shall come from a single manufacturer and series.

Water flow switches shall be provided and connected under this section but installed by the mechanical contractor.

Where possible, locate water flow switches a minimum of one (1) foot from a fitting, which changes the direction of the flow and a minimum of three (3) feet from a valve.

2.7 Sprinkler and Standpipe Valve Supervisory Switches:

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 25 mm conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

2.8 Non-Alarm Input Operation

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

Combo Zone: - A special type code shall be available to allow water flow and supervisory devices to share a common addressable module. Water flow devices shall be wired in parallel, supervisory devices in series.

2.9 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

2.9.1 Addressable Devices - General

Addressable devices shall use simple to install and maintain decade, decimal Address Switches. Devices shall be capable of being set to an address in a range from 001 to the maximum address provided by SLC loop.

Addressable devices, which use a binary address setting method, such as a Dip switch, are not an allowable substitute.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP Signaling line circuit.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7 or EN 54.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DB minimum, a relay base and an isolator base designed for Class A applications.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (Photoelectric, Thermal& Photo-thermal).

Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

2.9.2 Programmable Electronic Exit Point Directional Sounders

Electronic sounders shall operate on 24 VDC nominal. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device. It shall be capable to broadcast preprogrammed Voice Message also and shall be flush or surface mounted as shown on plans. It shall produce broad-band directional sound to guide occupants to safe exists even in complete darkness.

Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria: The maximum pulse duration shall be 2/10 of one second.

Strobe intensity shall meet the requirements of UL 1971.

The flash rate shall meet the requirements of UL 1971.

2.9.3 Addressable Pull Box (manual station)

Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.

2.9.4 Intelligent Multi-Co-Operative Sensing Photoelectric Smoke Detector (As required)

a. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall be in position to work in advance multi Co-Operative Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density.

b. Photo- electric Fire Alarm detector having photo electric smoke sensor and thermal sensor incorporated and shall send individual smoke sensitivity and temperature operation to panel having following technical specifications: -

- Operating Temperature - 0 to 50°C
- Humidity - 10 to 95%
- Smoke sensor sensitivity - 0.2% to 3.7% per foot of smoke Obstruction
- Smoke sensor Air velocity - 0-610 m/min

2.9.5 Intelligent Thermal Detectors (As required)

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a fixed rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

2.9.6 Intelligent Multi Criteria (Photo- Thermal) Acclimating Detector

The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and

smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

The detector shall have Isolator modules to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the campus.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

2.9.7 Two-Wire Detector Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

2.9.8 Addressable Control Module

Addressable control modules shall be provided to supervise and control the operation of Lifts, sprinkler, switch gears etc., one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.

The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.

The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30V DC.

2.9.9 Addressable Relay Module

Addressable Relay Modules shall be available for HVAC (AHUs & Ventilation Fans) control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

2.10 EXECUTION

2.10.1 INSTALLATION:

- a. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- b. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior

to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

- c. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- d. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

2.10.2 TYPICAL OPERATION:

- Actuation of any manual station, smoke detector, heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:
- Activate all programmed speaker circuits.
- Actuate hooter units until the panel is reset.
- Light the associated indicators corresponding to active speaker circuits.
- Release all magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.
- Where required, return all elevators to the primary or alternate floor of egress.
- A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
- Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.
- Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as appropriate.
- Activation of any sprinkler system low-pressure switch, on valve tamper switch, shall cause a system supervisory alarm indication.

2.10.3 HVAC/Smoke Control System Operation:

- On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan.
- The OFF LED shall be Yellow, the ON LED shall be green, and the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
- Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify

correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

- All HVAC switches (i.e., limit switches, vane switches, etc.) which shall be provided and installed by the HVAC contractor, but the detail of the switches required shall be provided by the vendor for fire alarm system as per the equipment layout in the building.
- It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic annunciators if the project requires such.

2.10.4 TEST

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

- a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- c. Verify activation of all flow switches.
- d. Open initiating device circuits and verify that the trouble signal actuates.
- e. Open signaling line circuits and verify that the trouble signal actuates.
- f. Open and short notification appliance circuits and verify that trouble signal actuates.
- g. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
- h. Ground initiating device circuits and verify response of trouble signals.
- i. Ground signaling line circuits and verify response of trouble signals.
- j. Ground notification appliance circuits and verifies response of trouble signals.
- k. Check alert tone and prerecorded voice message to all alarm notification devices.
- l. Check installation, supervision & operation of all intelligent smoke detectors using walk test.
- m. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- n. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

2.11 FINAL INSPECTION:

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

2.12 INSTRUCTION & SEQUENCE OF OPERATION:

Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

CHAPTER J

TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT TELEVISION SYSTEM & PA SYSTEM

1.0 GENERAL

All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.

All systems and components shall have been thoroughly tested and proven in actual use.

2.0 INDOOR CCTV DOME CAMERA SYSTEM (COLOUR)

The COLOR CCD camera shall meet or succeed the following design and performance specifications:

- a. The CCD camera shall be a 1/3" interline transfer imager meeting CCIR signal format specifications.
- b. The camera shall have factory fitted 3mm lens.
- c. The camera shall be 2:1 interlace, with AC line lock, which is adjustable via remote control.
- d. The image sensor shall have a total pixel array of 811(H) x 508(V) with an effective pixel array of 768(H) x 494(V).
- e. The camera shall provide a resolution of 520 TV lines.
- f. The camera shall provide for automatic electronic iris and a shutter speed range of 1/60 to 1/30,000.
- g. The camera/lens package shall provide for a sensitivity of 1.0lux at F1.4, signal level of 20 IRE, gain high.
- h. The camera shall have a signal to noise ratio of >46dB.
- i. The camera shall have a factory fitted dome housing, which should compliment with the interiors of the building.
- j. The camera shall have PT mechanism and allow panning of 360° C degree and tilting 120 ° C (degree).

3.0 DIGITAL VIDEO RECORDER

- a. The digital recorder shall be 16 channel (with built-in multiplexer) hard disk digital recorder. The digital recorder shall have the capability to record 5 recording resolutions, Fine/ Normal / Basic/ Economy/ Network. The digital recorder shall have the capability to set the following resolutions for the recordings:
 - a. 704x576/ch,
 - b. 704x288/ch,
 - c. 352x288/ch
- b. The digital recorder shall have 16 Video Input terminals (BNC x 16), 1 Video main monitor Output (BNCx1), 1 Monitor 2 output (BNCx1), S-Video output and 1 VGA monitor.
- c. The digital recorder shall have a one-touch operation for Play, Stop, Record and Still. The digital recorder shall have high-speed digital fast-forward and review.
- d. The recorder shall have 4 audio inputs and 1 audio output (RCA x 4 in, RCA x 1out).

- e. The digital recorder shall have a built-in CD-R/RW drive for backing up data to CD-R/RW and a built-in USB terminal for backing up data to a USB memory.
- f. The digital recorder shall have a built-in LAN terminal (100Base-TX/ 10Base-T) for remote viewing by running the utility software (included in the product package) on a specified network.
- g. The digital recorder shall have motion sensor for each of 16 channels.
- h. The sensitivity level can be set to a value between 1 and 9. The lower is the value, the higher is the sensitivity.

The digital recorder shall offer the following search modes:

- EVENT SEARCH
- TIMELINE SEARCH
- T/D SEARCH
- BOOKMARK SEARCH

The digital recorder shall have SSP(RS485) communication for the controller operation and the camera operation.

The digital recorder shall have switching between PAL and NTSC video systems.

The digital recorder shall be no larger than 432 x 98 x 349 mm (W x H x D) and weigh approximately 7.5 Kg (with two HDD units).

The digital recorder shall be CE listed, ISO9001, and ISO14001 certified.

Minimum Performance Specifications

Hard disk capacity	Max HDD capacity (technically) per bay: 540 GB
Compression Method	MPEG4 (video)
Signal format	PAL / NTSC colour signal standard (switchable)
Video Input	16 (BNC x 16)
Main Monitor output	1 (BNC x 1)
Monitor 2 output	1 (BNC x 1)
S-video output	1
VGA output	1(VGA X 1)
Audio input	4 (BNC x 4)
Audio output	1 (BNC x 1)
USB terminal	For Compact Flash reader (Front Panel)
LAN terminal	100BASE-TX / 10BASE-T (RJ-45)
Menu Language	English / French / German / Spanish/ Italian/ Russian/ Chinese/ Polish/ Czech/ Swedish/ Rumanian/ Bulgarian/ Serbian/ Japanese
Picture Resolution	NTSC: 704 x 480, 704 x 240, 352 x 240 PAL: 704 x 576, 704 x 288, 352 x 288
Picture Quality	5 levels (Fine/ Normal/ Basic/ Economy/ Network)
Screen display	1-screen display / 4-screen display / 9-screen display / 16-screen display
Number of cameras	16
Playback	Playback/ still/ search/ Cue/ Review/ Frame advance/ Slow
Backup to USB2.0 memory & CD-RW	JPEG & AVI
Search Mode	

Event Search	Search by event
Timeline Search	Search by calender
Time / Date Search	Search by time and date
BOOKMARK Search	Search by bookmark
Control Signal	
RS-485	Push Lock x 4 terminals
Telemetry control protocol	SSP, PELCO-D, KALATEL, VICON, SENSORMATIC, ELMO
Alarm in	16 inputs
Alarm out	4 outputs
Remote control	IR remote control can control up to 99 units.
Electrical	
Power Source	Input:100V to 127V AC, 4A or 200V to 240V AC, 2A
Power consumption	Max. 90W (HDDx2 and CD-RW)
Operating conditions	Temperature: 5°C to 40°C, [41°F to 104°F], Humidity: 80% or less
Physical	
Dimensions (W x H x D)	432 x 98 x 349 mm (17.0 x 3.9 x 13.7 inch)
Weight	7.5kg (264.6 oz) with two HDD units + built-in CD-RW)

4.0 21" COLOR MONITOR

- The 32" COLOR monitor shall be comprised of a high resolution CRT, and solid state electronics housed in a rugged metal case.
- The 32" COLOR monitor shall meet or exceed the following design and performance specifications:
- The monitor shall provide a 32" picture display, 90 degrees deflection.
- The monitor shall meet CCIR standards.
- The monitor shall feature a display with integral implosion protection.
- The monitor shall provide a minimum of 1000 TV lines resolution at the centre and 800 TV lines at corners.
- The monitor shall feature automatic degaussing circuitry and fast warm up period.
- The monitor shall operate on 230 VAC, 50Hz. Input power and use a maximum of 48 watts.
- The monitor shall provide horizontal within 15% and vertical linearity within 10%.
- The monitor shall accept 0.5 to 2.0 V p-p composite video.
- The monitor shall use internally derived synchronization.
- The monitor shall feature brightness, vertical hold, horizontal hold, contrast and power ON/OFF controls on the front panel.
- The monitor shall provide a video gain of 30 dB.
- The monitor shall provide a terminating slide switch and two BNC connectors, one looping, on the rear.
- The monitor shall be provided with a 6', 3 wire grounded AC power cord.
- The monitor shall be constructed of a black matte, textured coat finished steel cabinet with black plastic faceplate.

- The monitor shall have an operating temperature range of 50 deg. F to 131 deg. F and an operating humidity range of 10% to 95% relative, non-condensing.
- The monitor shall be rack mountable in a standard EIA rack

5.0 SPEAKER CUM HOOTER

- a. A moveable jumper provided should have a choice for high (98 db A) or low (94 db A) outputs.
- b. Speaker cum hooter will be dual transformer speaker capable of operating at 25 and 70.7 Vrms and will have a frequency range of 400 to 4000Hz.
- c. The synchronized speaker should be supplied with "ALERT" (wall orientation) as the standard marking. It should be for indoor and outdoor installation.

6.0 PUBLIC ADDRESS SYSTEM CUM VOICE EVACUATION SYSTEM

- a. The public address system with microphone and amplifier of adequate capacity with 2 Nos. manual selector switches for selecting between: (a) alarm or public address system (b) Alert tones or Evacuation tones to all the channels.
- b. The amplifier shall work on A.C. or 24 VDC power supply separate from that of the fire alarm panel. Master control for adjustment of volumes shall be provided. The amplifier unit shall have complete protection against over loads, short circuits and wrong battery polarity. The amplifier shall have hum and noise level better than 60db.
- c. Speakers with line impedance transformers (at speaker end) shall be connected to amplifier. This will be integrated with panel and shall be capable of announcing pre-recorded messages.
- d. A Message Unit shall be provided having up to 30 seconds of pre-recorded emergency messaging.
- e. The message contained in the message unit shall be recordable in the field.
- f. The Public address system shall be provided with a separate full battery back-up and suitable chart.

CHAPTER K**TECHNICAL SPECIFICATION FOR HVAC****SECTION 1: - SYSTEM DESIGN DATA****A. General:**

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

B. Location:

The proposed CGHS Wellness Centre and Administrative Building at Sector 13, R.K. Puram, New Delhi

C. Scope of works :

The work proposed under this tender includes providing and fixing air-conditioning and ventilation systems for the above work. Providing and fixing at site all main equipment associated with air-conditioning and ventilation for the above.

To execute all incidental work at site including material supply at site associated with the system asked in the specifications.

Nature of such works will be sheet metal ductwork, air distribution devices viz. grilles and diffusers, copper refrigerant piping and its insulation, drain piping etc., incidental civil works, incidental electrical works, cable, control panel etc. at site for all manufactured items at works and also items fabricated at site.

Routine Testing, pressure testing of fabricated components, commissioning of complete plant at site.

Performance testing at site of complete air-conditioning, air-cooling and ventilation system / installations at site.

D. Basis of Design:

Station Name	-	New Delhi- India
Geographic Latitude	-	28.35° North
Geographic Longitude	-	75° 02' East
Geographic Altitude	-	216 metres from MSL
Daily Range	-	25° F
Out side Conditions	Summer	: Dry bulb temperature 43.3°C/110°F Wet Bulb Temperature 23.9°C/75°F
	Monsoon	: Dry bulb temperature 35.0°C/95°F Wet Bulb Temperature 28.3°C/78°F
	Winter	: Dry bulb temperature 7.2°C / 45°F Wet Bulb Temperature 5.0°C / 41°F
Inside Design Conditions :		23±1°C and RH 55-60% in summer and monsoon 22±1°C and RH 40-50% in winter

Lighting Load	:	2 watts / ft2
Roof Insulation :	All the exposed roof to be insulated with 50 thick expanded polystyrene insulation / or equivalent insulation	
Toilets ventilation	:	10 air changes per hour
Basement ventilation	:	12 air changes per hour (normal operation) 30 air changes per hour (in case of emergency/fire)

Based on the above parameters the estimated Air conditioning load/requirements of various area/floors is tabulated as below. :

Areas to be air-conditioned :

S. No.	Area Description	Area in ft2	TR
1	Upper Basement	250	3.0
2	Ground Floor	8451	58
3	First Floor	8209	46
4	Second Floor	8405	45
5	Third Floor	7415	48
	Total	32730 ft2	200

Areas to be ventilated:

S. No.	Area Description	Area in ft2	
1	Upper Basement	17000	
2	Lower Basement	17000	
	Total	34000 in ft2	

Proposed air-conditioning System :

The total air-conditioning load for the above areas works out to be 201 TR. After considering diversity it is proposed to install central chilled water air-conditioning system (water cooled type) to provide year round thermal environmental control for the above areas. It is proposed to use 2 Nos. 190 TR Cooling Capacity water cooled Screw compressor type water chilling Machines (one standby) with 3 nos. chilled water primary pumps (one stand by) , 3nos chilled water secondary pumps with VFDs (one standby) & 3 nos .condenser water pumps (one standby), 3 nos. Cooling Towers (one standby).Air Handling Units and Fan coil Units as per the requirements at various floors/areas and as shown in the HVAC drawings and schedule of quantities.

The plant shall be installed at the Plant space allocated at Basement and chilled water from this plant shall be supplied to various AHUs at different floors as per requirements and as shown in the drawings. The system shall be complete with electrical panel boards, power cabling, control cabling, earthing and controls.

SECTION 2: -Water Chilling Screw Compressor Type Chilling Machines**1. General:**

The contractor shall furnish and install where indicated on plans water chilling machines. Each machine shall be guaranteed by chilling machine manufacturer to produce a capacity of not less than specified tons of refrigeration at specified water temperatures. The construction and rating of the chilling machines shall be in accordance with latest ARI standards 590 and shall comply with ANS B9.1 safety code, national electric code and ASME code necessary 3 phase /50 Hz/450 Volts A.C power supply shall be made available to all units.

Each water chilling machine shall be standard cooling model type and shall comprise of following

- a. Rotary Screw compressors (minimum two) along with motor.
- b. Condenser with accessories and controls.
- c. Chiller with accessories and insulation.
- d. Steel structure as required for assembling/mounting the above.
- e. Microprocessor based control panel with automatic control/display.
- f. Accessories as specified/required
- g. Interconnecting Refrigerant Piping.
- h. Full Charge of Refrigerant R-134a and oil.
- i. Close transition type Star Delta Starter.
- j. COP of the chilling machines shall be min 5.79 and NPLV and IPLV shall be 0.45 & 8.27 respectively. ARI selection sheets shall be submitted for the same for approval of client/Engineer-in-charge.
- k. The chiller shall be supplied with BMS compatible communication card with Bacnet/Modbus/Lonwrks protocol and shall comply with ECBC/NBC and green building norms.

Compressors:

Each unit shall have at least two rotary screw compressors. The compressors shall be mono/twin screw design. The compressors used shall be manufacturers own make to guarantee long term spare parts availability/supplies. The compressors shall be manufactured from forged steel. The profile of Screws shall permit safe operation up to a speed of 3000 rpm for 50 Hz operation. The compressor housing shall be high grade cast iron, machined with precision to provide a very close tolerance between rotor and housing.

The rotor shall be housed on ant friction bearings designed to reduce friction and power input. There shall be special bearings to handle radial and axial loads. There shall be a built in reservoir to ensure full supply of lubricants to all bearings and check valve to prevent spin during shut down. There shall be oil sump or other means of forced lubrication of all parts during start up, running and coasting for shut down. An oil heater shall be provided in casing. The unit shall be complete with capacity control mechanism between 20% and 100% of capacity range.

An oil seperator shall be included to remove oil from the refrigerant and there shall be suitable heat exchanger for oil seperator if required.

The driving motor of the compressor shall be suitable hermetic type as required protected against damage by means of built in protective devices.

Condenser/s :

Each unit shall have one/two horizontal shell and tube water cooled multi pass condenser fitted with safety devices. The shell shall be of welded steel construction fitted with machined steel tube sheets on either end. The tube shall be of at least 19 mm O.D. of seamless copper with integral fins. The tube shall be supported in the shell to avoid noise and vibrations and the end shall be properly expanded in the tube sheet to prevent leakage of refrigerant gas. The water heads shall be of lubricated steel, easy to remove with suitable baffles for multi pass water flow in and out connections and gaskets to prevent leakage.

The condenser shall be tested against leaks with a pressure of 15.8 Kg/cm²(225 PSIG) on both shell side and water side.

The condenser shall be complete in all respects and shall include support for mounting, refrigerant in and out connections, water in and out connections, relief and purge valves.

Cooler/s :

The cooler shall be flooded shell & tube type with steel shell and seamless copper tubes. The refrigerant head shall be removable type. The tube shall be supported in shell with adequate stiff supports to eliminate noise and vibration. The tube ends shall be fixed firmly into the tube sheet to prevent leakage of refrigerant gas.

The cooler shall be tested and stamped against leaks as per ASME code for the refrigerant being used and otherwise tested and constructed in accordance with ASME / equivalent approved code. The cooler shall be factory insulated with 19 mm nitrile rubber insulation.

Controls:

All the controls shall be factory wired and located in a weather proof enclosure. These shall include fuses, selector switch, oil safety switch, high and low pressure cutouts, interlocks for crankcase heaters and inherent motor protection devices, fan control thermostat, recycling pump down circuit, high discharge temperature cutout indicator lamps shall be provided for the compressor units. Necessary starters for compressor motors shall be included and provided within the unit. The compressor and condenser fans shall be electrically interlocked such that the compressor can run only when at least one of the condenser fans are running.

The water chilling machine shall be complete with microprocessor based control system which shall have the following features.

Electronic/float type expansion valve for economic operation of the system.

Self diagnostic capability to locate faults and give early warning.

Leaving chilled water Temperature control and reset capability with provision to accept override command from IBMS.

Automatic sequencing of various functions of starting, running and stopping of the various components of the unit based on the demand.

A programmable microprocessor with key pad and led display window to perform the above functions.

The control package shall also consist of but not limited to the following components.

Low control voltage to unit.

Field power and control; circuit terminal blocks.

On./Off switch

Replaceable relay board.

Leaving chilled water set point board.

Diagnostic digital display module.

Microprocessor board

Temperature reset board

The control system shall have an extended module for control and monitoring from a control location including the reset of chilled water temperature.

Refrigerant Circuit :

The refrigerant piping between the compressor, chiller and condenser shall be of heavy gauge copper with brazed joints. The circuit shall include site glass, moisture indicator, solenoid valve, electronic/float type expansion valve filter drier and necessary shutoff valves with charging connections.

Tests at Factory :

At least one chiller shall be tested on ARI certified test bed at 100%, 75%, 50% and 25% load at the manufacturers works and shall be witnessed by clients representative along with the consultant at factory. The cost of the same shall be included in the chilling machine prices.

Limitations :

The water velocity in the cooler shall not exceed 10 FPS(3m/s).The fouling factor for cooler shall be 0.0005 FPS Units and for condenser it shall be 0.001 FPS Units.

SECTION 3:- Cooling Towers

1. General

The various items of cooling tower shall be complete in all respect and comply with the specification given below:

2. Cooling Tower (FRP Construction)

The cooling towers shall be of FRP, vertical induced draft type complete with FRP body, fan, motor and starter assembly, fill media, distribution pipes, concrete-steel foundations, etc.

2.1 General Construction

The body shall be made of FRP (fibre glass reinforced plastic) sections of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 160 KM/HR., vibration and earthquakes.

The water basin shall also be of FRP having an auxiliary suction tank, at the bottom. The basin shall be complete with connections for drain, overflow, make up water, quickfill and float valve plus hot dipped galvanised suction strainer.

The support structures for the tower shall be of mild steel duly hot dipped galvanised.

2.2 Water Distribution System

The hot water shall be distributed through a gravity system having a uniform slash through removable nozzles placed at the floor of basin. It should provide full coverage of fill hot water basin suitably covered with GRP sheet to eliminate algae formation.

2.3 Fan Assembly

The fan shall be of axial flow type with cast aluminium multiple blades of aerofoil design and adjustable pitch. The fan assembly shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 10 M/S and the tip speed shall be below 4500 m/min.

The fan motor shall be totally enclosed fan cooled squirrel cage type conforming to I.P.55 for outdoor operation. The fan guard shall be hot dipped galvanised.

The total sound intensity with all fans in operation shall not exceed 75 db at a distance of 15 meters from the nearest face of tower.

2.4 Ladder

All towers, whose height exceeds 2.5m, shall be provided with a ladder, made out of hot dipped galvanised M.S. tubes and with a safety cage and hand railing.

2.5 Accessories

Each cooling tower to include:

- i) Valve at make up, quick fill, make up float valve and drain valve.
- ii) A hot water bleeds connection to the drain line through a stop valve.

2.6 Testing

Tower performance curves shall be furnished. Acceptance test to demonstrate the performance of the installed cooling tower shall be conducted in accordance with the current ASME power test code for the atmospheric water cooling equipment and test result shall show tower capacity (computed from the performance curves) within $\pm 5\%$ of the specified capacity at the designed W.B.

SECTION 4:- AIR HANDLING UNITS / FAN SECTIONS/ AIRWASHERS

1 SCOPE

The Scope of this section comprises the supply, erection, testing and commissioning of double skin Air Handling Units conforming to these Specifications and in accordance with requirements of drawings and schedule of quantities.

2 TYPE

The Air Handling Units shall be of floor mounted or ceiling suspended draw through type having sections such as filter section with pre-filters and fine filters as required under BOQ, cooling coil section with suitable chilled water cooling coil, fan section with fans, mixing section where required under BOQ, humidification section with centrifugal fan as per schedule of quantities and arrangement shown on the drawings.

3 CAPACITY

The air moving and coil capacities (Air Conditioning Load) shall be as shown in Schedule of equipment and quantities and on drawings.

4 CASING

The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total/ semi knock down conditions

depending upon the conditions. The frame work shall be of extruded aluminium hollow sections with thermal break profile fitted with pre-formed insulated sections. All the members shall be assembled thru mechanical joints to make a sturdy and strong frame work for various sections. Casings should be as per D1 of class EN 1886 air leakage as per class L1 of EN 1886, thermal bridging of minimum TB2 class and thermal transmittance of minimum T2 class as per EN 1886.

Double skin panels (each not exceeding 750mm wide) shall be made of 22G pre-coated Galvanised sheet steel and 22G galvanised sheet inside with pressure injected PU foam insulation of 25mm thick X 38 Kg/Cu.M in between, these panels shall be with thermal break barrier also. The panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with powder coated hinges and latches shall be provided for access to various panels for maintenance.

The fan and the motor arrangement and the entire AHU housing shall be mounted on to the extruded aluminium base or galvanized steel channel frame work depending on size.

Drain pan shall be constructed of 16 SS sheet having 12 mm thick 32 Kq/Cu. XPE insulation. The pan shall have necessary slope to facilitate for fast removal of condensate.

5 **MOTOR AND DRIVE**

Fan motors shall be 230 \pm 10% volts 50 cycles 3 phase totally enclosed fan cooled with IP-55 rotation. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement. Belts shall be of oil-resistant type. Adjustable sheaves shall be provided. Frequency converter shall be supplied by the manufacturer for all AHUs in case if the contractor opts for direct driven motors in that case the scope of VFDs from IBMS shall be deleted and AHUs shall be supplied with factory fitted VFDs on these AHUs. All motors shall be EFF1 only.

6 **FAN**

The fan shall be centrifugal backward curved double inlet double width type or plug fans complete with motor and drive package to give maximum efficiency for given duty conditions. In case of Plug fans the entire fan with casing will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent / AHRI or AMCA and entire fan and motor assembly shall be balance at manufacturer's works before dispatch. Computerized fan selection sheets shall be submitted for approval by consultants/clients.

The wheel and 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 and pillow block heavy duty ball bearings. The fan shall be selected for a speed not exceeding 1000 RPM. The fan outlet velocity shall not be more than 1800 fps for floor mounted AHUs. Fan housing with motor shall be mounted on a common steel base mounted inside the AHU on anti vibration springs or cushy foot mount. The fan shall be direct driven type. Another fire retardant canvas connection shall be provide at unit outlet to connect the ducts.

7. **Cooling Coils :**

The cooling coil shall be seamless copper tubes not less than 0.437 mm thick and 12.5 mm O.D to 15mm O.D. The coil shall have continuous aluminium fins. The tube shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube. The coil shall be tested against leaks

At a hydraulic pressure of 21kg/m³ for a period of two hours. The water headers shall be of copper pipes to connect all the tubes. The header shall be complete with water In/Out connections, vent plug and drain at the bottom and designed to provide a water velocity between 0.6 to 1.8 m/s (2 to 6 FPS)

8. Filters:

As asked for under Bill of quantities.

9. Electrical Panel:

Each unit shall have its own electric panel consisting of MCCB / fuse switch unit, starter, indicating lamps, incoming/outgoing internal and external wiring and earthing as per the details in BOQ.

10 Fresh Air Control:

An adjustable opposed blade damper of aerofoil aluminium sections with bird screen, air inlet louvers and air filters shall be provided for fresh air entry. The damper shall be sized for 50% of designed air quantity.

11 Limitations:

The air velocity across the cooling coils shall not exceed 500 fpm.

The fan outlet velocity shall not exceed 9m/s in any case floor mounted AHUs.

The fan outlet velocity shall not exceed 11m/s in any case ceiling suspended AHUs.

The velocity across the filters shall not exceed 500 fpm in any case.

SECTION 5:- FAN COIL UNITS

1 General

The fan coil units shall be ceiling mounting box type complete with finned coil, fan section with motor, insulated drain pans, cleanable air filters and fan speed regulator and other controls as described.

2 Cooling and heating Coils

The coil shall be of seamless copper tubes not less than 5/8" O.D, 0.56 mm thick. The coil shall have aluminium fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 M/S (6 FPS) the fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes.

The coils shall be tested against leaks at a hydraulic pressure of 10 kg/sq.cm. This pressure shall be maintained for a period of 24 hours. No drop should be observed indicating any leaks.

3 Fan

This shall consist of (2) two light weight aluminium impellers of forward curved type, both statically and dynamically balanced, along with properly designed G.I. sheet casings.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at (3) three speeds.

A G.I. plenum shall connect the fan outlets to the coil.

4 Drain Pans

The drain pan shall be sandwich type fabricated out of deep drawn single piece stainless steel sheet, covering the whole of coil section and extended on one side for accommodating coil connection valve, etc. and complete with a 25mm drain connection. The drain pan shall be insulated with 12mm XPE insulation.

5 Air Filter

The filter shall be cleanable type 15mm thick with 90% efficiency down to 20 micron of rubberised coir to be mounted behind the return air grille in the unit casing.

6 Speed Control

A sturdy switch shall be provided with the unit complete with wiring, for off and with minimum (3) three speed control, of the fan.

7 Automatic Controls

Each unit shall have a room type thermostat and water control and balancing valve as asked for in BOQ. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions.

The water valves on inlet line shall be of gun metal ball type with internal water strainers, having BSP (FPT) inlet and flare type MPT outlet connection. The valves on return line shall be as above, but without the water strainer.

8 Water Connections

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300 mm long, type L seamless solid drawn copper tubing, with flare fittings and connections.

SECTION 6:- PUMPS

1. General

The various items of pump shall be complete in all respect and comply with the specification given below:

2. Pump Sets

The pump sets shall be vertical split casing type with end suction and top discharge flanged connections, mounted on drip proof squirrel cage induction motor with suitable starter as specified.

Pumps shall be as per IS: 1520-1960, IS: 9079, IS: 325 and shall be of the following construction:

1.	Casing	Cast Iron/Cast Steel
2.	Impeller	Bronze/ CI with corrocoat
3.	Shaft	High Tensile Steel
4.	Shaft sleeve	SS
5.	Bearings	Heavy Duty Ball/Roller bearings
6.	Base Plate	Cast Iron/Fabricated M.S.
7.	Flanges	BIS 1536/1960
8.	Stuffing Box sealing	Mechanical seal
9.	Max. Speed	1500 RPM/2900 RPM

10.	Drive	TEFC motors EFF 1 motors
11.	Starter	See Section "Electrical Switchgears"

- a) Drive ratings shown are only tentative and Tenderers shall select their drivers at least 5% in excess of the maximum BHP of the pump plus transmission losses, if any. Drivers shall be supplied with starters unless otherwise stated.

3. Accessories & Fittings

The following accessories/fittings shall be provided with each pump among other standard accessories/fittings required:

- i) Lubrication fittings and seal piping
- ii) Test and/or air vent cocks
- iii) Steel channel base frame for fixing pump on the concrete foundation
- iv) Suction and discharge pressure gauges not less than 150mm dia. and of the appropriate rating, with gauge cocks, etc.
- v) 25 mm G.I. gland water drain piping.

4. Installation

Pumps shall be installed as per manufacturer's recommendations. Pump set shall be mounted on concrete block which in turn is mounted on machinery isolation cork or any other equivalent vibration isolation fitting.

Concrete foundation will be made by the Contractor as per approved drawings and specifications and the isolation pad foundation bolts, etc., shall also be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned whenever necessary; site alignment shall be done by competent persons. Before the foundation bolts are grouted and the coupling bolted, the bed plate levels and alignment results shall be submitted to the Engineer.

5. Insulation

Pumps used for chilled water service shall be insulated so that the dismantling of pumps not affected. Insulation shall be provided in a manner so as to minimize the damage to the insulation in case of maintenance of pumps or other components.

6. Testing

Tenderers shall submit the performance curves of the pumps. They shall also be responsible for the selection of capacity and total head requirements of each pump to match his own piping and equipment layout.

On completion of the entire installation, pumps shall be tested for their discharge head, flow and B.H.P. Test results shall correspond to the performance curves.

Tenderers shall furnish the required testing instruments and arrange for their connection as required.

7. Painting

After complete installation and testing, pumps accessories and fittings shall be given two coats of approved finishing paint.

8. Secondary Pumps VFD salient features:

VFDs shall have built in AC chokes for line side protection and harmonic reduction, VFDs shall be provided with I/O expander cards for expanding the input / output requirements. they shall have BMS option cards for integration with IBMS and also shall have pump logic controller for synchronizing the VFDs for pump application.

VFDs shall have pump functions like sleep frequency, wake frequency, dry pump protection, PID controller/built in PLC for performing the pumping functions.

VFDs shall be with 4 line alpha numeric display.

VFDs shall be housed inside sheet steel cubicle panel with associated switchgears like SFU / MCCB/MPCB, contactors, overload relays, indicating lamps, push buttons, selector switches, control transformers, cooling fans along with filters.

The power and control circuit shall be separated to meet the EMI guidelines for the use of VFDs inside the hospital premises.

VFD panel shall be placed near the secondary pumps motor to keep the cable length below 30 m.

Motors used for VFD shall be inverted duty and shall have VPI treatment, insulated bearing housings, EFF 1 class only.

Chilled water Primary Pumps: 7.5 H.P/5.5KW

Chilled water Secondary Pumps: 10 H.P/7.5KW

Condenser water Pumps: 25 H.P/18.5KW

Hot Water Pumps: 5H.P/3.7 KW

SECTION 7:- Ducted Inline Fans

1. General:

The ducted inline ventilation fan shall be complete in all respects and shall generally comply with the following specifications given below:

2. Inline Fans:

2.1 General :

The inline fan shall be complete in all respects and shall comply with the following specifications:

2.2 Fans:

The fan shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators etc.

2.2.1 Housing:

The housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal shall be either spot welded or screwed or mounted together with the rivets. The housing shall indicate arrow showing rotation, make, and model and duty condition.

2.2.2 Fan Wheel:

Fan wheel shall be forward/backward curved type and it shall be statically and dynamically balanced.

2.2.4 Ball Bearing:

The ball bearing shall be completely maintenance free and can be used in any mounting position at maximum indicated temperature. The bearing lubricant shall be suitable for min. ambient temperature of 15C. For applications at max. indicated ambient temperature life expectancy LIO is 40,000 hours minimum.

SECTION 8:- Sheet Metal Work & Air Distribution

1. Scope :

The scope of work shall include supply of factory fabrication of G.I. sheet metal duct and its installation as shown in the relevant duct drawing, testing at site, loading & unloading of G.I. sheet ducts at site, and shifting and other hardware from site stores to exact location inside the office complex. The packing shall be suitable for marine transportation purpose and all other natural disasters and the same shall be transported to respective office warehouses to achieve a guaranteed commercial operation of the same to the entire satisfaction of client.

2. RAW MATERIAL

Galvanizing shall be uniform coating of zinc on both sides (total) of 275gm/sq.m and Lock forming quality prime material along with mill test certificates. 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.

GAUGES, BRACING BY SIZE OF DUCTS

All ducts shall be fabricated from galvanized steel/ aluminum of the following thickness, as indicated as below:

For Rectangular ducts shall with external SP up to 250 Pa (25mm Wg)

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

All transverse connectors shall be 4 bolt slip-on flanges system with built-in sealant.

Duct construction shall be slip-on flange in compliance with 1" (250Pa) w.g. static norms as per SMACNA. Important to note is Slip-on flanges system should have 3rd party testing & certification.

FOR SELECTION OF 4 BOLT SLIP-ON FLANGE CLASS AND DUCT GAUGES AT 1200 MM SPACING						
Duct Dimension	Duct Pressure in Inches / (Pascals)					
	1"(250)*⁵	2"(500) *⁴	3"(750) *³	4"(1000)	6"(1500)	10"(2500)
in(mm)	Reinforcement Class – Duct Gauge					
150 – 250	E-26	E-26	E-26	E-26	E-26	E-24
251 – 300	E-26	E-26	E-26	E-26	E-24	E-24
301 – 350	E-26	E-26	E-26	E-26	E-24	E-22
351 – 400	E-26	E-26	E-26	E-26	E-24	E-22

401 – 450	E-26	E-26	E-26	E-26	E-24	F-20
451 – 500	E-26	E-26	E-24	E-24	E-24	F-20
501 – 550	E-26	E-26	E-24	E-24	F-24	H-20
551 – 600	E-26	E-26	E-24	E-24	F-22	H-20
601 – 650	E-26	E-26	E-24	E-24	F-22	H-20
651 – 700	E-26	E-26	E-24	F-24	H-22	H-18
701 – 750	E-26	E-26	E-24	F-24	H-22	I-18
751 – 900*²	E-26	E-24	F-22	H-22	H-20	I-18
901 – 1000	E-26	F-24	H-22	H-20	I-18	J-16
1001 – 1200	E-24	H-22	H-20	I-18	I-18	
1201 – 1300	F-24	H-20	I-18	I-18	J-16	
1301 – 1500	F-24	H-18	I-18	I-16	NOT APPLICABLE	
1501 – 1800	H-22	I-18	J-16			
1801 – 2100	I-20	J-18				
2101 – 2400	I-18	J-18				
2401 – 2700	I-18					

Notes:

SMACNA- Sheet Metal and Air conditioning Contractors' National Association Inc-"HVAC Duct Construction Standards- Metal and Flexible"- 2005, U.S.A.

For non-critical comfort cooling applications (1" w.g. pressure class), optional "C & S" or "C & SS" cleat joints can be used.

Upto 450 mm duct size use "C & S" cleats.

451 to 750 mm duct size use "C & SS" cleats.

Over 750 mm duct size use 4 bolt Slip-on flanges.

FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1. A coil (Sheet metal in Roll Form) line to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
2. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

3. All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
4. Kitchen exhaust ducting shall be with 16 G MS suitable access doors shall be provided at every 3 m. Provision shall be made for fire fighting agency to install duct mounted sprinklers at every 3m. Generally exhaust duct shall have slop towards kitchen hood.

DUCT CONSTRUCTION

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes:

- a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of quantities. Duct dimension shown in the drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
- b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be air either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- c) All ducts up to 75 cms width within conditioned spaces shall have slip and drive (C&S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken ensure that S/SS cleats are mounted on the longer side of the duct and cleats on the shorter side. Ducts more than 75cms width shall have 4 bolt slip-on flanges. Ducts and accessories within the ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
- d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-vanes shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- e) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall adequately supported and braced where required with standing seams, tees or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
- f) All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed of 18G GSS/16G Aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
- g) Plenums shall be shop/factory fabricated panel type and assemble at site. Fixing of galvanized angle flanges on the duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- h) Self adhesive Polyethylene lining of minimum 4.5mm thickness instead of felt shall be used between duct flanges and between duct supports in all ducting installation.

3. Accessories:

- All dampers, except where shown, shall be louver dampers having multiple opposed blades type or with parallel blades of airfoil construction. The construction of the dampers shall be robust and tight fitting. They should be made from 18 gauge galvanized sheets. The depth should be minimum of 150mm and flanges of 40mm. Blades shall be connected with a suitable linkage for operation by an extending by an extending lever, which shall have a locking quadrant with

positions of the damper indicated on it. Dampers and their operating device shall be made robust, easily operable and accessible through suitable access doors in the ducts.

- Dampers shall be provided in ducts at every branch supply or return air duct connections whether or not indicated on the drawings for the proper volume control and balancing the system.
- Where shown, splitter dampers shall be installed. This damper consists of double thickness airfoil blade hinged on the downstream edge. The operating lever shall extend outside the duct and insulation with an airtight hub and locking arrangements. The thickness of the damper blades shall be the same as the duct in which they are installed but not less than 1.5mm thickness.
- Fire & Smoke dampers shall be motorized type UL Listed with leakage class 2 confirms to UL555 & UL555S standards with Triple V-groove construction wherever specified shall be provide in the ducts to minimize spreading of fire through ducts, i.e. points where duct passes fire (rated 1 ½ hrs. or more) wall or slab. Fire dampers shall have minimum sleeve length of 508mm –and face area as required. The outlet casing of the damper shall be fabricated out of 12 gauges M.S. sheet duly epoxy painted with two coats. The louvers shall be provided with smooth pivoted linkage, tripping mechanism of steel bar with heavy-duty spring assembly and provision of motor. The louvers to be arranged to pivot and hold in an open position and can be closed by an electrically operated motor. The damper is used in conjunction with a smoke alarm system. The entire assembly shall be duly epoxy primer of 2 coats (epoxy paint) or aluminum spray painted. The dampers shall be designed for automatic as well as manual tripping.
- Motors shall be rated for fire damper (spring to close power to open) operation and shall be suitable for outdoor installation (IP55). Fire dampers are closed on a signal from the fire control module. Module supply and wiring by fire control contractor.
- Motorized dampers should be single flap dampers with 18 gauge construction with Belimo or Equivalent make spring return type. Opening time should be more than 75secs. And closing time should be 30secs. The power shall be given from the electrical panel and will be routed through the unit.
- 300mm X 300mm access panels with gasket neoprene and stud bolt type shall be provided near lower dampers/ splitters dampers and fire damper. All main ducting work shall be accessible throughout using tight fitted hinged access doors. Doors shall be cemented sponge rubber gaskets of 6mm thickness. Felt is not acceptable. In the case of insulated ducts with access doors, the same shall be properly insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the ducts when he plant is running.

4. Installation Guidelines

- The duct fabrication and installation shall generally confirm to IS 655-1963.
- All ducts shall be supported from the concrete slab or beams. Duct supports shall be fixed through the use of two anchor fasteners for each leg. The anchor fasteners shall be of approved make. If ducting is supported from steel structure, Beam Clamps shall be provided. In no case shall the duct be supported from the false ceiling hangers or be permitted to rest on a hung ceiling.
- Transverse joints shall be provided with rubber gaskets (6mm thk.) of nonflammable type. Use of felt shall not be permitted.
- Wherever the ducts are acoustically lined, the duct size shall be increased by the thickness of the duct lining.

- The contractor shall provide and neatly erect all sheet metal work as per the specifications and drawings. This work ,in all its parts and details, shall meet with the approval of the Engineer
- The contractor shall make all necessary allowances and provisions for beams, pipes or other obstructions in the ducting, whether or not the same has been shown in the drawings. Wherever necessary to avoid beams or other structural works, plumbing or other pipes / conduits, the ducts shall be transformed, divided or curved to one side as approved or directed by the Engineer. However the required cross-sectional area shall be maintained.
- All metal work shall be done in dead or furred down spaces so as not to cause any delay to other contractors on the building.
- If a duct cannot be installed as shown in the drawings, the contractor shall install the duct between the required points by any path available subject to the approval of the Engineer and Architect.
- All ducts shall be rigid and shall be adequately supported with standing seams, tees or angles of ample size wherever required to keep the ducts true to shape, prevent buckling, vibration and breathing.
- All duct joints shall be tightly fitted using rubber gasket of nonflammable type and all interior surfaces shall be smooth. Bends shall be made with radius not less than one-half of the width of the duct or with properly designed interior curved vanes. Two vanes shall be spaced such that the aspect ratio of each of the individual elbows formed by the vane will be about five to one.
- All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed from 16G galvanised iron thoroughly stiffened with 25mm X 25mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Doors shall not be less than 46 cm X 71cm. Sheet Metal connections to indoor units shall be flexible, double thickness fiberglass cloth or equivalent nonflammable material of 100mm long.
- Where metal ducts or sleeves terminate in woodwork, brick or masonry openings tight joints shall be made by the means of closely fittings heavy flanged collars.
- Resistoflex or similar vibration isolation material of 6mm thickness shall be provided between ducts and duct support.
- Where ductwork is connected to rotating equipment duct such as fans, air handling units (indoor unit of split/package system), the connections shall be made with double thickness nonflammable flexible material, 100mm long.

5. Grilles and Diffusers:

• Supply Air Side Wall Outlets

- Wherever specified in the B.O.Q. shall be in Aluminum construction.

• Double Deflection Grilles:

- Wherever specified in the B.O.Q. shall be in Aluminum construction. Aluminum double deflection grills for supply air shall be provided with vertical and horizontal adjustable bars and an approved blade damper adjustable from the front face of the grille. The grilles will be powder -coated in a shade as given in the schedule of finishes of this handbook.

• Fixed Bar Linear Grilles

Fixed bar grilles will be in extruded aluminum construction. Bars shall be fixed in position using vertical tie bars. Bar spacing shall not exceed 12mm and the grilles shall have 60% free area. Deflection angle of the bars shall be 0. The grilles will be powder coated in a shade as

per the owner/architect. Irrespective of grille finish, vertical tie bars shall be powder coated in Matt black. Supply air outlets shall be provided with volume control dampers to be installed in the duct collar. Dampers shall be in black Matt powder coated finish. Where required by the Architects/Consultants, the grilles shall be provided with a margin on all sides. Supply air outlets shall be provided with end closure pieces for the supply portion of the grille. The end closure pieces shall not come to the grille face.

- Continuous grilles shall butt with hairline joints and be provided with interlocking splines.
- All return air grilles shall be similar and equal to the above as determined by consultants.
- All exhaust air grilles shall be similar and equal to the supply air grilles specified above.

6. Ceiling Outlets:

Square / Rectangular Diffusers: Shall be of aluminum construction wherever specified in the BOQ. Corners of inner and outer cores shall be assembled to provide precise mitered corners. Supply air diffusers shall be provided with multi blade butterfly dampers. Damper flaps shall be provided with a nylon worm gear assembly for ease of operation. Diffusers will be powder -coated in a shade as approved by client/Architect. Diffuser shall be half step down type.

7. Guidelines for Installation of Grilles/Diffusers

Installation of the grilles/diffusers shall be done by the air conditioning contractor irrespective of the type/model of false ceiling systems .The diffusers will have to be individually suspended from the duct and aligned to match the ceiling line level. In case gypsum or any other false ceiling system, all wooden frames, rectangular or circular for supply/return/exhaust air diffusers will be provided by the Air conditioning contractor.

All air outlets/return air inlets in the same room shall be of the same size unless otherwise specified.

Grilles and diffuser samples must be submitted to the consultants for prior approval before procurement and installation.

Wire Hangers shall be used to suspend all static HVAC services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

- a. Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, UL, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
- b. The contractor shall select the correct wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire Hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

Table. 1

Wire (Gripple) Hanger Safe Working Loads		
Size	Minimum breaking load of wire rope	Working load limite (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg/ 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg/ 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg/ 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg/ 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg/ 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg/ 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application; the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. **Comply with manufacturer's load ratings and recommended installation procedures.** Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

Ducting Supports:

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 2000mm centre, for above 2000-2250mm 50x50x5 mm angle should be used under the duct (refer to typical drawings), above 2250mm appropriate size angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection. Support ducting in accordance with Schedule I at the end of this Section. Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting

the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

Piping Supports: Rigid supports may be used in conjunction with Gripple hangers to assist with alignment of services as per the Schedule II. These can be at 30m intervals or so depending on the run of the service. Rigid support must also be used in conjunction with Gripple hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval. Support piping in accordance with Schedule II at the end of this Section.

Duct Hanger Schedule

For ducts with external SP upto 250 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger No.
1-750	26	2
751-1000	26	2
1001-1200	24	3
1201-1500	24	3
1501-1800	22	4
1801-2100	20	4
2101-2700	18	4

For ducts with external SP upto 500 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger No.
1-600 mm	26	2
601-750 mm	26	2
751-1000 mm	24	3
1001-1200 mm	22	4
1201-1300 mm	20	4
1301-1500 mm	28	4
1501-1800 mm	18	4
1801-2100 mm	18	4
2101-2250 mm	18	4
2251-2400 mm	18	4
2401-2700 mm	18	4

Pipe Hanger Schedule

Pipe size	Weight of pipe + fluid	Weight of pipe fluid per Rmt	Spacings (pipe + fluid + insulation)	Spacings (pipe + fluid + plaster)	Total Weight of pipe + fluid	Total Weight of pipe + fluid	Gripple Hanger No.	Gripple Hanger No.
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(mm)	With insulation (kgs/rmts)	With sand cement plaster (kgs/rmts)	Between supports (mts)	Between supports (mts)	With insulation (kgs/rmts)	With sand cement plaster (kgs/rmts)	With insulation (kgs/rmts)	With sand cement plaster (kgs/rmts)
12-32	11.73	14	1.5	1.5	18	21	2	2
40-65	11.73	14	2	2	23	28	2	2
80-125	34.73	41.67	2	2	69	83.34	3	3
150-250	112	134	2	1.5	224	201	4	4
300-350	180	215	1.5	1.5	270	322.5	5	5
400-500	320	383	1.5	-	480	-	6	-
600-above	As per the manufacturer recommendation and with prior approval							

Rigid Supports for pipes to be used in conjunction with wire supports:

Pipe size	Rod size
Upto 12 mm	10 mm
15 to 25 mm	10 mm
30 to 150 mm	10 mm
Over 150 mm	12.5 mm

SECTION 9: - Pipes & Valves:

1. General

The scope shall comprise the supply, installation of pipe, fittings, valves, etc. and testing/balancing of complete system. Pipe sizes shown on drawing are for the guidance of Contractor and shall not relieve Contractor of responsibility of providing smooth, noiseless circulation of fluid.

2. Pipes

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder:

All pipes shall be of schedule 40 thick as per ANSI-B-36.1.

All pipes in sizes upto 150mm dia shall be M.S. ERW pipe heavy class as per IS: 1239-Part-I (as per latest amendment).

All pipes in sizes 200mm and above shall be M.S. ERW pipe heavy class as per IS: 3589 (as per latest amendment).

3. Fittings

The dimensions of the fittings shall conform to I.S. 1239-Part-II (as per latest amendment) unless otherwise indicated in the specifications.

All bends in sizes upto and including 150mm dia. shall be ready made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200mm and larger dia. shall be fabricated from pipes of the same dia. and thickness with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

All fittings such as branches, reducers, etc. in all sizes shall be fabricated from pipes of the same dia. and thickness and its length should be at least twice the dia. of the pipe.

The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by Engineer-in-Charge.

Blank ends are to be formed with flanged joints and 6mm thick blank between flange pair for 150mm and over in case where, a future extension is to be made, otherwise blank end discs of 6mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm x 5mm heavy angles.

4. **Flanges**

All flanges shall be of mild steel as per IS:6392/71 and shall be steel slip-on-type, welded to the pipes flanges thickness shall be to suit class-II pressures. Flanges may be tack welded into position, but all final welding shall be done with joints dismantled. 3mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre reinforced rubber as approved by the Engineer-in-Charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows:

Counter flanges for equipment having flanged connections.

Flanged pairs shall be used on all such equipment, which is required to be isolated or removed for service e.g. pumps, refrigeration machines, air handling units, etc.

All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connection, for removal of valves from main lines for repair/replacement.

5. **Valves**

a) **Butterfly Valves, Gate Valves, Balancing Valves , Check Valves and Ball valves :**

All gate valves, balancing and check valves upto and including 40mm dia. Shall be of gun metal screwed type, conforming to class 1 of IS:778.

All butterfly valves of 50mm dia. and above shall be flanged type, have cast iron body with black nitrile rubber seat and conforming to class PN-16 of IS:780 (for sizes upto 300mm) and of IS:2906 (for sizes 350mm and above).

All balancing and check valve of 50mm dia. and above shall be flanged type in cast iron construction and conforming to class PN-16.

All ball valves body shall be made of hot pressed brass CuZn40Pb2 and nickel plated. Ball shall be brass hard chrome plated, Handle shall be dacromet rugged steel with PVC grip.

Air valves/vents shall be provided at all higher points in the piping system for venting as per the sizes shown in the BOQ.

All air needle valves shall be of gun metal and tested upto a pressure of class 1 pressure rating. All globe valves of size 50mm and above shall be of rising spindle type.

b) **2 WAY MODULATING / PRESSURE INDEPENDENT BALANCING AND CONTROL VALVE for- AHU's & FCU's**

A pressure independent balancing and control valve is a self balancing, pressure independent, 2-way control valve with 100% authority on the control valve. It can be fitted with an actuator to accept input signals from the control system.

Each Air Handling Unit / Fan Coil Unit shall be provided with a 2-way Pressure Independent Balancing and Control Valve. The control valve should be a globe type.

Regarding control – The response characteristic should be independent of pressure and. A differential pressure controller should ensure 100% valve authority at all loads and all settings.

Regarding Balancing – Each Valve should have a precisely adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and the system can still function as designed.

All Valve actuators should be microprocessor based with a self calibrating feature to adjust to any valve travel or setting with full control range.

The valve should have a linear characteristic and the actuator should have a function that can convert it to a logarithmic characteristic to ensure that the valve-actuator combination can be used for all applications.

Minimum required differential pressure should not exceed 20 kPa for fan coil units DN32 and not exceed 30 kPa for air handling units to minimize pump head requirements,

The valve should be equipped with an electronic modulating actuator which can accept either “4(0)-20 mA / 2(0)-10 V DC signals. Operating voltage for actuator shall be 24V AC. The actuator shall be able to close against maximum differential pressure of 6 Bar

VALVE SPECIFICATIONS

Discription	For 15 to 32 mm	For 40 to 150 mm
Diff Pressure (P1-P3)	16 To 600 kPa	30 To 600 kPa
Media Temperature	-10 ° to 120 °C, -... ° to 248 °F	-10 ° to 120 °C, -... ° to 248 °F
Body Material	Brass (CuZn40Pb2 - CW 617N)	Grey iron EN-GJL-250(GG25)
Test Ports	Needle measuring nipple	Needle measuring nipple
Leakage acc. to standard IEC 534	No visible leakage (at 100N)	max.0,01 - 0.05% of kv at 650N
Stem Seals	EPDM - CuZn40Pb2 – CW 617N	EPDM –NBR
Maximum Close Off Pr	600 kPa, ... psi	600 kPa, ... psi
Pressure rating	PN16, ... psi	PN16, ... psi
Control Range	Standard IEC 534 Since CV Characteristic is linear control range is Infinity (1:256 as a result of the actuator-valve combination)	
Control Valve Character	Linear characteristic and, with the help of actuator, logarithmic	

ACTUATOR SPECIFICATIONS FOR ALL SIZES

Supply Voltage : 24V AC

Power Consumption : 10V AC

Frequency : 50 HZ

Control Input : 2-10V DC, 4-20mA, 3-point Selection.

Position Output : 2-10V DC 4-20mA

Body Housing Insulation: Non Corrosive - IP 42 or higher

GENERAL SPECIFICATIONS: Pressure Independent Balancing and Control Valve shall be provided/ installed at each outlet of cooling coil unit., AHU & FCU.

A: - Valve Body and Characteristics:-

- The differential pressure controller should maintain a constant differential pressure across the control valve, irrespective of fluctuations in the system, with the help of a self adjusting diaphragm.
- The control valve shall accurately control the flow, with help of a modulating actuator
- All valve sizes should have testing ports for verifying the flow by measuring the differential pressure.

B: - Valve Actuator and Housing:-

- The valve and actuator must have the ability to undertake both Logarithmic control characteristics and linear control characteristics. This ensures compatibility for both Water/Air and Water/Water Heat Exchanger.
- Control/Dip switch settings should be easy to access, to avoid Manual Contact directly with Integrated IC Circuit of the system.
- The actuator should not play a part in the balancing process. This will ensure that an operational issue in the actuator will not lead to a loss of balancing, causing problems elsewhere in the system.
- Only linear characteristics should not be acceptable as with this valve + actuator characteristic, the resultant energy characteristic will not remain linear and this shall lead to improper control leading to fluctuating room temperatures.
- In chilled water systems, the valve should be mounted with the actuator above the valve to prevent condensation water leaking into the actuator.

C:- Valve Flow Balancing :

- Balancing & Control: The balancing should be accomplished by the spring loaded diaphragm and the control should be done by the actuator receiving signals from room thermostats or BMS.
- Flow Setting Balancing (Commissioning) for the valves should be simple and not require measuring devices.
- Setting the flow should not involve the actuator.
- Proper operation of the valve should not be dependent on additional operations like de-airing of the valve or flushing procedures

c) Miscellaneous Valves

All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection on one end or extended upto the drain pit as the case may be.

All valves on the supply line of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) FPT inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as above but without integral water strainer.

d) Strainers

The strainers shall either be 'pot' type or 'Y' type with cast iron or fabricated steel body, tested to a pressure of 10 kg/sq.cm. applicable for the butterfly valves as shown on the drawings.

The strainers shall have a perforated bronze sheet screen with 3mm perforation, 0.63mm thick.

Pot strainers and Y strainers shall be provided with flanged connections.

The strainers shall be designed to facilitate in easy removal of filter screen for cleaning, without disconnection of pipe line

Pot strainer shall be fabricated out of M.S. sheet and the sizes shall be as under:

Pipe size (mm)	Pot Dia (mm)	Pot HT (mm)	Basket dia (mm)	Basket HT (mm)
50	300	400	200	240
80	350	450	250	250
100	450	500	300	280
125	500	600	330	340
150	540	700	360	390
200	610	815	400	470
250	800	955	550	510
300	1000	1105	750	580
350	1190	1300	895	678
400	1350	1500	1020	785
450	1518	1700	1060	890
500	1690	1800	1100	900

6 Jointing

- All pipelines shall be welded type except G.I. piping which shall have screwed connections.
- Square cut plain ends will be welded to pipe upto and including 100mm dia.
- All pipes 125mm dia. or larger will be bevelled by 35° for welding.

7. Miscellaneous

- Provide all piping, required to make the apparatus connected, complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Engineer-in-Charge.

Consult drawings and specifications to determine number and requirements of all items of equipment requiring piping, such as bend, drain, relief, etc. wherever equipment is provided with connections for such piping.

- Unless otherwise specified, pitch the lines of piping as follows:

All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20mm per metre wherever possible, but not less than 10mm. Drains from other equipment shall be pitched similarly without trap seal.

- Provide valves and capped connections for all low points in piping system, necessary or required for draining systems. Provide for all risers isolating valves and drain valves to permit repairs without interfering with the rest of the system
- During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering piping system.
- Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.

- f) Provide suitable platforms, etc. to facilitate the maintenance-repair and replacement of valves and fittings.
- g) Unions, if used, shall be flanged, as required, wherever indicated and in connections to all equipment, apparatus, and specialties requiring disconnection for repairs or replacement. Locate unions between shut-off valves and equipment, as directed by Engineer-in-Charge.
- h) Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with remaining of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalised. By-pass and stop valves shall be provided for all automatic control valves as specified
- i) Arrange piping for maximum accessibility for maintenance and repair; locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
- j) Cut the pipes accurately according to measurements, established at building and work into place without springing or forcing.
- k) Pipe supports shall be adjustable for height and prime coated with rust preventive paint and finish coated with grey paint, both as approved by Engineer-in-Charge. Spacing of pipe supports shall not be more than that as specified below :

Nominal pipe size (MM)	Spacing (Metres)
15	1.25
20 & 25	2.00
32, 40, 50 & 65	2.50
80, 100 & 125	2.50
150 & above	2.50

- l) Extra supports shall be provided at the bends, and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceilings by means of 'Hilti' metallic dash fasteners.
- m) Insulated piping shall be supported in such a manner so as not to put undue pressure on the insulation.

Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.

All hangers and supports shall be made of steel or other durable and non-combustible materials, galvanised or plated. Wood, wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts and pipe racks, specifically approved.

No hanger/equipment shall be suspended midway, between steel joists and panel points.

Drilling or punching of holes in steel joist members will not be permitted.

All pipes in AC plant room shall be supported from pipes and channels from floor.

9 Sleeves

Where pipes pass through walls, provide galvanised steel pipe sleeves 50mm larger than outside diameter of pipe without any extra cost. Where pipes are insulated, sleeves shall be large enough to have ample clearance for insulation.

Where pipes pass through outside walls or floor slab the space between pipe and sleeve shall be packed with lead wool and oakum.

The centre of pipes shall be in the centre of sleeves and sleeves shall be flush with the finished surface. Floor sleeves shall project 50mm above finished floor level.

10 Expansion or Contraction

The Contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

11 Arrangement and Alignment of Piping

All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Engineer-in-charge.

Unless otherwise specified, the piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide a maximum head room.

All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference at the discretion of the Engineer-in-Charge.

All piping shall be carefully installed to provide for proper alignment, slope and expansion.

The stresses in pipelines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing, gauges, controls or other equipment installed on any apparatus, shall not be coiled or excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging. The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions. All tubing/capillaries shall be provided with PVC sleeves to save it against frictional cuts or damage due to vibration.

12 Testing

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall piping equipment or appliances be subjected to pressures exceeding their test rating.

The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.

After tests have been completed, the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

All piping shall be tested to hydraulic test pressure of at least two times the maximum operating pressure but less than 10 kg/sq. cm. for a period of not less than 24 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-Charge, without any extra cost.

All the piping systems shall be tested in the presence of the Engineer-in-Charge or their authorised representative. Advance notice of test dates shall be given and all equipments, labour, material required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire system is found satisfactory to the above authority. The tests shall be carried out for a part of work if required by the Engineer-in-Charge in order to avoid hinderance in the work of the insulation contractor.

All water and condensate pipes shall be tested and proven tight under hydrostatic pressure of 10 kg/sq.cm., unless otherwise stated, for a minimum period of 24 hours without drop in pressure.

The Contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor air bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectification.

The Contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place during the testing or/and after the testing to avoid damages to employer or other contractors properties. Any damage caused by the contractor to the employer or other contractors properties, shall be borne by the Contractor.

13. Copper Piping

Heavy gauge soft copper tubing, type M, shall be used to make connections to equipment, wherever required or specified by Engineer-in-Charge.

Flare fittings e.g. flare nuts, tees, elbows, reducers, etc. shall all be of brass.

14. Refrigerant Piping

The refrigerant circuit piping shall be of carbon steel seamless, as per ASTM-A-106, grade B or BS-3602 grade 23 and dimensioned as per ANSI B-36.1, schedule 40. The fittings shall be heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls, etc. shall be with flare fittings. The refrigerant valves, required in the circuit shall be as follows:

Valve Size	Valve Material	Type of Connections/fittings
Upto 12mm	Brass packless type	Flare
16mm and above	Brass/Steel packed	Brazed/Welded type
Note :- All valves shall be tested against leaks upto 28 kg/sq.cm.		

The strainers for the refrigerant liquid line shall be 'Y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit. The moisture indication sight glass in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant. Silencers and moisture drier etc. shall be provided as part of the refrigerant piping.

Bolts wherever used shall be electro-galvanised steel. Brazed joints, in the refrigerant piping, which has leak, shall be opened and re-done. These shall in, no case be repaired by addition of brazing alloy to the joint.

15. Drain Piping

The drain piping shall be medium class galvanized steel as per IS:1239 (as per latest amendment).

The fittings shall be of as per IS:1239 Part-II with screwed connections.

The gate valves shall be of gun metal as described earlier.

Pipe crosses shall be provided at bends, to permit easy cleaning of drain line. The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

Drain lines shall be provided at all the lowest points in the system, as well as at equipments where leakage of water is likely to occur, or to remove condensate and water from pump glands. The drain pipe work shall be carried out with threaded joints only. No welded joint shall be permissible.

16. Painting

All pipes supports, hangers, etc., shall be given two coats of red oxide primer.

All pipes (insulated and non- insulated) shall then be given two coats finish paint, of a type and colour as approved by the Engineer-in-Charge.

Section 10:- Air & Dirt Separators/Vacuum Degasser

The Air and Dirt separator shall be of a solid and robust construction (Mild Steel). It shall be able to remove free air and micro bubbles as well as remove solid particles upto 10 microns and less from water. Removal of Air via Centrifugal Force is not acceptable. The unit shall be able to condition the water to make it highly absorptive at all points in the system. This ensures that micro bubbles can no longer exist at any point in the system. All connections, fittings and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & copper wire or stainless steel depending upon the quality of water to be passed through it. This medium should be non clogging in nature. An automatic air vent of at least 40mm free area to be connected at the top for the release of the air separated from the water. The flow should not be obstructed by the dirt collected. A Drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Air & Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the air and dirt separator shall not exceed the values below:

For Max velocity of 1.5m/s	For Max velocity of 3m/s	
Connection (DN) of Air & Dirt Separator	ΔP @ Max. Flow (kPA)	ΔP @ Max. Flow (kPA)
50	3.0	11.8
65	2.7	11.6
80	2.9	12.4
100	3.7	14.6
125	4.2	16.8
150	4.9	19.4
200	5.8	23.1
250	6.9	27.7
300	7.7	31.0

350	7.8	31.0
400	8.4	34.0
450	10.0	39.0
500	11.0	43.0
600	12.0	47.0

For connections larger than DN 600, the contractor must provide the pressure drop calculations in his submittal for approval.

Vacuum Degasser

The vacuum degasser shall be of a solid and a robust construction. It should work on pressure differential deaeration principle. It shall be installed as a bypass to the main CHW line and shall be used for removal of dissolved gases from water to make the water absorptive in order to prevent corrosion as well as remove air locks from the most distant ends of the CHW pipeline. The Degasser shall be of Plug & play type & shall be of automatic operation. The degasser shall be capable of refilling the CHW pipeline with degassed water to compensate the volume of vented gases. The Degasser shall be able to switch itself off when the pipeline achieves desired Pressure & degassed levels of water. It should be with a Multi-stage Centrifugal pump. The Degasser shall be of Carbon Steel with a Brass Automatic Airvent. It should degas the volume from 150 to 300m³ holding capacity.

Section 11:- Duct and Pipe Insulation

Ductwork shall be insulated as per the below specified guidelines.

Painting

Angle iron Flanges, Stiffeners, hangers and supports shall be painted with 2 coats of anti-rust primer and remaining uncovered duct shall be further painted with 2 coats of synthetic enamel paints of black color.

Testing and Balancing

After completion of ducting work, system shall be tested for air leakage. Leakage if any shall be plugged and all the adjustments and balancing are completed. The air quantity readings shall be recorded. All dampers shall be set and locked in position after the final adjustments. All readings made shall be submitted to the consultants for approval.

Insulation

All tests like pressure testing should be completed and recorded. All systems shall be approved by the Consultants before insulation is applied to the equipment, duct and piping. Insulation material shall be supplied by approved manufacturers and shall be of the type specifically intended for the services required.

Ductwork & Piping Insulation Application Guidelines :

Piping and accessory insulation application shall be as follows:

- Pipes shall be thoroughly cleaned with wire brush and rendered free from all rust and grease.
- For insulation of straight pipe slip on method shall be used. For elbows and bends snap off method will be used.
- First 2 coats of specified Insulation adhesive shall be applied then the Insulation shall be fixed tightly on the surface taking care to seal all joints .

- Adequately sized PVC self-adhesive tape shall be provided to seal all joints afterwards
Al cladding shall be done as per requirements.

Pipework Insulation:

All chilled water and drain pipes Insulation shall be as follows. The material will be TF quality Expanded polystyrene of 20kg/m³ density minimum.

10 to 40 mm pipe size	-	25 mm
50 to 100 mm pipe size	-	50 mm
Above 100 mm pipe size	-	75 mm

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.

Air conditioning Ducts shall be fabricated for Glass wool duct panels Climaver plus R 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 12:- Controls

1. General :

- 1.1 The various controls listed below shall be electrically operated and generally comply with the specifications listed below:
- 1.2 In case of low voltage controls necessary step down transformers shall be provided with each control as required.

2. Chilling Unit Control:

The Chilling machines controls shall be generally standard as per the selected manufacturer standards.

3. Air Handling Unit and Fan Coil Unit controls:

- 3.1 AHUs thermostats shall be cooling/heating suitable for mounting in the room or the return path as required. The thermostat shall be modulating potentiometer type with an adjustable throttling range and required accuracy.
- 3.2 The thermostat for Fan coil unit shall be space type for cooling. It shall be snap acting type , line voltage, mercury bulb type with differential of 1.1 C. It shall have minimum three speed control complete with wiring etc.
- 3.2 The water pressure gauges shall be of robust construction 150 mm dial of suitable range and occupancy range.
- 3.3 The thermometers shall be mercury filled industrial stem type with metal casing and threaded fixing arrangement.

Section 13:- ontrol Panel, Motors and switchgears**1. General**

This specification covers the designs, material, construction features, manufacture, inspection and testing at the VENDOR'S/his sub-contractors work, delivery and performance testing of metal-enclosed Medium Voltage Switchgear of voltage not exceeding 1000 V AC.

The switchgears would comprise of Motor Control Centres (MCCs) required for the supply of power to the motors of the plant for medium voltage equipment.

2. Codes & Standards

The design, construction, manufacture and performance of equipment shall conform to latest applicable standards and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

Equipment shall conform to the latest applicable standards as mentioned. In case of conflict between the standards and this specification, this specification shall govern.

All components shall be of reputed make and subject to Purchaser's approval and as per recommended manufacture.

3 Power Supply System

The incomer power supply shall be 415V, 3 phase, 3 wire, 50 Hz, non-effectively earthed AC system. The fault level for the switchgear shall be 40 KA for 1 sec.

Dynamic - 84 Ka (Peak) - Short time

Variation of voltage and frequency from their rated values are as below :

Variation of voltage	$\pm 10\%$
Variation of frequency	$\pm 5\%$
Combined voltage and frequency Variation	$\pm 10\%$

4 Site Conditions

The following site conditions shall be considered for the design of the MCCs

Reference Temperature	}	Ref: Basis of Design
Relative Humidity	}	
Climatic Conditions	}	

5 Sheet Metal Work

The switchgear frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2 mm.

Frames shall be enclosed by sheet metal of thickness not less than 2 mm cold rolled or 2.5mm hot rolled, smoothly finished, levelled and free from flaws. Doors and covers shall be made of sheet steel of thickness not less than 1.6mm. Cold rolled or 2mm hot rolled. Stiffeners shall be provided wherever necessary.

All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Cut-outs shall be true in shape and devoid of sharp edges.

The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

6 Painting

All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with applicable standards.

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.

Panels shall be dry electrostatic painted (powder coated).

Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

7 Constructional Features

Switchgear panel shall be:

- a) of the metal enclosed, indoor, floor mounted modular type
- b) made up of the requisite vertical sections
- c) of dust and vermin proof construction
- d) provided with a degree of protection of IP-54
- e) easily extendable on both sides by the addition of vertical sections after removing the ends covers
- f) provided with a metal frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated
- g) provided with labels on the front indicating the switchgear designation
- h) provided with cable entry facilities at top or bottom with 3mm thick removable and plates and necessary cable glands. For 1 core cables these plates shall be non-magnetic
- i) of uniform height of not more than 2450 mm
- j) of double front execution
- k) provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors
- l) provided with copper busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.

Operating devices shall be incorporated only in the front of the Switchgear.

The Switchgear shall be provided into distinct vertical sections each comprising:

- a) A completely metal enclosed busbar compartment running horizontally.
- b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.

- c) Enclosed vertical busbars serving all modules in the vertical sections. For safety isolation of the vertical busbars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical busbars.
- d) A vertical cable alley covering the entire height. The cable alley shall be minimum 200mm wide for motor control modules and 500mm wide for circuit breaker controlled modules.
- e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

Each vertical section shall be equipped with space heaters which may be located in the cable alley as specified in schedule of quantities.

One metal sheet to be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.

All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

For dial out type, modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing.

Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

After isolation of power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the busbars and adjacent circuits live.

The withdrawl chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance of cable connections to any one circuit with the busbars and adjacent live circuits. Adequate number of slotted cable support arms shall be provided for dressing the cables.

All doors shall be provided with concealed type hinges and captive screws.

The withdrawable chassis housing circuit breakers shall be of the fully drawout type.

The chassis/base plate housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully-drawout, or fixed type.

a) Fully Drawout Type

In this type of construction it shall be possible to drawout the withdrawable chassis without having to unscrew or unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control drawout type connections shall be of the stab-in or sliding type. All drawout contracts, including the auxiliary and control wiring shall be of self-aligning type.

b) Fixed Type

In this type of construction all power connections to the equipment mounted on the base plate shall be of the bolted type. All control circuit connections to equipment mounted on the base plate shall be carried out through conventional terminal blocks mounted in the respective base plate. It shall be possible to remove the base plate after unbolting/unscrewing all the power and control circuit connections to the equipment mounted on the base plate.

c) Interchangeability

All identical equipment and corresponding parts including chassis of drawout modules of the same size shall be fully interchangeable, without having to carry out modifications. For trouble free interchangeability, the drawout arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules. Components and equipment that are not fully interchangeable will be rejected. VENDOR shall replace all such equipment by fully interchangeable equipment at his cost.

Switchgear shall be designed in such a way that all component equipment and bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing with the switchgear cubicle, with reference ambient temperature outside the switchgear cubicles.

All dummy cubicles necessary to meet the requirements of this specification shall be included in the VENDOR's scope.

No equipment/devices associated with a particular circuit shall be mounted in any other circuit module.

8 Main And Auxiliary Buses

a) Main buses & Tape

Switchgear shall be provided with three phase busbars and neutral.

Busbars shall be of uniform cross section throughout the length of the switchgear.

The busbars shall be made of high conductivity copper alloy of E91E grade.

Busbars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase system.

All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection; impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phase. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0 deg.C to 90 deg.C.

Busbars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Busbars supports shall be made of Hylam sheets, glass reinforced moulded plastic material, permali wood or cast resin.

Separate supports shall be provided for each phase of the busbars. If a common support is provided for all three phases, antitracking barriers shall be incorporated.

Busbar joints shall be complete with high tensile steel bolts and lock washers and nuts. Busbars shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

b) Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary busbars and necessary connections to the supply transformers and associated circuits shall be in the VENDOR's scope.

9 Circuit Breakers

a) Circuit breakers shall be of the airbreak drawout type, mounted along with its operating mechanism on a wheeled carriage moving on guides, designed to align correctly and allow easy movements.

- of the shunt trip type.
- provided with an operating mechanism of the type specified.
- provided with mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker.
- provided with mechanical operated, red 'trip' push button, shrouded to prevent accidental operation.
- provided with locking facilities in the 'Service', 'Test' and 'Isolated', positions. In test position the breaker will be tested without energising the power circuits. The breaker shall remain fully housed inside the compartment in the test position.
- provided with 6 No. and 6NC potential free auxiliary contacts, rated 10A at 240V A.C. and 1A (inductive breaking) at 220 V D.C.
- provided with 'red', 'green' and 'amber' indicating lamps to show 'closed', 'open' and 'auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.

b) Circuit breakers shall be provided with the following interlocks.

It shall not be possible to plug-in a closed circuit breaker, or to drawout a circuit breaker in the closed position.

It shall not be possible to operate a circuit breaker unless it is in the fully plugged-in, test, or fully isolated position.

c) Circuit breaker closing and trip coils shall be rated for satisfactory operation on a control supply system indicated in Data Sheet-A.

d) Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

Closing coils-85% to 110% of rated voltage.

Trip coils-50% to 110% of rated voltage.

The breakers controlling motors shall operate satisfactory under following conditions :-

- i) Direct-on-line starting of the specified motor.
- ii) Breaking no load current of the specified motor.

e) Operating Mechanism

Circuit breaker shall be provided with operating mechanism as specified .

Power operated mechanism shall be of the motor wound spring charging stored energy type.

The closing action of the circuit breaker shall charge the tripping spring ready for tripping.

Speed of closing of contacts shall be independent of the speed with which the handle is operated.

All stored energy mechanisms shall be provided with mechanical Indicators to show the 'charged' and 'discharged' conditions of the spring.

Circuit breakers provided with stored energy operating mechanisms shall be provided with the following interlocks.

- i) The circuit breaker shall not close unless the spring is fully charged.
- ii) Shocks, vibrations, or failure of springs shall not operate the breaker or prevent intended tripping.

Power operated mechanism shall be

- i) Provided with a universal motor suitable for operation on A.C. and D.C. control supplies specified in Annexure-A with voltage variation from 85% to 110% rated voltage.
- ii) Designed to enable a continuous sequence of closing and opening operation as long as power is available and at least one opening operation on power supply failure.
- iii) Provided with emergency manual charging facilities.

10. Moulded Case Circuit Breaker:

Moulded case circuit breakers shall be made of insulating case and cover made of high strength, heat resistant and frame-retardant thermosetting insulating material.

The switching mechanism shall be made/quick-break type utilizing a trip free toggle mechanism. The handle position shall give positive indication of whether the breaker is ON (top), OFF(down) or tripped (midway). For overload protection, three bimetal magneto-thermal release and electromagnets releases for short circuit protection to be provided. The magneto-thermal release shall be variation and direct acting. All releases shall operate on a common trip bar so that all phases are disconnected in the event when fault occurs even on only one of them.

The contacts shall be made of silver alloy and arc chutes shall be made of de-lon plates. These plates shall be housed in a vulcanised fibre casing. The arc chutes shall be capable of quenching the arc rapidly and drawing away the arc from contact tips.

The terminals shall have sufficiently large dimensions to accept links or cable lugs of suitable sizes.

11 Miniature Circuit Breakers (MCB)

- a) MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.
- b) MCB shall be provided with overload/short-circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 3 KA r.m.s. at 415V/220V D.C.
- c) MCBs shall be provided with locking facility.

12 Air Break Switches

- a) Air break switches shall be of heavy duty, group operated load break, fault make type, complying with the requirements of applicable standards.
- b) The switches shall be capable of withstanding the thermal stresses caused by overloads, locked rotor and short circuit currents of values associated with protective relay settings and the let through current of the associated fuse.
- c) The switches shall be capable of withstanding the mechanical stress caused by the peak short circuit current of value equal of the cut-off current of the associated fuse.
- d) Whenever solid links are used for the connections between switches and fuses, such links shall be fitted with insulated sleeves.
- e) All live parts of the switch shall be shrouded.
- f) Switch operating handles shall be suitable for padlocking in 'OFF' position.
- g) Each switch shall be interlocked with the associated compartment door to achieve the following interlocks.

It shall be possible to open the door only when the switch is in the 'OFF' position.

It shall not be possible to close the switch with the door open.

Suitable means however shall be provided to intentionally release the interlocks specified above for making trip setting adjustments and operation tests.

13 Fuses

Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of not less than 80 kv at 440 V. Fuses upto 63A for distribution systems of medium short circuit levels may be of HRC cartridge screw-cap type, having a certified rupturing capacity of not less than 46ka at 440 V and 16 KA at 250V DC.

Fuses shall be provided with visible indication to show that they have operated.

Fuses shall preferably be mounted on moulded plastic carriers and shall be complete with fuse bases.

Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug in type of bases. In such cases an insulated fuse pulling handle shall be provided for each size of fuse for each switch board.

14 Motor Starters

a) Contactor

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver plated copper.

Each motor-starter contactor shall be provided with two NO and two NC auxiliary contacts.

Insulation class of operating coils shall be class B or better.

Operating coils of contactors shall be suitable for operation from the specified control supply system.

Contactors shall be of the double break, non-gravity type.

One number spare auxiliary contactor with 4 No./4NC contact along with its coil completely wired up to the terminal should be provided.

b) Direct-On-Line Starters

Direct-on-line starters shall be suitable for Class AC 3 utilisation category.

c) Reversing Starters

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

Reversing starters shall be suitable for Class AC 4 duty.

d) Thermal Overload Relays

Starters shall be complete with a three elements, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The settings range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand reset type.

'Stop' push button of the starter and hand reset device shall be separate from each other.

Overload relay hand reset push button shall be brought out on the front of the compartment door.

Overload relay shall be provided with atleast one 'NO' and one 'NC' or one change-over contact.

15 Current Transformers

Current transformers shall be of the dry type.

Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second.

Unless otherwise specified, the minimum performance requirement of current transformers are as follows: -

a) Measuring CTs-7.5VA, accuracy class 1.0 and an instrument safety factor of 5.

b) Protective CTs - 7.5 VA, accuracy class 5P and an accuracy limit factor of 10.

Notwithstanding the above it shall be the VENDOR'S responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.

Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance. (CTs built-in with the thermal relays of the contactors are excluded).

16 Voltage Transformer

Voltage transformers shall be of dry type.

Unless otherwise specified, the minimum performance requirements of voltage transformers are as follows:

- a) Measuring VTs - 15 VA per phase and accuracy class 1.0.
- b) Protective VTs - 15 VA per phase and accuracy class 1.0.
- c) Dual purpose VTs - 100 VA and dual accuracy class 1.0/3.0 for metering and protection respectively. VA is per phase.

All secondary windings of voltage transformers including open delta windings shall be rated for 110/ 3 V per phase.

Voltage transformers shall have a continuous overvoltage factor of 1.2 and short time overvoltage factor as follows:

1.5 for 30 seconds in case of effectively earthed. 1.9 for 8 hours in case of non-effectively earthed system.

Voltage transformers shall be complete with suitable rated primary, secondary and tertiary fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Fuses shall be provided on each sub circuit.

It shall be possible to replace voltage transformers without having to de-energise the main bus bars.

The terminals of V.T. secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.

Single phasing preventers relay shall be provided when required to protect motor against single phasing. The relay shall not operate for supply voltage unbalance of $\pm 5\%$ but shall positively operate for supply voltage unbalance of more than $\pm 5\%$. The relay shall operate in the event of a single phase fuse blowing even though the motor c.m.f. in the concerned phase is of the order of 85%.

After sensing single phasing the relay shall operate with a time delay of 2 to 3 sec. The relay shall not operate for a 3 phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

The relay shall be suitable for application to protect reversible and non-reversible motors. The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay shall be of the fail safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

17 Relays

The following clauses shall apply to the protective relays.

Relay shall be -

- a) Enclosed in dust proof flush mounting drawout type cases.
- b) Accessible for setting and resetting from the front.
- c) Provided with positive acting hand-reset flag indicators visible from the front.

Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.

Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.

Each relay shall be provided with at least two separate voltage from contacts.

Make and type of relays shall be subject to the EIC approval.

18 Indicating Instruments And Meters

Electrical indicating instruments shall be of minimum 96mm x96mm square size, suitable for flush mounting.

Indicating instruments shall have provision for zero adjustment outside the cover.

Instrument dials shall be parallex free with black numerals on a white dial.

Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current.

Watt-hour meters shall be of the direct reading electro-dynamometer type complete with cyclometer type dials and reverse running stops.

19 Indicating Lamps

Indicating lamps shall be:

- a) of the filament type and of low watt consumption
- b) provided with services resistors
- c) provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as required in the control wiring diagrams.

Bulbs and lenses shall be easily replaceable from the front.

20 Control and Selector Switches

Control and selector switches shall be :

- a) of the rotary type
- b) adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 240V AC and 1A inductive break) 220V DC.
- c) provided with escutcheon plates clearly marked to show the positions.

Control switches for circuit breakers shall be provided with pistol grip type handles. Control switches for circuit breaker control shall be provided with

- a) contact development and sequencing device.

Selector switches shall be:

- a) of the maintained contact stayput type. Switches in ammeter circuits shall have make-before-break type contact.
- b) provided with oval handles.

21 Push Buttons

Push button shall be:

- a) of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- b) fitted with self reset, 2 NO and 2 NC contacts.
- c) provided with integral escutcheon plates marked with its function.

'Start', 'Open', 'Close' push buttons shall be green in colour.

'Stop' push buttons shall be red in colour.

All other push buttons shall be black in colour.

'Emergency Stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

22 Space Heaters (if applicable)

Space heaters for switchgear panels shall be :

- a) suitable for operation on a supply system as specified
- b) provided with single pole MCD with overload and short circuit release
- c) provided with thermostats to cut off the heaters at 45 deg.C.

For details for spacing between terminals; clearance between gland plate and first row terminals; and size of gland plate refer Annexure - B, Table-I, II & III.

23 Cable Terminations

Suitable compression type heavy duty brass cable glands with nuts, rubber sealing ring and brass washers mounted on a removable and control cables entering the switchgear shall incorporate built in facilities for earthing the wire armour of cables. Cable glands shall be plated to avoid corrosion.

Power cable glands and crimping type lugs shall be supplied to suit the cable sizes given in clause 3. If during course of detailed engineering of the switchgear it is found necessary to provide more glands or glands of higher size than those envisaged the vendor shall provide and accommodate the same.

Wire Sizes:

The vendor shall select the power cable glands and lugs based on the following cable sizes.

Type of cable: 1100 V grade stranded aluminium conductor PVC insulated PVC sheathed armoured and outer sheathed FRSL coated cable conforming to IS:1554 Part-I.

KW Rating Service	No. of cores x conductor size(mm ²)	approximate overall diameter in mm
Upto 3	3 x 4	18
3.1 - 7.5	3 x 6	19.5
7.6 - 15	3 x 16	24
16 - 25	3 x 35	30
26 - 40	3 x 70	34
41 - 55	3 x 120	40
56 - 70	3 x 185	49
71 - 85	3 x 240	55.5

86 - 110	3 x 400	60
111- 175	3 x 1C x 500	-
Space Heating	2 x 6	19

For supporting & clamping cable cores at regular intervals inside the cable alleys, suitable shuttled angles, upto the respective terminal blocks shall be provided.

Necessary crimping type of tinned copper cable lugs for connecting the individual cores to the respective terminals shall be provided.

24 Internal Wiring

Control wiring shall be of the rating of 650V and power wiring shall be of the rating of 1100V.

Wiring inside the switchgear shall be carried out with 1100/650 V grade, PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 4 sq.mm copper or equivalent size aluminium conductor. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5mm diameter respectively.

Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washers/lock-nuts.

Not more than two connections shall be made on any one terminal.

25 Terminal Blocks

Terminal blocks (both for power and control circuit) shall be of reputed make especially for CT and VT circuit. It shall comprise of finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and locknuts. The studs shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification. Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit. Where duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks.

Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5 sq.mm size.

26 Labels

All labels shall comprise white letters on a black background.

Labels shall be made of non-rusting metal or 3-ply lamicaid, or engraved PVC.

Labels shall be properly fixed, with provision to prevent distortion due to expansion.

Size of lettering shall be 6mm.

27 Earthing

Each MCC and LCC shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified in data sheets. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the main earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the main earthing conductor.

Earth busbars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wires/bare busbars of cross section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth busbar using 1100/650 V grade, 2.5 sq.mm stranded, copper, earthing conductor.

28 Local Push Button Stations

Constructional Features

The constructional features of the local push button stations shall be as follows :

- a) Metal enclosed; weather-proof suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium or sheet metal of 2mm thickness.
- b) Dust and vermin proof.
- c) Provide a degree of protection of not less than IP:54.
- d) Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.
- e) Provided with inscription plates of rear engraved perspex with white letters on black background. The letter size shall be 6mm.
- f) Provided with two earthing terminals suitable for 8 SWG G.I. wire.
- g) Provided with removable undrilled gland plate and adequate members of cable glands for PVC insulated, armoured cable. The cable entry shall be from the bottom.
- h) All local push button stations shall have locking facility. The lock switch shall have two positions "locked" and "unlocked". When in unlocked position the switch shall allow individual starting of the equipment. Start/stop push buttons provided for local operation of the equipment shall be provided on the same enclosure and stop push buttons shall be lockable in stop position. The lock switch shall be key operated.

Push Buttons

- a) The Open/Close/Start push buttons shall be of the momentary contact push to actuate type.
- b) The stop push buttons shall be stay put type with mushroom knob.
- c) All push buttons shall be:
 - i) Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts. (10A at 240 AC).
 - ii) Provided with integral escutcheon plates marked with its function.
- d) 'Open/Close/Start' push buttons shall be green colour.
- e) 'Stop' push button shall be red in colour.

Wiring

The push button stations shall be as follows : Push button station Type-A - Each P.B., station shall comprise three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motors.

Push button station type B - Each P.B. station shall comprise two push buttons viz. 'START' and 'STOP' for control of non-reversible motors.

Push button station type-C - Each P.B. station shall comprise only one push button i.e. 'STOP' for emergency stop function.

Power - Electricity at specified voltage (415/220V).

29.2 The controls shall be complete with actuators, probes, relays, transformers, wiring, etc.

Safety controls of chilled water unit shall be as under :

- a) Compressor - High/Low pressurestat/manual reset type high bearing temperature safety.
- b) Chiller thermostat - Manual reset type antifreeze.
- c) Oil pressure - Differential safety switch with manual reset button. It should have a time delay relay for start up of the compressor.
- d) Main motor - Thermal relay to avoid overloading of motor & overheating of winding.

Interlocks for refrigeration unit shall be:

- a) Flow switches in condenser and chiller lines to prevent compressor starting without water flow.
- b) Oil temperature to be maintained at set point.
- c) Condenser and chilled water pumps and cooling tower fans shall be interlocked with chilling units to prevent operation without pump and cooling tower fan running.

30 Tests

Switchgear shall be subjected to following tests :

- a) Temperature rise test on power circuits.
- b) Short time current tests on power circuits.
- c) Mechanical operation test.

- d) High voltage test.
- e) Electrical control interlock and sequential operation tests.
- f) Verification of wiring as per approved schematic.

Type tests and routine tests shall be carried out on all associated equipment as per relevant standards.

Certified copies of all type and routine test certificates shall be submitted for the Engineers approval before despatch of the switchgear.

31 Drawings and Data

As part of proposal BIDDER shall furnish the following drawings and data:

- a) For each switchgear, overall dimension drawing showing front view, plan, elevation and cross-section.

All drawings and data sheets shall be annotated in English.

Section 14:- Electrical Cabling Works

CABLES:

PVC insulated aluminium conductor Armoured cables shall be used for connecting motors.

CABLE GLANDS:

Heavy duty compression type cable gland alongwith the cable lugs shall be used for termination of cables. The cable glands shall be of cadmium plates brass. For all power cables, crimped type copper cable lugs shall be provided.

The cable trays shall be channel type made out of M.S. sheets (slotted) having a minimum thickness of 2mm duly painted. (Cable trays exposed to atmosphere shall be hot dip galvanised). The Clamps used shall be Aluminium with G.I./Cadmium plated nut-bolts. The size of these trays shall be selected considering the number of cables and leaving minimum 20% spare area. The arrangement of cables in these trays shall be in Single Tier Formation.

Sharp bending of the cables shall be avoided. The radius for bending PVC insulated cable and sheath armoured cable shall not be less than 10D where "D" overall diameter of the cable. Wherever cable rises from concrete trenches, these shall be taken in G.I. pipes of suitable size. The Contractor shall make sure that the 40% area of pipe shall be free after the cable is laid.

WIRE SIZES

Final connection to the equipment shall be through flexible wiring enclosed in galvanised flexible conduit rigidly clamped at both ends. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. P.V.C. insulated single strand hard drawn copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification. All the wires shall be suitably sized for motor duty.

EARTHING

Main power upto the Electrical panels in Plant rooms along with earthing shall be provided by other agency. Each panel shall be earthed to building main earthing. All the motor etc. shall be double earthed to the panel. All three phase motors/equipment shall be earthed

with two independent earth conductors as per the requirement of Indian Electricity Rules and Regulation - 1956.

DRAWINGS

Shop drawing for control panel and wiring of equipment showing the route of conduit/cables shall be got approved by the Consultant/Architect before starting the fabrication of panel and starting the work. On completion four sets of completion/"As installed" drawings incorporating all details like conduit routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cable route etc. shall be furnished by the Contractor.

TESTING

Before commissioning of the equipment the entire Electrical Installation shall be tested in accordance with code of Practice IS:732-1963 (Revised) and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and certificate from Electrical Inspector shall be submitted. All tests shall be carried out in presence of Consultant/Architect.

Painting

All sheet steelwork shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising passivating and then sprayed with a high corrosion resistant primer. It shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

SECTION 15 :-Mode of Measurement

1 General

This specification covers measurement of various items/materials at site.

2 Unit Prices in the Schedule of Quantities

The item description in the Schedule of Quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the

All equipment, 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 equipment.

All the labour required to supply and install the complete installation in accordance with the specifications.

Use of any tools, equipment, machinery, lifting tackle, scaffolding ladders etc. required by the contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipment foundations, from the building structure, wherever necessary and suggested by the Engineer.

Storage and insurance of all equipment apparatus and materials.

The Contractor's unit price shall include all equipment, apparatus material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as

well as all additional equipment, apparatus, material and labour usual and necessary to complete the system even though not specifically shown, described or otherwise referred to.

3 Measurements of Sheet metal ducts, grilles/diffusers, etc.

a) Sheet Metal Ducts

All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars and other fittings. Gaskets, nuts, bolts vibration isolation pads, vanes are included in the basic duct items of the B.O.Q.

The unit of measurements shall be the finished sheet metal surface area in metre squares. No extra shall be allowed for overlaps.

All the guide vanes, deflectors access panels, splitter dampers within the duct work shall be considered as part of the duct and nothing will be paid extra on this account.

The unit duct price shall include all the duct hangers, supports and 'Hilti' metallic fasteners as well as any materials and labour required to complete the duct frame.

b) Box Dampers

Box dampers wherever shown or required in ducts shall be measured as per finished inside cross-sections and paid as per the calculated area in sq.m.

c) Grilles/Diffusers

All measurements of grilles/diffusers shall be the nominal outlet size excluding the outer flanges.

The square or rectangular grilles/diffusers shall be measured in plain sq.m.

All round diffusers shall be measured by their diameters in centimetre.

All linear diffusers shall be measured as per actual length in meters.

4 Measurements of Piping, Fittings, Valves, Fabricated Items

a) Pipe (Including Water Piping, Oil Piping, L.P. Gas Piping, Air Piping, Vacuum Piping, etc.)

All pipes shall be measured in linear meter (to the nearest Cm.) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducer, elbows, hanger support bracket, etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, 'Hilti' metallic fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Engineer-in-Charge.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowances being made for providing the same.

The length of the pipe for the purpose of payment will be taken through the centre line of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above the fittings. For valves and flanges, section 1.16.3.2 below applies:

b) Valves and Flanges

All the C.I. and G.M. valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length, will be made wherever valves occur.

All gate and globe valves shall include two nos. of flanges and two numbers 150 mm long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on- flanges.

Rate for all valves shall also include the necessary number of bolts, nuts and washers, 3mm thick insertion gasket of required temperature grade companion flanges and all items specified in the specification.

The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps, etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

c) Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Engineer-in-Charge.

d) Copper Connections for Fan Coil Units

Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass tees, brass reducers, fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

5 Painting

Painting of all pipes, supports, valves and fittings shall be included with the cost of these items. Nothing extra shall be paid for this work.

Painting of grilles/diffusers, tanks and equipment wherever required shall be in the cost of these items.

6 Insulation

Measurement of insulation for vessels, piping, equipment and ducts shall be made over the bare uninsulated surface area of the metal.

a) Pipes

The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is R1 and the inner radius is R2, the centre line radius shall be measured as $(R1+R2)/2$. Measurement of all valves, flanges and fittings shall be taken in running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

b) Ducts

The measurements for insulation of ducts shall be made in actual square meters of bare uninsulated duct surface.

In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for damper, flanges, fittings shall be for the surface dimension for the connecting duct. Nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

c) Vessels

The area of standard dished and flat ends of vessels shall be measured as the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handle ribs, dampers, expansion joints etc. all projections on vessels or tanks shall be measured separately as pipe/duct.

d) Accessories Insulation

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be of uninsulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves. The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

e) Acoustic Duct Lining

In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metre, shall be final for billing purpose.

The insulation/acoustic treatment shall include cost of battens/sections, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

f) Roof and Wall Insulation and Acoustic Treatment

The unit of measurement for all underdeck roof insulation wall insulation, wall/roof acoustic panel shall be the acoustic uninsulated area of walls, roofs, to be treated, in square metres.

The insulation/acoustic treatment shall include cost of battens supports, adhesives, vapour proofing, finished boards/sheets as well as additional labour and materials required for completing the work.

g) Acoustic Baffle Boxes (wherever required)

The unit of measurement shall be the exposed inside face of the acoustic baffle boxes in square meters.

The unit price shall include all hold fasts, nuts, and bolts connecting the size of wall opening and making it good as well. Any additional materials and labour to fabricate and fix the boxes.

Section 16- VARIABLE FREQUENCY DRIVES

- 1) The VFD shall be of the type suitable for operation on a 3 phase, 415 V, 50 Hz input power supply at the following conditions:

Input supply voltage variations	:	$\pm 10\%$
Input supply frequency variations	:	48 – 62 Hz $\pm 1\%$
Ambient temperature	:	0 - 45 °C, without derating.
Maximum relative humidity	:	95% non condensing
Vibration :		0.7 g RMS in 3 directions
Minimum efficiency at full load	:	96%

- 2) The VFDs will be mounted in the open near the AHUs Cooling towers in the AHU room / Plant room. Hence the VFDs shall have integrated; factory built metallic enclosures of IP 54 rating, without any de-rating. VFDs of IP00 / IP 20 / IP 21/ IP 42 rating enclosures with additional sheet metal enclosures to achieve IP 54 ratings are not permitted.

- 3) VFDs shall conform to the recognized international standards like IEC and manufactured according to ISO 9001, BS 5750 part 1 & 2 and shall be UL listed. It shall carry the CE mark on EMC compliance.
- 4) The VFD shall be capable of providing a starting torque of 160% for 0.5 sec and an overload torque of 110% torque for 1 minute.
- 5) The VFD shall maintain full output voltage during main's variations of + 10% to prevent loss of torque and speed variations occurring during motor operation.
- 6) The VFD shall comply with Electro Magnetic Compatibility (EMC) product standard EN61800-3, First Environment, Unrestricted distribution with minimum 50 meters of output cabling. The supplier of drives shall include additional filters needed, if any, to meet this compliance.
- 7) The VFDs shall allow connecting shielded / screened 3 core plus earth motor cable for all power sizes, without any restriction.
- 8) The VFDs shall have internal harmonic filters on both limbs of the DC bus to reduce current harmonics. AC line chokes on the input side are not allowed for harmonic current control as it will cause voltage drop to the VFD and motor.
- 9) For easier maintenance and to reduce inventory, the VFD shall allow connection of motors one frame size larger and 4 sizes smaller than its nominal rating.
- 10) The VFD shall have the following protective functions: Electronic motor overload, Protection to motor and VFD against input transients, phase loss, short circuit, under voltage, over voltage, phase imbalance, motor over temp., phase to phase short circuit or earth fault at motor terminals.
- 11) The Upeak of the VFD shall be below 1000 Volts (when measured with a cable length of 50 meters) to prevent damage to motor insulation. Manufacturer of the VFD shall submit data sheet to verify this requirement in order to permit the usage of standard motors for the applications specified.
- 12) The VFD shall be capable of having an output motor cable length of at least 150 meters (armoured cabling) with out any need of additional equipment like output chokes. This is essential for applications like chilled water pumps and cooling towers where the motors are located far away from the control center.
- 13) The VFDs shall incorporate a surge protection circuit as standard to protect the VFD from transients and spikes in the incoming power supply.
- 14) The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor and switching back ON with VFD in on mode.
- 15) The VFD shall monitor the belt (AHU etc.) or coupling etc.), and it shall display a warning signal if it detects a broken coupling / belt. There shall be provision to export this warning signal to the BMS system through RS 485, without any need of I/Os.
- 16) The display of the VFD shall be Alpha numeric type. Display of all messages and faults shall be in English text format. Codes are not acceptable The display shall show the following operating parameters:
 - Power consumed by motor in kW
 - Run time of motor in Hours
 - Current drawn by motor in Amps.

- Output frequency in Hz.
 - Motor speed in RPM
 - Set point in process units
 - Feedback in process units
- 17) It shall be possible to see at least 4 of the above operating parameters in the VFD display, simultaneously.
- 18) A parameter lock shall be available in the VFD local display panel to prevent unauthorized resetting of parameters.
- 19) The VFDs shall have internal galvanic isolation (PELV) to avoid damage to BMS / PLC / DDC system when interconnected. If PELV is not available, the VFD vendor should offer opto-isolators for all the inputs and outputs in the VFD.
- 20) The VFD shall automatically adjust the switching frequency based on motor current demand rather than motor speed so that the best possible switching frequency is provided, to match both performance and to maintain silent operation all speeds. The switching frequency range shall be from 4-14 kHz for VFDs to be installed on AHUs.
- 21) The VFD shall monitor the relationship between voltage and current in the motor and adjust the output voltage to minimize current and maximize motor and drive efficiency. VFDs offering fixed settings of V/f ratios are not permitted.
- 22) The VFD shall have Auto / OFF / Manual switch on the key pad itself. It shall be possible to manually change the speed of the AHUs from the key pad of the VFD, if required, without the need of an external potentiometer. In manual mode the speed reference signal shall be from keypad of VFD and in auto mode, the reference shall be from the remote – either BMS or transmitter.
- 23) The VFD shall have self adjustable ramp times to prevent tripping / VFD damage in case inappropriate ramp times are set with respect to application requirement.
- 24) The VFDs shall have the provision to program a minimum and maximum speed of operations, through the VFD programming itself.
- 25) In case of a power failure, the VFD shall be capable of automatically restarting after a programmable time delay, without the need of an operator having switch on the unit.
- 26) To prevent damage to the VFDs due to pre-rotating fans, the VFD shall have the capability to detect such spinning fans and adjust its frequency to its spinning speed before it starts controlling the fan. If the fan is running in the opposite direction, the VFD should brake the fan by sending a DC current, before starting the fan in the right direction.
- 27) If a temperature / pressure / flow feedback signal is given to the VFD, it shall use its PID controller to modulate the speed in such a way that the set point of temperature or pressure is accurately maintained.
- 28) The VFD shall be capable of accepting two such feedback signals simultaneously and be able to do a speed control based on average / sum / difference / minimum / maximum / 2 zone control of the above 2 signals.
- 29) The feedback signal shall be monitored by the VFD and should provide a warning signal if the feedback goes above or below the programmed high and low limits. It shall be possible to transfer this signal to the BMS system as well.

- 30) If the VFD loses the feedback signal or reference signal in auto mode, the VFD shall be capable of maintaining the speed at which it is running or to go to maximum speed or to trip.
- 31) The VFD shall have the provision to automatically stop the motor when the feedback signal remains at the low level for a predetermined time.
- 32) The PID controller shall be capable of programming the set points and incoming signals in any of the flowing units : RPM, l/s, l/m, l/h, m³/h, m³/s, bar, Pa, kPa, GPM, lb/s, lb/h, CFM, in³/h, inwg, ft wg, PSI, kW, HP, oC, oF, as required by the application, and be able to display the same while in operation.
- 33) The VFD shall enable the motor to step over speeds that cause mechanical vibration / resonance in duct work / pipe lines which can potentially damage the mechanical components in the system.
- 34) The VFD shall have an auto de-rating facility by operating at a lower capacity in case of a phase loss or higher ambient temperature so that minimum air conditioning can be maintained. VFDs that trip on a phase loss or high ambient temperature are not suitable for this application and hence not permitted.
- 35) The VFDs shall have the provision of 4 parameter set ups, which can be activated by the IBMS or by digital inputs.
- 36) The VFD shall have the provision to generate a warning signal, if the operating frequency is above or below programmed the high and low limits, to stage on /off other devices.
- 37) The variable frequency drives (VFD) shall have the provision to integrate into a BMS system, utilizing a serial communication through Modbus RTU protocol that enables a full "read & write" seamless interface between the VFD & IBMS. The VFD manufacturer shall be responsible for technical support to the IBMS Vendor in the implementation of a serial interface to the BMS System. The BMS Vendor shall be responsible for the complete "integration and interoperability" of the VFD through the IBMS via the serial interface.
- 38) The VFD shall provide to IBMS, via serial communication (by RS-485, 2 wire), access to the following VFD parameters as a minimum:
 - Motor current
 - Motor kW
 - AHU kWh
 - AHU Running hours
 - Auto / Off / Manual status feedback
 - PID controller programming
 - Set point programming
 - Alarms
 - Run & Trip status
 - Air flow status / alarm
 - Dirty filter status / alarm
 - Fault log history

- 39) The VFD shall also be able to provide the following selectable & programmable physical I/Os to the BMS system
- 5 Digital inputs (for start, stop, interlock, auto, manual, setup selection etc.)
 - 1 Relay outputs (for reading Auto / Manual status & VFD On / Off indication)
 - 1 Analog input, 4 – 20 mA (for single feedback signal to VFD)
 - 2 Analog inputs 0-10V (for feedbacks, if two feedbacks are taken)
 - 2 Analog Outputs, 4-20 mA (for speed & kW feedback to IBMS)
- 40) It shall be possible to read the digital / analog inputs and control the analog and relay outputs of the VFD from the BMS system through the serial communications, thereby enabling the drive's inputs / outputs to be used as extended I/Os for the IBMS system, to achieve maximum operational and cost efficiency.
- 41) To extent the life of a motor in a damp environment (like cooling towers), the VFD should trickle a small amount of current to the motor, while stopped, to protect it from condensation and the effects of a cold start.
- 42) Upon receiving a start command, the VFD should be able to export another signal, which can be used to start a damper / valve motor actuator. On receiving the signal from damper / valve that it is open, the VFD should start its operation. If the valve / damper is closed, the VFD should not start.
- 43) The VFD should have a start delay feature, where in it gives time to prepare for the operation, open dampers or VAV boxes before starting to accelerate the motor.
- 44) The VFD should have a fireman's override feature, where in the drive can override its standard settings to provide for a life safety application such as building pressurization or smoke purge operation.
- 45) The VFDs shall have a Real Time Clock (RTC) by which the start / stop of the system can be programmed on a real time basis along with scheduling. The RTC should also allow the speed of the VFD to be changed on the basis of actual time and also log the faults with a date and time stamp.

Section 17 : Variable Air Volume Boxes (VAV)

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, installation, testing, commissioning and carrying out performance test at site of Variable Air Volume System.

2.0 CODES and STANDARDS

The design, materials, construction features, manufacturer, inspection, testing and performance of air distribution system shall comply with all currently applicable statues, regulations, codes and standards in the locality where the system is to be installed. Nothing in this specification shall be construed to relieve the Contractor of this responsibility. In particular, the air distribution system shall conform to the latest edition of following standards.

3.0 CONSTRUCTION FEATURES

Construction details shall be generally in accordance with the details given here under.

VARIABLE AIR VOLUME (VAV) BOXES

- a. These shall of the low velocity variable air volume boxes without re-heat coils, and shall be a proprietary line as marketed by a firm specializing in this field. The contractor shall supply and install units to the quantity and locations as specified.
- b. The unit shall be complete with damper, airflow ring, and solid-state electronic controls to provide accurate room temperature control. The damper shall be aerofoil type construction with bearings.
- c. Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 22 G GSS minimum fitted with a completely sealed, easily removable means of access to all internal parts. Access to all boxes must be from the underside only.
- d. The actuator shall be of 24V AC Bi-directional, direct coupled to the damper shaft. The required transformer to step down of the voltage range from 230V to 24V shall be part of the unit. The UPS power point with an isolator near the VAV will be provided by other agencies.
- e. The unit shall be complete with transformer, access panel and other accessories as per the standard. The noise level shall be less than 35Dba.
- f. Maximum allowable static pressure to the boxes for its satisfactory operation shall not exceed 0.10 "W.G. otherwise fan and motor selections may be affected.
- g. Boxes shall be able to reset any air flow between 15% and the maximum air quantity that the boxes can handle without changing orifices or other parts. Air quantity limiters will not be accepted.
- h. A suitable device shall be provided for the field adjustment of minimum airflow. All boxes shall be initially factory set at minimum air quantity of 15% of the design requirements. Under shut-off conditions, all boxes shall not have air leakage more than 2% of the maximum air quantity at 75mm static pressure.
- i. The VAVs shall be used in standalone mode complete with its own temperature sensor and controller and shall perform the function of maintaining the temperature and airflow. However, the VAVs shall be BMS compatible to enable to network the VAVs to a Network Control Unit and onto BMS. In this mode all VAV data shall be available at the BMS workstation and it shall be possible to change set points and flow settings from the BMS workstation. VAVs shall able to release open protocol Lonworks and to integrate with any third party Building Management System.
- j. The boxes shall be pressure independent.

SECTION 18:- Technical data**Contractor shall submit catalogues of the equipment offered by him:**

Sr.No.	Equipment description	unit	Condition of service
--------	-----------------------	------	----------------------

1. Chilling Machines

- | | | | |
|------|--------------------------------|--|--|
| i. | Capacity at design (TR) | | |
| ii | Chilled water flow lpm/Usqpm | | |
| iii. | Chilled water In Temp (F) | | |
| iv. | Chilled water out temp (F) | | |
| v. | Condenser water flow lpm/Usqpm | | |
| vi. | Condenser water In Temp (F) | | |
| vii. | Condenser water out temp (F) | | |

Condenser:

- | | | | |
|-------|-------------------------------|--|--|
| i. | Manufacturer,s name | | |
| ii. | Dia. Of Condenser Shell (mm) | | |
| iii. | Length of condenser tobex (m) | | |
| iv. | No.of Tubes (Nos.) | | |
| v. | Material of Tube | | |
| vii. | Dia.of tube (mm) | | |
| viii. | No.of integral (fins/cm) | | |
| ix. | No.of passes (Nos. | | |
| x. | water velocity (m/s) | | |
| xi. | Pressure drop M) | | |
| xii. | Quantity (Nos.) | | |
| xiii. | Fouling Factor (FPS) | | |

Cooler:

- | | | | |
|-------|--------------------------|--|--|
| i. | Manufacturer,s name | | |
| ii. | Dia. Of Shell (mm) | | |
| iii. | Length of tobex (m) | | |
| iv. | No.of Tubes (Nos. | | |
| v. | Material of Tube | | |
| vi. | Dia.of tube (mm) | | |
| vii. | No.of integral (fins/cm) | | |
| viii. | No.of passes (Nos.) | | |
| ix. | Water velocity (m/s) | | |
| x. | Pressure drop (m) | | |
| xi. | Quantity (Nos.) | | |

xii.	Fouling Factor (FPS Unit)				
2.	Pumps	Chilled Water Primary	Chilled water Secondary	Condenser water	Hot water
a.	Manufacturer				
b.	Model No.				
c.	Capacity	USGPM			
d.	Head	Meter			
e.	Speed	RPM			
f.	Motor Rating	KW			
g.	Type of motor				
3.	Cooling Towers:				
a.	Manufacturer				
b.	Type				
c.	Model No.	-----			
d.	Overall Dimension	mm			
e.	Fan dia/motor rating	mm/HP			
f.	Type of motor	-----			
g.	Speed of motor	RPM			
h.	Type of drive	-----			
i.	Capacity	Kcal/Hr (TR)			
j.	Wet Bulb (design)	F			
4.	Double Skin AHUs :				
a.	Manufacturer	-			
b.	Casing	-			
c.	Coil	-			
d.	Blower	-			
e.	Type	-			
f.	Overall Dimension	-			
g.	Unit Weight	-			
h.	Air Quantity	-			
i.	Fan outlet velocity	-			
j.	Design static pressure	-			
k.	Fan balancing static/and or Dynamic				
h.	Fan motor output	-			
i.	Motor location i.e inside or outside the fan section			-	
j.	Type of casing finish	-			

- k. Type of drive/vibration Isolators -

AHU Coil Data :

- a. Cooling Coil Area -
 b. No.of Rows -
 c. No.of fins/cm -
 d. Tube Material -
 e. Tube dia -
 f. Coil Header materia -
 g. Thickness of tube -

5. FAN COIL UNITS :

- a. Manufacturer -
 b. Casing -
 c. Blower -
 d. Type -
 e. Overall Dimension -
 f. Unit Weight -
 g. Air Quantity -
 h. Cooling Coil Area -
 i. No.of Rows -
 j. No.of fins/cm -
 k. Tube Material -
 l. Tube dia -
 m. Coil Header material -
 n. Thickness of tube -
 o. Fan motor output -
 p. Impeller dia -
 q. material of Impeller -
 r. No.of fans & Speed -
 s. Capcities (cfm/TR) -
 t. Type & make of Automatic controls -
 u. Type of vibration isolators -

6. Exhaust Fans sections/Airwasher :

- a. Make -
 b. Air Quantity at Operational speed -
 c. Static Pressure -
 d. Diameter/size -

- e. Type -
- f. Current characteristics -
- g. Motor Rating -
- h. Type of Motor -
- i. Fan outlet Speed -
- j. Fan Speed -
- k. Motor Speed at the duty conditions -
- l. Operating Weight -
- m. Type of vibration isolators -
- o. Type of bearings -
- p. Performance curves -
- q. Motor Efficiency -
- r. Class of Insulation -

7. **Controls**

Make and Model of the following:

- a. Flow Switch -
- b. PID type Valves -
- c. Operating Voltage -
- d. Air Stat/Humiditystat -
- e. Pressure Gauge -
- f. Thermometer -
- g. AHU Thermostat -
- h. FCUs Thermostat -

8. **Electrical Accessories :**

Make of the following

- a. Motor Control Centre (MCC) -
- b. Air Circuit Breaker -
- c. MCCB -
- d. MCB -
- e. Rotary Switch -
- f. Soft Starter -
- g. Auto-transformer starter -
- h. Direct on line starter -
- i. Contactor -
- j. Current transformer -
- k. Single phase preventer -

- l. Push button/changeover switch -
- m. Ammeter/Voltmeter -
- n Relays -
- o Indicating Lamps -
- p. Cables/wires -

9. Water Piping;

- a. Make of pipes/class of pipes -
- b. Pipe wall thickness -

- c. Valves & Strainers Make Material

- i) Butterfly Valve
- ii) Balancing Valve
- iii) Ball Valve
- iv) Ball valve with strainer
- v) Pot Strainer
- vi) Flexible connections
- vii) Check Valves
- viii) Gate Valves
- ix) Globe Valves
- x) Y-Strainers

- c) Pressure Gauge

- i) Make

- ii) Model

- iii) Dial

- d) Thermometer - Make/Type & Range

9. Galvanised Steel Sheets :

- a. Make
- b. Gauge/Thickness
- c. Class of galvanizing

- 10. Grilles/Diffusers & Dampers/Louvers** - Make/Material/Gauge

11. Insulation

- a. Manufacturer -
- B. Duct Insulation Material/Density -
- c. Duct Acc. Lining Material/Density -
- d. Pipe Insulation Material/density -

SECTION 17:- LIST OF BUREAU OF INDIAN STANDARD CODES

IS:277-1992	-	Galvanised steel Sheet (plain & corrugated)
IS:544-1985(Reaffirmed 1996)-		Dimension for pipe Threads
IS:778	-	Valves (gate/globe/check type)
IS:655-1963	-	Metal Air Ducts
IS:13095-1991	-	Butterfly Valves
IS:659-1964	-	Air-conditioning (safety codes)
IS:1239-1990/92	-	Mild Steel Pipes
IS:325	-	3 phase induction motor
IS:822	-	Code of procedure for inspection of welds
IS:900	-	Code of practice for installation and maintenance of motors
IS:6392	-	Steel Pipe Flanges
IS:1822	-	Motor starters for voltage not exceeding 650 Volts
IEC	-	Relevant Sections
IS:996	-	Single phase small A.C. Motors
IS:4894-1987	-	Centrifugal Fans
IS:1554(I)	-	PVC Insulated (heavy duty)electric cables for working Voltage upto and including 1100 Volts
IS:8623-1993	-	Bus Bar Trunking System
IS:8828-1996& IEC898-1995	-	Miniature Circuit Breakers
IS:9537-1981 Part II	-	Rigid steel conduit for electrical wiring
IS:10810-1989	-	Method of Test of Cables
IS:13947-1989	-	Circuit Breakers
IS:13947-1993	-	Switches, disconnectors, fuse combination units
IS:139-1993(Part IV)	-	Contactors & Motor Starters
Duct Fabrication standards	-	SMACNA
ASHRAE Handbooks	-	Application 1995
	-	Fundamentals 1997
	-	System & equipment 1996
	-	Indoor Air Quality 62-1982

SECTION 18:- QUALITY CHECKS ON DUCTING

SL	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		
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		
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 19:- 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.

SECTION 20:- TECHNICAL SCHEDULE OF EQUIPMENTS

The capacity/ratings of various equipments in this contract are for guidance purpose only. a/c contractor shall check in details the design/selection of equipments. a/c contractor shall be finally responsible for maintaining the desired inside conditions and shall not deprive him of the responsibility if selection of equipments is not thoroughly checked. in case of shortfall the a/c contractor shall replace/modify equipments for achieving desired parameters without any extra cost to owner/employer.			
1.0	WATER PIPES		
	i. Material	MS	
	ii. Class	'C'	
	iii. Wall Thickness		
	25 MM TO 40 MM	4	
	50 MM TO 65 MM	4.5	
	75 MM	4.8	
	100 MM TO 150 MM	5.4	
	200 MM TO 610 MM	6.35	
2.0	GSS DUCTING		

	i. Class of Galvanizing	VIII (120 GM/SQM)	
	ii. Code of Fabrication	IS - 655 (LATEST)	
	iii. Material of Hangers	MS	
	iv. Quality of Sheet	LFQ	
3.0	INSULATION		
	A) DUCTS		
	i. Material	Closed cell cross linked polythelene foam	
	ii. Density	30 ± 3 KG/CU.M.	
	B) ACCOUSTIC LINING		
	i. Material	Fiberglass	
	ii. Density	32 KG/CU.M (minimum)	
	C) PIPE INSULATION		
	i. Material	TF' Quality Expanded Polystyrene	
	ii. Density	18 KG/CU.M (minimum)	

SECTION 21:- TEST READINGS**21.1 CHILLER TEST REPORT**

PROJECT _____
 UNIT _____
 LOCATION _____
 MANUFACTURER _____
 MODEL _____ SERIAL NO. _____
 CAPACITY _____ REFRIGERANT _____
 STARTER _____ HEATER SIZE _____

COMPRESSOR	DESIGN	ACTUAL	MOTOR STARTER	DESIGN	ACTUAL
Make/Model			Make/Model		
Serial No.			Type		
Type (Reciprocating / Centrifugal / Screw / Scroll)					
Piping Material			Amps		
Suction Pr/Tem			O/L Release Range		
Discharge Pr/Temp					
Refrigerant			EVAPORATOR	DESIGN	ACTUAL

Oil Pump Type			Make/Model		
Oil Pressure			No. of Passes		
Oil Failure Switch Pressure			Ref. Level		
Unload Arrangement			Ref: Pressure/ Temperature		
Unload Set Points			Ent. Water Temp/ Pressure		
Drive			Leaving Water Temp/ Pressure		
Compressor Speed			Temperature Difference		
Oil Level			Pressure Difference		
Oil Temperature			Water Quantity GPM		
L P Setting			Relief Valve Setting		
H P Setting			IKW / Ton		
Anti Freeze Setting					
Purge Unit Type					
Purge Operation Checked					
Make/Model			Make/Model		
Type			No. of Passes		
Voltage			Ref: Pressure/ Temperature		
Motor Rated Current			Ent. Water Temp/ Pressure		
COMPRESSOR MOTOR	DESIGN	ACTUAL	CONDENSER	DESIGN	ACTUAL
Motor F L Current			Leaving Water Temp/ Pressure		
			Temperature Difference		
			Pressure Difference		
			Water Quantity GPM		
			Relief Valve Setting		
REMARKS					
TEST DATE _____					
READING BY _____					
Note: Please Furnish test report for all chillers separately.					

21.2 PUMP TEST REPORT

PROJECT _____				
DATA	PUMP NO	PUMP NO	PUMP NO	PUMP NO
Location				
Service				
Manufacturer				
Model Number				
Serial Number				

GPM/Head				
Req. NPSH				
Pump RPM				
Impeller Mfr./Frame				
Motor Mfr./Frame				
Motor HP/RPM				
Volts/Phase/Hertz				
F.L Amps				
Seal Type				
Pump Off-Press				
Valve Shut Diff				
Actual Impeller Dia				
Valve Open differential				
Valve Open GPM				
Final Dischg.Pressure				
Final Suction Pressure				
Final Δ p				
Final GPM				
Voltage				
Amperage				

REMARKS

TEST DATE _____ **READINGS BY** _____

Note: Please Furnish test report for all CHW & CDW pumps.

21.3 AIR HANDLING EQUIPMENTS TEST REPORT

PROJECT _____ SYSTEM / UNIT _____					
LOCATION _____					
UNIT	DATA	MOTOR	DATA		
Make/Motor No.		Make / Frame			
Type/Size		H.P / RPM			
Serial Number		Volts/Phase/Cycles			
Arr./Class		F.Lamps.			
Discharge		Pulley Dia/Bore			
Pulley dia/ Bore		Pulley/ Distance			
No. Belts/make/Size					
No. Filters/type.Size (Pre.)					
No. Filters/type.Size (secondary)					
TEST DATA	DESIGN	ACTUAL	TEST DATA	DESIGN	ACTUAL
Total Cfm			Discharge S.P		

Total S.P					
Fan RPM			Cooling Coil S.P		
Motor Volts			Filters S.P		
Out air Cfm					
Return air Cfm					
REMARKS.					
TEST DATE _____					

READINGS BY _____

Note : Please Furnish above report for all AHU.

21.4 RECTANGULAR DUCT TRAVERSE REPORT

PROJECT _____ SYSTEM _____

LOCATION / ZONE _____ ACTUAL AIR TEMP. _____ DUCT S.P _____

DUCT	REQUIRED	ACTUAL
SIZE _____	FPM _____	FPM _____
SQ.FT. _____	CFM _____	CFM _____

POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
VELOCITY SUBTOTALS													

21.5 GRILLES AND DIFFUSERS TEST REPORT

PROJECT _____

SYSTEM _____

OUTLET MANUFACTURER _____

TEST APPARATUS

[illegible]

REMARKS.

TEST DATE _____ READINGS BY _____

Note : Please Furnish above report for all grills/diffusers with S.No. marked on respective drawings

CHAPTER I

TECHNICAL SPECIFICATION FOR IBMS

Section 1:- Special Conditions of Contract

General:

These are special conditions to the contract and intended for the same.

1. Scope of work:

- a) The general character and the scope of work to be carried out under this contract is illustrated in the Data Point Summary, specifications and the schedule of the quantities. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the owner's site representative/consultants. The contractor shall furnish all labor, materials and equipment as listed under the schedule of quantities and specified otherwise, transportation and incidentals necessary for supply, installation, testing and commissioning of the complete IBMS system as described in the specifications. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the documents as being furnished or installed. But which are necessary and customary to be performed under this contract and which are required under the Bill of Quantities and the specifications for the central Integrated Building Automation System.

2. Associated Civil Works:

All civil works associated with IBMS installations like making openings to run the conduits and making them good and any other as required shall be covered under the scope of this contract.

3. Project Execution and management:

The contractor shall ensure that senior planning and execution personnel from his organization are assigned exclusively for this project. They shall have minimum 10 years experience in this type of installations.

For quality control & monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control, adherence to the specifications and ensuring top class workmanship for the air-conditioning installation.

The contractor shall arrange to have mechanized and modern facilities for transportation of materials to the place of installation for speedy execution of work.

4. Performance Guarantee:

The Contractor shall carry out the works in accordance with the specifications, schedule of the quantities and other documents forming part of the contract. The contractor shall be fully responsible for the performance of selected items/equipment (installed by him) at the specified parameters and for the efficiency of the installations to deliver the required end results. The contractor shall guarantee that the IBMS system as installed shall maintain the parameters required under the BOQ and specifications. The guarantee shall be submitted in the Performa sheet. Complete set of architectural drawings are available in the office of architect/consultants and reference may be made to same for any detail or information. The contractor shall also

guarantee that the performance of various equipment individually, shall not be less than the quoted capacity.

5. Bye-Laws and Regulations:

The installations shall be in conformity with the by-laws and regulations and standards of the local authorities concerned, in so far as these become applicable to the installations. But if these specifications and drawings call for a higher standard of material and /or workmanship than those required by any of the above regulations and standards then these drawings and specifications shall take precedence over the said regulations and standards. However if the specifications require something which violates the bye-laws and regulations, then the bye-laws and regulations shall govern the requirement of the installations.

6. Fees and permits:

The contractor shall obtain all permits/licenses and pay for any or all fees required for inspection, approvals and commissioning of their installations if required.

7. Technical Datas:

Each tenderer shall submit along with his tender, the technical data for all items. Failure to submit complete data with the tenders may result in summary rejection of the tender.

8. Shop Drawings:

- 8.1** All the shop drawings shall be prepared on computer through Autocad system based on the architectural drawings, site measurements and interior designers' drawings. These shop drawings shall contain all information required to complete terminations. These shop drawings shall contain all the information required to complete the project as per specifications and as required by the Architect/Consultant/Owners site representative. These drawings shall contain details of constructions, size arrangement, operating clearances, performance characteristics and capacity of all items of equipment. Each shop drawing shall contain tabulation of all measurable items of equipment/material/works and progressive cumulative totals from other related drawings to arrive at a variation in quantity statement at the completion of all shop drawings. Minimum 7 sets of drawings shall be submitted after final approval along with their floppies.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufactures listed in under the approved list of makes and quoted by tenderer in technical data part of tender.

When the Architect/Consultant makes any amendment in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints for approval. The contractor shall submit further 7 sets of the shop drawings

When the Architect/Consultant makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with amendments duly incorporated along with check prints for approval. The contractor shall submit further seven copies of shop drawings to the owner's site representative for the exclusive use of the owner's site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession the approved shop drawing for the particular material/equipment/installations.

- 8.2** Shop drawings shall be submitted for approval four weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in works due to his

failure to produce shop drawings at the right time in accordance with the approved program.

- 8.3 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which the material /equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data for general nature shall not be accepted.
- 8.4 Samples of all materials like sensors, field devices, controls, control wires etc. shall be submitted to the owner's site representative prior to procurement. These will be submitted in 2 sets of approval and retention by owners' site representative and shall be kept in their site office for reference and verification till the completion of the project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installations.
- 8.5 Approval of shop drawings shall not be considered as a guarantee of measurement or that of a building dimension. Where drawings are approved said approval doesn't mean that the drawings supercede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirements to furnish material and perform as required by the contract.
- 8.6 Where contractor propose to use an item or equipment other than that specified or detailed on the drawing which requires any redesign of the structure, partitions , foundations, piping or any other apart of the electrical and architectural layouts ,all such redesign and all new drawings and detailing required therefore shall be prepared by the contractor at his own expenses and gotten approved by the architect/consultant/owners site representative. Any delay on such account shall be at the cost and consequences to the contractor.
- 8.7 IBMS contractor shall prepare coordinated service shop drawings based on the drawings prepared by HVAC, electrical, plumbing & low voltage contractors to ensure adequate clearances are available for installation of service for each trade. Where the work of the contractor has to be installed in close proximity to or will interfere with the work of other trade he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the owner's site representative, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to work of the other trades. If the contractor installs his works before coordinating with other trades or so to cause any interference with work of other trades he shall make all necessary changes without extra cost to the owner.
- 8.8 Within four weeks of the approval of the relevant shop drawings the contractor shall submit four copies of a comprehensive variation in quantity statement and itemized price list of recommended (by manufacturer) imported and local spare parts and tools covering all the materials/equipment in the contract. The project manager shall make recommendation to owner for acceptance of anticipated variation in contract amounts and also advise Owner to initiate action for procurement of spare parts and tools at the completion of project.

9. Quite Operation and Vibration Isolation:

All equipment shall operate under all conditions of load without any sound and vibration which is objectionable in the opinion of the owner's site representative.

In case of rotating machinery sound or vibration noticeable outside the room in which it is installed or annoyingly noticeable inside its own room shall be considered objectionable. Such condition shall be corrected by the contractor at his own expenses. The contractor shall guarantee that the equipment installed shall maintain the specified NC levels.

10. Accessibility:

The contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceiling for proper installation of his work. His failure to communicate is insufficiency of the same. The contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions.

11. Materials and equipment :

All materials and equipment shall conform to the relevant Indian standards and shall be of the approved make and design. Makes shall be strictly in conformity with the list of approved manufactures.

12. Manufactures Instructions :

Where manufacturer has furnished specific instructions relating to the material/equipment used in this project, covering points especially not mentioned in these documents, such instructions shall be followed in all cases.

13. COMPLETION CERTIFICATE:

On completion of the installation for IBMS a certificate shall be furnished by the contractor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority if applicable.

14. TESTING AND COMMISSIONING

Four copies of the certified manufacturers performance certificates for each piece of equipment, highlighting operational parameters for the project, shall be submitted along with the test certificates. Contractors shall also provide four copies of record of all safety and automatic control settings for entire installation.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the owners' site representative. All tests shall be carried out in presence of the representatives of the architect/consultant and owner's site representative.

15. COMPLETION DRAWINGS

Contractor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of floppies/CD's and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as installed. These drawings shall clearly indicate complete plant room layouts, location of wiring and sequencing of automatic controls, locations of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The contractor shall frame under glass, in the IBMS room, one set of these consolidated control diagrams.

16. Operating Instructions & Maintenance Manual:

Upon completion and commissioning of part IBMS system the contractor shall submit a draft copy of operating instructions, maintenance schedules and log sheets for all system and equipment included in this contract. This shall be supplementary to manufacturers operating and maintenance manual. Upon approval of the draft the contractor shall submit four complete bound set of typewritten operating instructions and maintenance manuals. One each for retention by consultant and the clients' representative and two for owners' operating personnel. These manuals shall also include basis of design, detailed

technical data for each piece of equipment as installed, spare parts manual and recommended spares for 3 years period of maintenance of each equipment.

17. On Site Training:

Upon completion of all works and all tests, the contractor shall furnish necessary operator's labor and helpers for operating the entire installation for a period not less than two weeks of ten hours each to enable the owners' staff get acquainted with the operation of the system. During this period the contractor shall train the owners personnel in the operation, adjustment and maintenance of all equipment installed.

18. Maintenance during defects Liability Period:

18.1 Complaints:

The contractor shall receive calls for any or all problems experienced in the operation of the system under this contract, attend to these within four hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

18.2 Repairs:

All equipment that requires repairing shall be immediately serviced and repaired. Since the period of mechanical maintenance runs for two years concurrently with the defects liability period, all replacement parts and labor shall be supplied promptly free of charge to the owner.

19. Uptime Guarantee:

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the defects liability period gets extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period the contract shall get extended by a month for every month having the shortfall and no reimbursement shall be done for the extended period.

The contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all temperature, pressure, humidity, power consumption starting and stopping times for various equipment, daily service rendered for the system alarms, maintenance records of unusual observations etc.

Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the owners' site representative / consultant's review. This should include the type of service planned to be offered during the defects liability period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the management.

The tenderer shall include a list of such project where such operation assistance has been provided.

20. Manpower:

- i) Adequate number of persons to the satisfaction of the owner's site representative shall be provided including relievers.
- ii) Statutory requirements of EPF, ESIC and other applicable labor legislations to be complied with: and monthly certificate to that effect be submitted.
- iii) Duty allocation and roaster control shall be contractor's responsibility.
- iv) No overtime shall be paid by the owner for reasons whatsoever.

Section 2:- Specifications

1.0 SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY

The system will consist of a flat, open architecture that utilizes the Bacnet/LonTalk protocol as the common communication protocol between all controlled and controlling devices, and LNS architecture for the definition of the device database. No other device database structure will be permitted. When necessary or desired, bacnet/LonTalk packets shall be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Any such encapsulation of the LonTalk protocol into IP datagram's shall conform to existing bacnet/LonMark guidelines for such encapsulation. Systems that utilize non standard routing methods or hierarchal systems consisting of master or global controllers that poll and/or control less intelligent unitary controllers on a secondary bus will not be considered.

Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC , electrical, Fire & plumbing and electrical system etc.) and carry out followings functions:

- a. Individual input/output point scanning, processing and control.
- b. Centralized operation of the plant (remote control).
- c. Dynamic graphic details of plant and building.
- d. Energy Management through optimization of all connected electrical and mechanical plants.
- e. Alarm Detection and early recognition of faults.
- f. Time, event and holiday scheduling as well as temporary scheduling.
- g. Prevention of unauthorized or unwanted access.
- h. Communication interface and control.

The control system shall be designed such that mechanical equipment will be able to operate under stand-alone control. In general, the operation of any controllers on the network shall not rely on any other controller for its functional operation. System controllers that require a master computer will not be considered. Function specific modules may be used to supplement the functionality resident in each controller. As such, in the event of a network communication failure or the loss of any other controller on the LON, the control system shall continue to independently operate under local control of the resident program stored in nonvolatile memory as detailed herein. In such a case, each individual controller shall continue to perform basic functions until a network connection can be restored.

Each stand-alone intelligent outstation shall control a maximum of One AHU and shall be located adjacent to the Units.

The number of controllers for central plant room equipments shall be decided by the contractor with a maximum capacity limited to 18 points per controller. Overall, the system shall be provided with 15% spare capacity, with spare of at least 15% points on each controller. Also, in case of HVAC system, each controller shall control maximum one chiller and associated chilled water pump.

There shall be one control station located in Building Automation Room. The computer shall be sized to cover the graphic display memory and planning information. The display shall be in the form of dynamic colour graphics and text format with menu driven pop-up windows and help facility.

Reference Standards

1. Control system components shall be new and in conformance with the following applicable standards for products specified:
 - i. ANSI/EIA 709.1 (LonTalk Protocol)
 - ii. LonMark Certified (Version 3.1 Guidelines)
 - iii. UL 916 (Energy Management Equipment)

Products

1. Utilize standard components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.
2. All products (PCU's, TDCU's and ID's) shall contain LonWorks networking elements to allow ease of integration of devices from multiple vendors.
3. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

2.0 CENTRAL STATIONS HARDWARE

The Control stations shall comprise of Personal computers (PC) providing high-level operator interface with the system. The terminals shall be capable of providing the operator with the facility for remote system interrogation, control, and retrieval / storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC \pm 10%, 50 HZ \pm 3%.

a. Minimum Specifications for Workstations

FEATURES	DESCRIPTION
Processor	Intel I core 3.0 Ghz
Memory	512 MB, DDR 333 Mhz expandable to 2 GB
Cache (External)	512 KB Pipeline burst cache
ROM	256 Flash ROM. Can be upgraded from a diskette
Expansion Bus	3 PCI Slots, 4 ISA slots (3 slot shared)
Graphic Accelerator	ATI RagePro/AGP graphics accelerator. 4 MB SDRAM
Hard Disk	1 TB HDD
Power Supply	350 W switchable/50 Hz
Keyboard	104 keys window 98 keyboard. PS/2 Compatible
Operating System	Supports Windows XP, OS/2 Warp, Windows NT, DOS 6.22
Software	Office XP/Vista
Power Management	EPA compliant
Desktop Manager	Based on SNMP protocol
Antivirus Software	PC-Cilin or equivalent pre-loaded
Diagnostic Software	PAQ 95 or equivalent pre-loaded
Network	100 Mbps Network Interface Card with wake on

CD Writer	Built in 52X CD Writer with speakers
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- b) Key board : The central station shall be complete with detached 101-keys keyboard which includes full upper/lower case ASCII keyset, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.
- c) Colour Monitor : The colour monitors shall be with a minimum 21 inch diagonal nonglare screen and minimum Super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 base colors. The monitor shall be with tilt and swivel facilities.
- d) Mouse : For keyboard less operation, in addition to the enhanced keyboard, a mouse shall also be provided as an alternative user interface for day to day system operation. 2 Nos. mouse pads shall be provided for each mouse.
- e) Printers: The contractor shall provide printers as specified for printing alarms, operator transactions and reports.

There shall be two printers with each Control Station. One printer shall be dedicated for alarm printing and the second printer for printing reports, trend log, summary, tantalizer logging, recording alarms and providing system reports etc. Each of these shall be identical and inter-changeable, and shall have the following characteristics:

- i) All the printers shall be Dot matrix printers.
- ii) 132 column/300 character per second print speed with minimum 24 pin head.
- iii) Adjustable line spacing of six or eight lines per inch with compressed mode option and bidirectional printing and logic seeking.
- f) The available PCI slots on the PC shall be used only for communication cards and shall not be utilized for mounting protocol converter cards. If protocol Oconverter cards are used, they shall be external to PC and separately powered and backed-up by the UPS supply.

3.0 CENTRAL STATION SOFTWARE

1. Command & Operating Software

- a. As a minimum, the menu driven command and operating software shall permit the operator to perform the following tasks with a minimum knowledge of the HVAC Control System provided and basic computing skills.
 - i. Configure the network.
 - ii. Create control sequences.
 - iii. Graphical interface to systems.
- b. Provide additional third party software to permit the operator to manage hard drive files such as access, delete, copy, modify, etc. The package shall be object oriented and permit the user to manage directories upon boot-up. The file management software shall organize directories and sub-directories using files, file folder objects.
- c. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
- d. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict

the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

- e. System Diagnostics. The system shall automatically monitor the operation of all HVAC control workstations, printers, modems, network connections, and nodes. The failure of these devices shall be annunciated to the operator.
- f. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. Data shall be able to transferable to other software packages so as to create custom reports.
- g. Web Browser Access: The DDC system shall provide total integration of the facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.

2. Graphical Object-Oriented Programming Software

- a. The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in LONWORKS® programmable nodes. The graphical object-oriented programming function shall provide programming elements to be connected together to create a logic diagram. The graphical object-oriented programming function shall include elements for mathematical, logical, timing, setpoint, display and input/output functions to create logic diagrams that represent sequences of operation for LPNs.
- b. Program elements shall be able to be combined into a custom template that can then be used as a standard function.
- c. Program checkout and debug tools shall include display of real-time and/or simulated system variables and inter-object data on the programming screens. The user shall be able to assign fixed or variable values to inputs during the dynamic debugging of the control sequence.
- d. The graphical programming tools shall provide the ability to print I/O lists, lists of standard network variables and lists of all parameters to be viewed by the HMI.
- e. The programming software shall reside on each POT and OW server for programming and/or configuring each model of LPN on the project. The applications shall be downloaded and executed at the appropriate nodes. The software shall allow for updated applications via the network from the OW.
- f. DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each LPN shall have available a full library of DDC algorithms, intrinsic control operators, arithmetic, trigonometric, logic, Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and relational operators for implementation of control sequences. 2-Position, Floating, Standard I/O And Counter Inputs, Time Based Data, Curve Fit Function, Psychometric Functions, Integration.

- g. All DDC setpoints, gains, and time constants associated with DDC programs shall be available to the operator for display and modification via the POT, DDU or OW interface.
3. Library of Applications: A library of control, application, and graphic objects shall be provided to enable the creation of applications and user interface screens. Provide the capability to cut & paste objects and libraries into applications for a node/system. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together, using a built-in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.
 4. Provide integral trend-logging presentation in the programming screen.
 5. Print capability, with page break reference tags to allow down to 8 ½"x 11" size paper
 6. Off-line simulations (step function, continuous run function, simulation of external inputs)
 7. Dynamic presentation of logic in on-line state (all intermediate values)
 8. Text to logic screens
 9. Memory monitoring
 10. Power cycle restart function
 11. Run-time capability
 12. Calculator objects, (basic stuff), including if-then-else, log, ln, exp, and trig functions.
 13. Recognize standard network variable type data (nvi) and create network variables to put on the network (nvo)
 14. Programming Objects
 - a. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects, regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.
 - b. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - c. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system (step function and run mode, integral trend logging).
 - d. The system shall support object duplication within the Owner's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

15. Object Libraries

- a. A standard library of object function blocks shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- b. The function blocks in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- c. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
- d. Application Specific Node Configuration software Tools: Provide application specific node configuration software tools that will permit the individual LASN to be configured and commissioned with appropriate parameters. This software will reside on the POT. Functionality shall include:
 - i. Recognize all Standard Configuration Parameters (SCPTs)
 - ii. Provide capability for setting all Standard Configuration Parameters (SCPTs)
 - iii. Translation capability for user defined configuration parameters
 - iv. Monitoring capability for nvo's from the nodes
 - v. Ability to set the values for nvi's to the nodes
- e. Network Management
 - i. LonMaker for Windows network management software tool shall be used to assign domain, subnet, and node addresses to nodes; configure all routers and repeaters; define network data connections between LonWorks® device network variables, known as "binding;" and record binding data into node addressing tables, and create a database of all addressing and binding information for all nodes on the network.
 - ii. Network management shall include the following services: browse all network variables on nodes; Attach, Detach, Manage, Add, Remove, and Replace nodes; plus transmission error off-line, on-line reporting.
 - iii. The network management database shall be resident in the operator workstation server, ensuring that anyone with proper user name/password authorization has access to the network management database at all times.
 - iv. The software shall have Client/server capability to allow multiple users ability to manipulate the database simultaneously.
- f. Human-Machine Interface - Operator Workstation Software
 - i. The HMI shall be a Web Server technology to allow multiple client access to an Ethernet connected server. The workstation shall operate also as a stand-alone workstation/server.

ii. The software shall enable an operator to interact with various devices including LonWorks® nodes, recorders, input/output (I/O) systems, intelligent transmitters, and other field devices.

iii. It shall provide the following functions:

- Calendar.
- Scheduling.
- Trending.
- Alarm monitoring and routing.
- Time synchronization.
- Time zone handling
- Integration of LONWORKS® controller data
- Object linking and embedding for process control (OPC) for connectivity to third party OPC compliant software/devices
- Color graphic display
- On-line plots
- Use Microsoft NT security
- System documentation generation
- Dynamic data exchange (DDE)
- Dispatch of a single time schedule to all programmable nodes

iv. System Configuration. At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access:

- Create, delete, upload, or modify control strategies.
- Add/delete objects to the system.
- Tune control loops through the adjustment of control loop parameters.
- Enable or disable systems
- Generate text file reports to a networked printer.
- Select points to be alarmable and define the alarm state.
- Configure alarms to be sent to Microsoft windows mail client
- Select points to be trended over a period of time and initiate the recording of values automatically.
- Provide different levels of security to every object in the HMI database
- Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords

v. Event Alarm Notification and Actions

- The HMI software shall provide alarm recognition, storage, routing, management, and analysis.

- The HMI software shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
- Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - To alarm.
 - Return to normal.
 - To fault.
- Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
- Provide timed (schedule) routing of alarms by class, object, group, or node.
- Provide alarm generation from “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- Control equipment and network failures shall be treated as alarms and annunciated.
- Alarms shall be annunciated in any of the following manners as defined by the user:
 - Screen message text.
 - Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - Day of week.
 - Time of day.
 - Recipient.
 - Pagers via paging services that initiate a page on receipt of email message.
- Auto answer (at OWS) and auto dial (from node)
- Graphic with flashing alarm object(s).
- Printed message, routed directly to a dedicated alarm printer.
- Audio messages.
- The following shall be recorded by the OWS HMI software for each alarm (at a minimum):
 - Time and date.
 - Location (building, floor, zone, office number, etc.).
 - Equipment (air handler #, accessway, etc.).
 - Acknowledge time, date, and user who issued acknowledgement.
 - Number of occurrences
- Alarm actions may be initiated by user defined programmable objects created for that purpose.

- Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.
- Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.
- Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.
- The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. An alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms.
- The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

16. Data Collection and Storage Requirements

- a. The OWS HMI shall have the ability to collect data for any property of any object and store this data for future use.
- b. The data collection shall be performed by objects, resident in the node, and if desired OWS, shall have, at a minimum, the following configurable properties:
 - i. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - ii. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - iii. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - iv. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 - v. All log data shall be stored in a database in the OWS HIM and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
 - vi. Systems that cannot provide log data in HTML formats at a minimum shall not be acceptable.
 - vii. The OW shall have the ability to archive its log data either locally (to itself), or remotely to a OWS server. Provide the ability to configure the following archiving properties, at a minimum:
 - Archive on time of day.
 - Archive on user-defined number of data stores in the log (buffer size).
 - Archive when log has reached its user-defined capacity of data stores.
 - Provide ability to clear logs once archived.

17. Audit Log

Provide and maintain an Audit Log that tracks all activities performed on the OWS HMI. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to OWS HMI or to a server. For each log entry, provide the following data:

- a. Time and date.
- b. User ID.
- c. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

18. Database Backup And Storage

- a. The OW shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- b. Shall have the ability to automatically complete full or partial backups; and have the ability to full or partial restore. Partial is defined as only items that have changed in the database.
- c. Copies of the current database and, at the most recently saved database shall be stored in the OW. The age of the most recently saved database is dependent on the user-defined database save interval.

19. Graphical Real-Time Displays. The HMI, shall at a minimum, support the following graphical features and functions:

- a. Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.
- b. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
- c. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
- d. Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered.
- e. Adjustments to analog objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value.
- f. The OWS shall be able to support multiple graphic objects at the same time. If tiled, then each graphical object shall be fully scalable or aspect locked.
- g. Trend Displays (variable versus time) - A trend display shall show the values of points plotted versus time similar to a strip chart recorder. Eight tags shall be trended per trend. The HMI software shall provide real-time and historical trending (for data which had been logged). This may be achieved by either color graphic page display or an Microsoft excel based display.

- h. Real-Time Trends - shall contain real-time data without consuming hard disk space.
 - i. Historical Trends Logs - A historical trend log display presents data stored on the computer's hard disk.
 - j. X-Y Plots (variable versus variable) - An x-y plot shall dynamically represent the real-time or historical relationship one variable plotted against another variable.
 - k. Automatic Generation - All trends and plots shall be self-generated and not require any programming by the user.
 - l. The HMI software shall provide dialog boxes and menu picks for configuring trends and plots.
 - m. Any analog or binary data may be trended or plotted.
 - n. The software shall store pre-configured presentation of trends to facilitate operator call-up of trend log displays. It shall be possible to call up a trend log with pre-assigned data.
20. Graphics Builder - The HMI software shall provide a graphics builder.
- a. Display Documentation - The graphics builder shall provide show, simulate, review, and document animation functions to allow the user to identify, diagnose, change, and document animation points on each display.
 - b. A library of vendor-supplied objects will be included. These objects, widgets, and symbols must be continuously scalable. These items shall be editable by the user.
 - c. A library of animated graphic objects shall be included.
 - d. Animation - The Graphics Builder will animate process graphics with real-time data from field devices.
 - e. Multi-State Color Animation shall be provided to change a graphic object's color from a palette of colors.
 - f. Alarm Color - Color animation for normal, alarm, and alarm acknowledged states for both analog and binary point tags shall be provided. The user shall define the foreground and background colors for each state.
 - g. Alarm Blink - Objects and text data shall blink based on alarm state and acknowledged state.
 - h. Text and Numeric Animation - The software shall display the numeric value of an analog point, text of a text point, and the descriptors of a binary point. Display Linking - The software shall provide a display linking function. Clicking the object associated with the link changes the display to a new user-defined display.
 - i. Pickable/Non-Pickable - The software shall enable active points to be selected with the mouse and accessed. It shall be possible to make a point non-pickable: the dynamic information shall be displayed, but the operator will not be able to access a detail display, change the value, etc. based on security settings of the software.
 - j. Ability to open external executable files from button click
 - k. Ability to open HTML web pages from button click

- I. Ability to view Microsoft Excel files from button click
- 21. On-Line Help. Provide a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.
- 22. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.
 - a. System security shall be selectable for each operator.
 - b. The system administrator shall have the ability to set passwords and security levels for all other operators.
 - c. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
 - d. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
 - e. All system security data shall be stored in an encrypted format.
 - f. Each object in the HMI database must be able to have a security policy applied to it.
- 23. System Diagnostics. The system shall automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciated to the operator.
- 24. DDE Server - The HMI software shall be able to communicate and exchange data with any Third Party DDE compliant application.
- 25. The same software will act as programming software.

4.0 DIRECT DIGITAL CONTROLLER

- a. DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT:
 - i. DDC controllers shall be capable of fully "stand- alone" operation i.e. in the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own. The controllers shall be LonWorks based products.
 - ii. The controllers shall consist of minimum single 16/32-bit microprocessors for reliable throughput, based with EEPROM based operating system (O.S.).
 - iii. The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of number of points being controlled by them.
 - iv. The controllers shall be UL listed and conforming to CE (Euro norms).
 - v. Controllers requiring nickle-cadmium/lithium battery to support the full operation of the RAM, shall have battery back-up upto 12 hours in the event of a localised mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.

In addition to the above battery reserve a further battery shall be provided to retain the RAM for a minimum of 2 days, after the expiration of the standard battery.

A low battery alarm shall be provided with each Controller and with an indication at the Control Station. In case the memory is stored on EEPROM, the battery backup will not be required.

- vi. The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.
- vii. The controllers shall have a resident real time for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network.

Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

- viii. The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 18 input/output (I/O) hardware points (with or without an expansion board). DDC's with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points.
- ix. If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met:
 - a. In addition to the basic outstation, a minimum of two slots shall be provided for the insertion of plug-in function cards.
 - b. The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.
 - c. The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.
- x. The DDC's shall have 15% spare capacity (digital/analog input/output) to give flexibility for future expansion.
- xi. All DDC controllers shall be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

Analog inputs/outputs of the following minimum types shall be supported:

- a. 4-20 mA.
- b. 0-1 volts.
- c. 0-10 volts.
- d. 0-5 volts, and
- e. 2-10 volts.
- f. Resistance Signals (either PTC or NTC)
(PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

Digital input/output types to be supported shall be, but not limited to the following:

- a. Normally-open contacts.
- b. Normally-closed contacts.

Modulating outputs shall be true proportional outputs and not floating control type.

- xii. Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.
- xiii. All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.
- xiv. Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, and Bus Error. All LED's shall be visible without opening the panel door.
- xv. It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localized mains failure.
- xvi. Controllers requiring fan cooling are not acceptable.
- xvii. There shall be the facility for accessing controller data information locally, via a portable plug-in keypad display which can be common to all controllers and normally removed to prevent unauthorized tampering. Alternatively each controller shall have a keypad and display integral with its casing for local interrogation and adjustment. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.
- xviii. In case the Portable operator Terminals (POT) are required to programme the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.
- xix. The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.
- xx. It shall be possible to add new controllers to the system without taking any part of the system off-line.

b. DIRECT DIGITAL CONTROLLERS CAPABILITIES:

- i. The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.
- ii. Operating system (O.S.) software for controllers shall be EPROM resident.

Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.
- iii. In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

- iv. In the event of memory loss of a Controller, or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded automatically and without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.
- v. Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.
- vi. Controllers must be able to perform the following energy management functions as a minimum.
 - a. Time & Event programs
 - b. Holiday Scheduling
 - c. Maximum and Distributed power demand
 - d. Optimum start and stop program
 - e. Night purge
 - f. Load reset
 - g. Zero energy bands
 - h. Duty cycle
 - i. Enthalpy analysis and control
 - j. Run Time Totalization
 - k. Sequencing and Optimization
 - l. Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Consultant.

- vii. The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience and current operating conditions.
- viii. Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.
Tenderers shall indicate their proposed system alarm handling capability & features.
- ix. Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.
- x. It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

- xi. Distributed power demand program shall be based on a sliding window instantaneous demand trend algorithm. The DDC interfaced to the demand meter shall calculate the demand, forecast the demand trend, compare it to the established demand limits, and initiate load shedding or re-establishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last.
- c. **SYSTEM INTERFACE UNITS (SIU) / LAN ROUTERS / REPEATERS**
 - i. **General**
 - a. Equip each router with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP).
 - b. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
 - c. Routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
 - d. Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
 - e. The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.
 - f. Provide a minimum of two Neuron 3120 or 3150 processors for use as the network router communication controller.
 - ii. **Ethernet IP Router**
 - a. Equip each router with an Ethernet IP communication on one side and a LonTalk® transceiver Type 1 FTT or Type 2 - TP on the other side.
 - a. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
 - b. On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.
 - c. On the LonTalk® side, the routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
 - d. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
 - e. The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

5.0 PORTABLE OPERATORS TERMINAL (POT)

- a. **General Requirements.**
 - i. The DDUs shall permit the project operating staff to:
 - a. Display point values
 - b. Display parameters
 - c. Change time schedule elements

- d. List and acknowledge alarms
- e. Monitor points in the system
- f. Command points (manual overrides) of points
- g. Override input points (put inputs in test)
- h. Read and check LonWorks variables on the network
- i. Password protected
- j. Node configuration for Fan Coil and Rooftop Unit TCUs
- ii. DDU with the following components:
 - a. Liquid Crystal Display
 - b. Minimum 4x20 character
 - c. Pushbuttons for scrolling display and enter
 - d. Permanent mount or portable connection.

6.0 DATA COMMUNICATION

The communication between controllers shall be via a dedicated communication network as per LonWorks recommended standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

- a. Every DDC must be capable of communicating with all DDC's.
- b. Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retries shall constitute a communication or device failure.

7.0 FIELD DEVICES

a. ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

General Requirements

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

- (i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

(ii) Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

Additional features

- (i) Concealed Adjustment: All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.
- (ii) Operating Voltage : All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

b. TEMPERATURE SENSOR

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :

- 1) Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 0.33 degrees F and sensitivity of at least 2 ohm/F.
- 2) Immersion sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm².
- 3) The connection to the pipe shall be screwed ¾ inch NPT (M). An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.
- 4) The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
- 5) Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
- 6) Outdoor air temperature sensor shall be provided with a sun shield.
- 7) The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types:

- 1) PT 100, PT 1000, PT 3000
- 2) NI 100, NI 1000
- 3) Balco 500.
- 4) Thermistor
- 5) NTC1800

c. HUMIDITY SENSOR

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

d. FLOW METER

Water flow meters shall be either ultrasonic type or electromagnetic type. For electromagnetic flow meter, Teflon lining with 316 SS electrodes must be provided. The housing shall have IP 55 protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.

The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to 'zero' the flowmeter without any external instruments, with the overall accuracy of at least $\pm 1\%$ full scale.

e. PRESSURE TRANSMITTER FOR WATER

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10°C to 60°C with ambient ranging between 0°C to 55°C .

f. DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

g. DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1 A rating.

The switch shall be supplied suitable for wall mounting on ducts in any plane. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and have differentials adjustable over 10%-30% of the scale range.

The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

h. AIR FLOW SWITCHES

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 2 NO/NC potential free. Site adjustable scale shall also be provided.

i. AIR PRESSURE SENSOR

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

j. WATER FLOW SWITCH

These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 2NO/2NC potential free.

k. TRANSDUCERS FOR ELECTRICAL SERVICES

Electrical transducers shall be integrated electronic type and rack mounted on the field. These shall work on 230 V supply with the output being standard type i.e. 4-20 mA, 0- 10 Volts etc.

Power factor, Voltage, Current, Frequency and Kilowatt transducers shall have standard output signal for measurement for the specified variable.

Kilowatt-Hour metering (if any) shall be poly-phase; three- element with current transformer (CT) operated type. The metering shall feature high accuracy with no more than +/- 1% error over the expected load range. The coils shall be totally encapsulated against high impulse levels.

l. LEVEL SWITCH

The level switches shall have to meet the following requirement:

Type	:	Float Type/Capacitance Type/Conductivity type
Mounting	:	To suit application.
Connection	:	Flanged ANSI 150 lbs RF Carbon steel
Float material	:	316 SS
Stem Material	:	316 SS
Output	:	2 NO, 2 NC potential free
Switch Enclosure:	:	IP 55

m. CONTROL VALVES (AIR HANDLING UNITS)

Control valves for the Air Handling Unit's shall be globe type, two way suitable for Variable flow hydraulic system.

The Manufacturer's standards shall be applicable for these valves.

Valves

a.	Type	:	Two way mixing
b.	Stem / Trim	:	SS-316 or better
c.	Plug and seat	:	SS-316 or better
d.	Plug characteristics	:	Equal Percentage
e.	Service	:	Chilled water
f.	Stroke Length	:	Minimum 20 mm
g.	Compliance	:	IEC 534
h.	Packing	:	Teflon

Actuator

a.	Actuator	:	Electrical/Electronic/Magnetic.
b.	Actuator type	:	Proportionating(Modulating)
c.	Spring return function	:	Yes
d.	Travel limit switch	:	2 Nos. for open and close.
e.	Hand wheel	:	Required
f.	Input signal	:	0 – 10 V dc, 4 –20 mA
g.	Power Supply	:	240 V ac
h.	Thrust	:	To be selected by the vendor
i.	End Connections	:	Screwed upto 2" Beyond that ANSI 150 Lb RF
j.	Noise Level	:	Not exceeding 70 DB
k.	Weather Proof	:	NEMAI

Note:

Actuator should be directly coupled to the trim. Eccentric linkages not acceptable.

Leakage not to exceed 0.1% of flow.

n. CONTROL FOR FCU

Control valves for the Air Handling Unit's shall be globe type, two way suitable for Variable flow hydronic system as indicated in BOQ.

i. Two way motorized valves

Two way motorized valves shall be provided in chilled water lines at each fan coil units. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing chilled water through the coil. The valve shall be provided with spring return function so that it reverts to fully closed position when fan is shut off. Valve shall be two/three position with flare connections. Valve shall have the facility to replace motor \ actuator without removing the valve body. Actuator shall be suitable for 240 V, 50 Hz ac or 24V ac. Maximum close off pressure shall be selected to suite the CV requirement.

ii. Thermostats

Thermostat shall be snap acting fixed differential type thermostat for air-conditioning application for actuating the two way valve at each fan coil unit with HI-MED-LO fan switch and system setting OFF-FAN-COOL. Switching off must break fan circuit. Thermostat shall be provided with necessary relays to operate valve of cooling coil.

o. TWO WAY MOTORIZED BUTTERFLY VALVE

i. Valve

a.	Type of valve	Butterfly Valve.
b.	Body Material	Carbon steel ASTM A 216
c.	Body seat ring (if applicable)	Gr WCB
d.	Vane	SS-316
e.	Packing	Teflon
f.	Mounting Stool	Required.
g.	Shaft	SS-316
h.	Seat	Nitrile rubber
J	Fasteners	SS-316

ii. Actuators

Type	Electric
Duty.	On/Off (Maximum 50 operations per
Motor power supply	230 V AC or 415 V 3-phase
Travel limit switches	2 Nos
Torque limit switches.	2 Nos
Hand wheel	Required
Speed	Approx 150 mm/min

NOTE

- a. Actuator must open/ close with one changeover contact. Control panel, if required, must be supplied integral with the Actuator.
- b. No gear box is envisaged, however if gear box is provided, the travel limit switches must be connected directly to the valve stem.
- c. Cover tube for the valve stem must be provided

8.0 ELECTRONIC METERING

Electronic metering shall be provided on the main LT panel at incoming and outgoing feeders. These meters shall be free supply by the BAS contractor to the Electrical contractor whereby these shall be installed in the LT panel by the Electrical contractor. The electrical contractor shall also provide necessary CT, PT and 220 V power input for the meters. All further control wiring and networking of the meters shall be in scope of BAS contractor.

The specifications for the electronic meters to be supplied by BAS contractor is as follows:

Type	:	Static Power Meter
		Class 1.0 accuracy.
Instantaneous		
Measurements	:	a. V (1-n), V (1-1) & 1 per ph & avg. V & I unbalance
		b. PF per ph & total, frequency

- c. Power & BI-directional energy (active, apparent, reactive)
- d. Peak & Predictive Demand (I, W, VA, VAR totals)
- e. V & I harmonics (Individual & Total)
- f. Time of use (internal calendar, multiple daily tariff, energy & demand accumulators).

- Features :
- a. Event Triggered
 - b. Sequence of event
 - c. Panel mountable
 - d. Internal battery backup
 - e. Transducerless connection via standard CT / PT
 - f. Y2K compliance

- Display : Local LCD display panel user formattable display with scrollable screens.

Software interface shall be ensured by BAS contractor for the electronic meters. Systems requiring transducers for duplicating the data shall not be accepted.

All the instantaneous measurements shall be displayed on the control stations and the data shall be logged. It shall be possible to access minimum / maximum logging of any parameter with alarm annunciation for unusual measurements. The system shall also accept user defined "Set-Point" limit of any parameter.

9.0 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note: All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54 protection) and UL listed.

10.0 CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers. Any modifications

suggested by the Contractor shall be got approved by the Architect /Engineers before the actual laying of conduits is commenced.

a. CONDUITS / TRUNKER

Conduits and accessories shall conform to relevant Indian Standards. PVC conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made, with help of adhesive.

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

b. CONNECTIONS

All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.

The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

c. BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

11.0 SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications:

- | | | |
|---------------------------|---|---|
| i. Wire | : | Annealed Tinned Copper |
| ii. Size | : | 1.5 sq. mm, 7 strands |
| iii. No. of conductors | : | Two (One pair) |
| iv. Shielding | : | Overall beld foil Aluminium Polyester shield. |
| v. Jacket | : | Chrome PVC |
| vi. Nominal DCR | : | 17.6 ohm/km for conductor 57.0 ohm/km for shield |
| vii. Nominal OD | : | 8.5 mm |
| viii. Nominal capacitance | : | 130 pF/m between conductors at 1 KHz 180 pF/m between one conductor and other conductors connected to shield. |
| ix. Colour | : | Black and Red |

a. COMMUNICATION CABLE

The communication cable shall be of the following specifications:

- | | | |
|------------------------|---|-------------------------|
| i. Wire | : | Annealed Tinned Copper |
| ii. Size | : | Minimum 24 AWG stranded |
| iii. No. of conductors | : | One pair (2 conductor) |

- iv. Shielding : Overall beld foil Aluminium polyester Shield.
- v. Jacket : Chrome PVC
- vi. Nominal DCR : 78.7 ohm/km for conductor 55.8 ohm/km for shield
- vii. Nominal OD : 5.64 mm
- viii. Nominal capacitance : 131 pF/m between conductors at 1 KHz 243 pF/m
between one conductor and other conductors
connected to shield.
- ix. Colour : Black and Red, Black and White)

INPUT / OUTPUT SUMMARY FOR BMS SYSTEM AS PROPOSED FOR CGHS R.K PURAM

SI.NO.	ITEM DESCRIPTION	QTY	AI	AO	DI	DO	FIELD DEVICES
	HVAC						
1	WATER COOLED CHILLING MACHINES	2					
i	Chiller run status and trip alarm				4		Potential free contact
ii	Chilled water supply temperature at chiller outlet		2				Immersion type temp sensor
iii	CDW supply temperature at m/c outlet		2				Immersion type temp sensor
iv	Chilled water flow status				2		Water flow switch
v	Outside air temperature cum RH monitoring		1				OA temp. + RH sensor
vi	Room air temperature cum RH monitoring		1				Rm temp. + RH sensor
	Sub-Total		6	0	6	0	
2	PRIMARY CHILLED WATER PUMPS	2					
i	Pump run status				2		Differential pressure switch-Water
	Sub-Total		0	0	2	0	
3	SECONDARY CHILLED WATER PUMPS	2					
i	Pump run status				2		Differential pressure switch-Water
iii	Auto manual switch status				2		Potential free contact
iv	VFD Speed Control			2			0-10 V DC from BMS to VFD
v	VFD Speed feedback		2				0-10 V DC from VFD

vi	Differential Pressure Sensor across pump		2				Differential Pressure Sensor
	Sub-Total		4	2	4	0	
4	CONDENSER WATER PUMPS	2					
ii	Pump run status				2		Differential pressure switch-Water
iii	Auto manual switch status				2		Potential free contact
	Sub-Total		0	0	4	0	
5	COOLING TOWERS FOR AIR-CONDITIONING SYSTEM	2					
i	Cooling Tower Fan run status				2		Potential free contact
ii	Cooling Tower Sump level monitoring (high/low)				2		Level Switches to be provided
iii	Cooling Tower water Outlet temperature		2				Immersion type temp sensor
iv	Cooling Tower isolation valve limit switch open/close status				2		Volt free contact from mot.valve to IBMS
	Sub-Total		2	0	6	0	
6	AIR HANDLING UNITS (FLOOR MOUNTED/CEILING HUNG)	14					
i	Air flow status			14			Differential pressure switch-Air
ii	Return air temperature		14				Duct type temperature sensor
iii	Signal to modulating valve			14			Modulating valve
iv	Filter status				14		Differential pressure switch-Filter
v	Feedback from AHU Valve actuator for position indication		14				0-10 V DC signal from Valve Actuator
vi	VFD Speed Control			8			0-10 V DC from BMS to VFD
vii	VFD Speed Feedback		8				0-10 V DC from VFD
	Sub-Total		36	36	14	0	
7	Basement Ventilation Fans	4					
i	Fan start /stop command for f/a intake and exhaust fans					4	Relay Output
ii	Air flow status				4		Differential pressure switch-Air
iii	Auto-manual switch status				4		Potential free contact

iv	Filter status				4		Differential pressure switch- Filter
v	CO Sensor		12				CO Sensor
vi	VFD Speed Control			4			
	Sub-Total		12	4	12	4	
	SUB Total for HVAC		60	42	48	4	
8	Tanks						
i	Overhead tanks Hi/Lo status	1			2		Level Switch
ii	Under ground tank Hi/Lo status	1			2		Level Switch
	Sub-Total		0	0	4	0	
	Sub Total for Fire Fighting		0	0	4	0	
	Grand total of all Points		60	42	52	4	

LIST OF BUREAU OF INDIAN STANDARD CODES

IS 1239 (Part– I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel Pipe Fittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 823-1964	Code of Procedure For Manual Metal Arc Welding of Mild Steel
IS 780-1984	Service Valves For Water Works Purpose
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration
IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves For Water Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS 3103 – 1975 Reaffirmed 1994	Code of Practice For Industrial Ventilation
IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Erection Motor
IS 3142 – 1993	V Grooved Pulley

BS-EN-779 – 1993	Particulate Air Filters For General Ventilation
IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel
ASHRAE Hand Books	<p>American society of heating, refrigeration and air conditioning books</p> <ul style="list-style-type: none"> - Applications 1999 - Fundamentals 1997 - System and equipments 1996 - Indoor air quality 62 – 1999

CHAPTER M**LIFT & ELEVATORS****A. BRIEF SPECIFICATION OF PASSENGER LIFTS PROPOSED FOR CGHS R.K PURAM (2B+G+3)**

1.	Type	Passenger Lift
2.	Capacity / Load	13 Passenger/884 Kg.
3.	Speed	1.5 Meter / Sec.
4.	No. of Stops	6
5.	Mode (Operation)	Duplex, (with or without attendant)
6.	Type of Drive	A.C. VVVF
7.	Signals & Other Features	a) Call register indicator at all Floors
		b) Digital car position indicator in car
		c) Battery operated alarm bell and Emergency light.
		e) Fireman's switch
		g) Over-riding Facility
		h) Adjustable guide shoes
		i) Music & hands free press & speak intercom
		j) Braille Buttons
		k) Stainless steel Hand rails on all 3 sides at 900 mm height
		l) Voice synthesizer
		m) Full height car operating panel
		n) Vendor's shall specify any additional feature if any
8.	Lift Well/shaft size	2500 mm x 1900mm (NBC) or as per manufacturer's Standards
9.	Car Size	2000 mm x 1100 mm (NBC) or as per manufacturer's Standards
10.	Door Operation	Automatic AC VVVF
11.	Door Frame	Stainless steel Hairline Finish

12.	Type of Door	Centre opening sliding door, one hour fire rated landing doors, Stainless steel Hairline finish.
13.	Car enclosure	Stainless steel Hairline finish, toughened glass Enclosure. The ceiling panel shall be with 4 down lights (CFL Type) in stainless steel panel, Ceiling cabin fan.
14.	Car Floor	25mm thick stone flooring by client.
15.	Car height	2300mm (NBC) or as per manufacturer's Standards
16.	Door height	2100mm or as per manufacturer's Standards
17.	Car Entrance	900mm wide.
18.	Machine Room	Gearless Machine M/C Room at Terrace
19.	Power Supply	415 Volts \pm 10%, 3 Phase 4 wire, 50 Hz A.C. supply.
20.	Safeties	a) Overload Safety device.
		b) Full length infrared curtain (min. 150 criss cross beam)
		c) Automatic Rescue device with maintenance free batteries
The contractor shall get approved the variations, if any from the Engineer-in-charge.		

B. The detailed technical specifications for lifts and Elevators as under:-

A. GENERAL

1. This section details the performance specification for the lift installation, associated control and auxiliary equipment.
2. The finish for lift cars, landing door/fixtures, architraves, transom panels, etc. are described generally in this Specification, unless it is separately shown on the drawings or described in the particular Specification. The stainless steel finished as specified shall have a thickness of not less than 2.0 mm. Construction and installation details for various applications shall be submitted to the Supervision Consultant for approval prior to commencement of work.
3. The Contractor shall take into account of the maximum loading of car internal finishes for each of the lifts (including false ceiling, wall panels, flooring, lighting fixtures and the like) when proposing the equipment for the Lift Installation. As a general guidance, the loading for internal finishes shall not be less than 30% (unless, otherwise specified) of the lift rated capacity. Exact provision shall be submitted for Supervision Consultant's approval prior to construction.
4. The type, quantity, capacity, speed of lifts shall be as described in the Technical Schedule and as shown on the Drawings.
5. To provide a complete electric operated glass Passenger and Service Lifts, including design, manufacture, installation at site, testing and commissioning of the same to the Employer's/Consultant's satisfaction. No consideration will be

given to extra payment based upon difference in interpretation of the specification and drawings.

B. SCOPE

- A. Safety during operation and maintenance to personnel and equipment
- B. Service Reliability.
- C. Minimal fire risk.
- D. Ease of maintenance and convenience of operation.
- E. Automatic protection of all electrical equipment through selective relaying system
- F. Maximum interchangeability of equipment spares.
- G. Fail safe feature.
- H. Suitable for applicable environmental factor.
- I. This specification defines the basic guidelines of the system as necessary for lifts. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere. Compliance with these specifications and or approval of any of Contractor's documents shall in no case relieve the Contractors of his contractual obligations.
- J. All works to be performed and supplies shall be affected as a part of contract requires specific approvals/review of Owner or his authorized representative. Major activities requiring approvals/review shall include but not limited to the following.
- K. Lift shaft section, Elevation and plan as per the drawing attached.
- L. Quality assurance procedures.
- M. Testing and commissioning procedures in field.
- N. Engineering activities to be performed by Contractor shall include but not limited to the following as relevant to the scope of work included in the project specification.
 - a) Control and protection scheme.
 - b) Making of shop drawings with bill of materials.
 - c) Sizing and calculation of Motors, breaking capacity, rope, cable trays/raceways etc.
 - d) Cable schedule based on the control schematic drawings.
 - e) Installation/operation and Maintenance Manual.
 - f) Lighting and ventilation of Lift Cabin.
 - g) Interconnection drawings.
 - h) Factory inspection and testing procedures.
 - i) Field testing and testing procedure.
 - j) Preparation of as-built drawings.
 - k) Any other work/activity which is not listed however is necessary for the completion of lift installation.
 - l) A complete check list (works/work site).

C. TESTS**1.0 Charging**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programmed.

2.0 Commissioning Tests

- A. The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted with specified load.
- B. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- C. Pre-commissioning test shall be carried out as per relevant IS and/or as specified elsewhere in the tender.
- D. The Contractor shall be responsible for obtaining clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by Owner on production of requisite documents.

D. PACKAGING

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of the wagons etc.

E. PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

F. CODES AND STANDARDS

The work shall be carried out in accordance with the C.P.W.D General Specification for Electrical work (Part-III) lift 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.
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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 electric 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 further-most 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 pass through the blind openings. Should there be other proposals for the indicating systems; the Contractor shall state them clearly as alternatives at the time of tendering. The detailed design of the indicator shall be confirmed with the Supervision Consultant and to be submitted for approval prior to manufacture.

C. Call Buttons

- i. Call buttons shall be provided at the car operation panel and at every served floor, adjacent to or in between the landing entrance.
- ii. For passenger lifts, micro-movement call buttons with a stainless steel face-plate of hairline finish and not less than 2.0mm thick shall be provided.
- iii. For goods lifts, push operated type vandal proof buttons shall be provided.
- iv. The momentary pressure of the call button shall register a call. The buttons shall flush with the face-plate, and illuminated when activated.
- v. One additional set landing call button adjacent to the lift designated for the handicapped shall also be provided. The landing call buttons shall be subject to Supervision Consultant's approval prior to manufacture.

D. Landing Indicators

- i. Directional indicators and an audible signal shall be provided on every served floor beside/above each lift entrance. The audible signal shall be in form of a chime which sounds softly in conjunction with the flickering of the predictive arrival directional indicator.
- ii. Flash indication should be provided on the indicators when lifts passes the blind openings.
- iii. Details of landing fixture including the chime and its sound shall be submitted for the Supervision Consultant's approval prior to manufacture.

E. Architrave down Light

18 watt CFL lights shall be supplied and installed on the underside of the hall lanterns. The spotlights on a particular floor shall be lit up to signify the arrival of the corresponding lifts. These spotlights shall be switched off after the corresponding lifts have left that particular floor. For parking cars, the spotlights on the parking floor shall be turned off after a preset period adjustable from 15 to 150 seconds. Should a call from the parking floor is registered; spotlight of the assigned parking car shall be switched on again together with the opening of the landing doors to attend the call.

F. In-Use Indication

For lifts with simple automatic control, a set of "IN USE" light and a red indicator shall be provided at every landing. The red indicator will be illuminated at the landing to show the car calls which will go off when the lift is emptied.

G. Intercom

For goods lifts, intercom shall be provided at each landing to allow direct communication with the lift car. The connection shall be established when the intercom call button is pressed. Provision shall also be made to allow "press to talk" and "release to listen" when the background is noisy.

H. Signage

A signage shall be provided and prominently displayed at each landing of goods lifts: "FOR GOODS ONLY- NO PASSENGER"

I. CAR OPERATION PANEL

- i. Unless otherwise specified or shown on the Drawings, car operation panels shall be of total integration design and shall be flush-mounted. The panels shall consist of the following:
 - a. Illuminated call buttons labeled in number to correspond with the landings served. All buttons shall be flush mounted.
 - b. Alarm push buttons with protection from accidental operation.
 - c. 'DOOR OPEN' and 'DOOR CLOSE' (with arrow indicators) buttons (For lifts with vertical bi-parting doors, the door shall remain open until the "Door Close" button is pressed).
 - d. Audio and visual signals in connection with the overload devices.
 - e. 'Up' and 'Down' directional indicator.
 - f. Inching buttons (for goods lifts only)
 - g. Attendant control cabinet for light switches, alarm reset switches, fan switches and cleaner's 'stop-switches' etc.
 - h. Intercom speaker for simultaneous intercommunication amongst lift car, lift machine room, central supervisory system, and, in case of goods lifts, the landing floors.
- ii. For lifts with centre opening doors, two identical car operation panels, one on each side of the front return panel shall be provided.
- iii. To cater for the disabled, a third car operation panel of a horizontal design shall be provided.

J. CAR CAGE

a. General

The following specification shall apply unless there are separate drawings or descriptions in the Particular Specification showing/detailing the requirements of lift car interior.

b. Lift Car Interior

The lift car interior shall generally complete with the following provisions:

- i. Ventilation fans complete with stainless steel No. 4 Satin Finish air grilles of size to limit the linear velocity of the air supply to be less than 1.5 m/s. Air change rate per hour shall be at least 20 times of the lift car volume. The effective area of the ventilation apertures in the lower part of the car shall be at least 1% of the available car area.
- ii. 18w emergency CFL down-lights.
- iii. Mounting frames for lift certificates lift number plates, lift loading plates, notice boards and 'No Smoking' signage in stainless steel hairline Finish.
- iv. Hairline stainless steel handrail on rear and two side walls.
- v. Exact car interior finishes being as detailed on the Drawings or described in the Particular Specification.

c. Emergency Exit

Imperforate emergency exit of minimum size 500 x 350 mm shall be provided for all lift cars in the car roof as per the requirement of EN81 and ASMA A17 and Local

India-west Bengal Authority. Such exit panels shall be:

- i. Operable only from outside;
- ii. Clear of any apparatus mounted above the roof of the lift car:
- iii. Held close with a key operated lock, which can be re-closed and relocked without a key:
- iv. Provided with an electric safety device to prevent operation of the lift when the panel is open:
- v. Able to operate the alarm bell when the above-mentioned key operated locks cease to function.

d. Car Platform

- i. Car platforms shall be of framed construction. The relationship between the rated capacity of the lift and the maximum available car platform area shall be in accordance with the schedules in the Particular Specification. The minimum car platform area for the specified rated capacity shall comply with EN81 and ASMA A17 and Local India-Delhi Authority.
- ii. For goods lifts, the design of the supporting and suspension systems shall be adequately sized to sustain the highest roll-over load of a laden manual operated trolley/forklift entering/leaving the car platform. The total weight of the laden trolley/forklift shall be equal to the rated load of respective elevators and be carried by two axles. The maximum load to be carried by an axle shall be 80% of the laden trolley/forklift weight and the maximum eccentricity of loading shall be based on the laden trolley weight being off centre laterally $\frac{1}{4}$ of the clear platform entering/leaving onto the entrance edge of the platform.

e. Car Top Control Station

- i. A control station shall be provided on the top of every lift car, and comprise the following switches clearly marked as:
 - 'STOP' switch;
 - 'NORMAL/INSPECTON' switch; and
 - Directional inspection buttons protected against accidental operation.
- ii. When the car top control panel is in operation:
 - It shall be impossible to control the car from any other position.
 - The car shall travel at a speed not exceeding 0.63 m/s.
 - The car shall be stopped if one of the safety devices operates.
 - The car shall move whilst the movement button is continuously pressed.
 - Where lift equipment is housed in a compartment separate from the machine room or lift hoist way, a switch shall be provided in that compartment which, when being placed in the 'STOP' position, shall cause the lift to stop and prevent it from being started until being placed in the 'RUN' position. Such switch shall also be provided in each lift pit.

f. Car Frames

- i. Every lift car body shall be carried in a steel car frame assembly which shall have sufficient mechanical strength to resist the forces applied by the safety gear or impact of the car on the buffers. The deflection of the steel members carrying the platform shall not exceed 1/1000 of their span under static conditions when the rated load is evenly distributed on the platform.
- ii. At least four renewable guide shoes or shows with renewable linings or sets of guide rollers shall be provided, two at the top and two at the bottom of the car frame assembly.

g. Notices & Signage's

- i. A stainless steel load plate indicating the rated load of the lift shall be fitted inside each lift car.
- ii. The following notice board shall be supplied and securely mounted in each car denoting:
 - The name of the Company, telephone number and emergency instruction.
 - "No Smoking", which shall be manufactured from stainless steel sheet of red letter.
 - A metal container housing the necessary tools, together with clear instructions for moving the lift car and releasing passengers in emergency shall be provided in the machine room in a conspicuous position.
 - "IN CASE OF FIRE DO NOT USE LIFT".
 - "FOR GOODS ONLY- NO PASSENGER" which shall be in red lettering for all goods lifts
- iii. Details of all the notice signage shall be submitted to the Supervision Consultant for approval before fabrication.
- iv. Name or Logo of lift manufacturer shall not be displayed inside the lift car interior.

h. GUIDES AND GUIDE FIXING

- i. The car and the counterweight shall be each guided by at least two rigid steel guides throughout their travel. The strength of the guides, their attachments and joints shall be sufficient to withstand the forces imposed due to the operation of the safety gear and deflection due to uneven loading of the car. This deflection shall be limited so as not to affect the normal operation of the lift.
- ii. The guides shall have machined guide surfaces.
- iii. Steel guide brackets shall be provided at suitable intervals of not more than 2.5m for passenger lifts and 2.0m for goods lifts to fix the guides to the walls enclosing the lift way. The method of drilling and mechanical anchoring to concrete or welding on steel support shall be used as the standard practice for fixing guides rail brackets. No boxing out shall be adopted.
- iv. Wood or fiber blocks or plugs shall be strictly forbidden for securing any guide brackets.
- v. The fixing of the guides to the brackets and to the building shall permit compensation, either automatically or by simple adjustment, of effects due to normal setting of the building or shrinkage of concrete.

i. HOISTWAY SAFETY**i. Buffers**

- a. Buffers shall be provided at the bottom limit of travel for cars and counterweights. The type of buffer to be used shall be in accordance with the following table:

<u>Rated lift speed</u>	<u>Type of buffer</u>
£ 1.0 m/s	spring with buffered return
> 1.0 m/s	oil

- b. Spring (Energy Accumulation Type) Buffer with Buffered Return –

Buffers shall be designed and constructed to absorb within the limits of their stroke, the whole kinetic energy of car carrying its rated load when the speed of impact is at the maximum governor tripping speed.

- c. Oil (Energy Dissipation Type) Buffer –

The stroke shall be such that the car or counterweight shall be brought to rest with an average deceleration of not more than 9.81 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 ¼ of the clear platform entering/leaving onto the entrance

edge of the platform.

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

<u>Rated lift speed (m/s)</u>	<u>Compensation means</u>
< 2.5	Quiet operating chains
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 N

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

- a. These shall comply with the IS codes as specified.

3. SUBMISSIONS

- a. Product Manuals
- b. Hydraulic Details

4. STORAGE

- a. These shall be stored as delivered in original packing.

1.04 FIRE, SPRINKLER AND JOCKEY PUMPS**1. PUMPING SETS**

- a. Pumping sets shall be multi stage horizontal split casing centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings.
- b. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.
- c. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.
- d. Pumps shall be provided with approved type of mechanical seals.
- e. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- f. The pump shall meet the requirements of the Tariff Advisory Committee and N.B.C.and N.F.P.A. and the unit shall be design proven in fire protection services.

2. ELECTRIC DRIVE

- a. Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.
- b. Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- c. Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.
- d. Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee. and N.B.C.and N.F.P.A.

- e. Motors shall be suitable for 415 volts, 3 phase 50 cycles a/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.
- f. Motors shall be designed for two-start system
- g. Motors shall be capable of handling the required starting torque of the pumps.
- h. Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- i. Speed of the motors shall be compatible with the speed of the pump.

3. AIR VESSEL

- a. Provide one air vessel fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 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.
cm automatically

4. VIBRATION ELIMINATORS

- a. Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

5. INSTALLATION

- a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- b. Pumps and motors shall be truly aligned by suitable instruments.
- c. All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.
- d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the 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 10.0 Kg/ sq.cm	Cut out →
Operating pressure			
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 pykote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.
- B. ABOVE GROUND PIPING: -
 - a. All above ground piping shall be installed on suitable to pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.

i.	20 mm to 32 mm dia	2 mtr
ii.	40 mm to 65 mm dia	2 mtr
iii.	65 mm to 100 mm dia	1.75 mtr
iv.	Above 150 mm dia	1.50 mtr
 - b. Piping shall be so installed that the system can be thoroughly drained. All the pipes shall be arranged to drain to the installation drain valve. In case of basement and other areas where the pipe work, is below the installation drain valve / auxiliary valves of the following sizes shall be provided.
 - i. 20 mm dia valve for pipes up to 50mm dia
 - ii. 25 mm dia valve for 65 mm dia pipes
 - iii. 32 mm dia valves for pipes larger than 65 mm dia
 - c. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 50 mm of larger diameters.

- d. The piping shall be pressure tested by the hydrostatic method upto a pressure of 1.5 times the working pressure the piping shall be slowly charged with water so that all the air is expelled from the piping by providing a 25mm inlet with a stop cock. The piping shall be allowed to stand full of water for a period of 2 hours and then the piping shall be put under pressure by means of manually operated test pump or by a power driven test pump. The pressure gauges used for testing shall be accurate and shall preferably be calibrated before the testing is carried out. All the leakages and defects in joints revealed during the testing shall be rectified to the entire satisfaction of the consultant. The system may be tested in sections parts as the work of erection of piping proceeds. The piping shall withstand 1.5 times the working pressure for at least 2 hours.

6.0 PUMP SETS:- Same as wet riser & Hydrant System specification.

7.0 ANNUNCIATION SPRINKLER PANEL

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

- a. Panel should be made in a module of 20 zones e.g. each module will have audible and visual indications and will monitor the circuit conditions. With 24v DC battery.
A.C. Power Supply
Fault and Fire indication lamp
Alarm acknowledgment push buttons
- b. The circuits provided in the control panel for each zone shall indicate the following conditions:
 - i. Open Circuit in zone wiring
 - ii. Short Circuit in zone wiring
 - iii. Normal conditions
 - iv. Power failure
 - v. Low battery
- c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.
- d. Suitable protection may be provided against charging of the battery over and above the specified values.

8.0 BATTERY UNIT

- i. The system shall be powered by lead acid storage stationery complete with automatic dual rate charger boost and 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 O

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, Im, Vm and FF for the module
 - vii. Unique Serial No. and Model No. of the module
 - viii. Date and year of obtaining IEC PV module qualification certificate
 - ix. Name of the test lab issuing IEC certificate
 - x. Other relevant information on traceability of solar cells and module as per ISO 9000 series.

Until 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 Client.
- f. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.
- g. The array structure shall be grounded properly using maintenance free earthing kit.
- h. Each panel frame structure should be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 200 km/hr. after grouting & installation. The front end of the solar array must be one meter above the rooftop. Grouting material for SPV structures shall be as per 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 conform 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 7days.

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 client after earthing by calibrated earth tester. INVERTER ACDB and DCDB should also be earthed properly.

13. DANGER BOARDS

Danger board should be provided as and where necessary as per IE act/IE rules as amended up to date.

14. DRAWING & MANUALS

- 5 copies of Engineering, electrical drawings and installation and O&M manuals are to be supplied with each Plant.
- Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the power plant and power evacuation, along with protection equipment. Approved ISI and reputed makes for equipment to be used.
- For complete electro-mechanical works, bidders shall supply complete design details and drawings for approval before progressing with the installation work.

15. TOOLS & TACKLES AND SPARES:

After completion of installation & commissioning of the power plant, necessary tools & tackles and spares are to be provided free of cost by the contractor for maintenance purpose. A list of requisite spares in case of Inverter comprising of a set of logic cards, IGBT driver cards, Junction Boxes, Fuses, MCCBs etc. along with spare set of PV modules shall be supplied with the equipment. A minimum set of spares shall be maintained in the plant itself for the entire period of warranty and O & M which upon use shall be replenished.

16. QUALITY AND ADAPTABILITY OF THE EQUIPMENT:

Bidders must verify the grid behavior, solar insulation levels, and general site conditions on their own before bidding. The bidder shall accordingly ensure that the equipment and the design submitted shall be able to perform as per guaranteed performance levels in the available site conditions. The design of the plant and the equipment offered by the bidders shall be evaluated for its quality and adaptability to the site conditions based on the purchasers past experience, projects earlier executed by the bidders and

from other sources. Bidders must submit detailed technical operational parameters and latest performance indicators.

**Construction of CGHS Wellness Centre and Administrative Building
at Sector 13, R.K. Puram, New Delhi
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 / Amstrong / 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 Fabricators	To be approved by the Engineer-in-Charge
8.	Anchor Fastner	Hilti / Faischer /Bosch
9.	Anti – Termite Treatment	Pest Control India Ltd. In case PCI is not able to undertake the work, it should be done by permanent members of IPCA as approved by Engineer-in-Charge.
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 / Birla Corp. Ltd. (Cement Divn.) / JK Cement / Jaypee-Rewa / Ambuja / Lafarge /Prism / India Cement / 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
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 / Insuboard 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 (Wooden)	Navair / Shaktimet / Promat
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 Device	Dorma / D-line
68.	Fire: Panic Exit Devices	Becker Fire Solution, Inersoll Rand LCN Series, Dorma PHA Series.
69.	Fire: Tower Bolts	Suzu, Nulite, Dorset
70.	Flush Door Shutters	Duro / Greenlam / Century/
71.	Flush Valves	Gem/ Jaquar / Marc
72.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini /Kanwal/ Vijay Cycle & Steel (VS)
73.	G.I. Fittings	R/Unik/Zoloto/K.S./Sun/Swastik
74.	G.I. Pipes	Jindal / Tata / Prakash Surya / SAIL / Swastik
75.	Geyser	Spherehot / Racold / Usha Lexus /Bajaj
76.	Glass : Mirror	Modiguard / Atul / Saint gobain/ Asahi India Safety / Modi Float
77.	Glass for Aluminum Doors/ Windows/ Structural Glazing	Modiguard / Saint Gobain / Pilkington/ Asahi India Safety Glass Ltd.
78.	Glass Wool / Insulation Boards	Rockwool / UP Twiga / Lioyd Insulation
79.	Grab bars and Disabled Hardware	Dorma / D-line
80.	Gunmetal Valves / C.P brass angle valve	Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco
81.	Gypsum Board & Gypsum False Ceiling	Beral Gypsum / Laffarge / Saint Gobain (Gyproc)
82.	Hand Drier	Kopal / Utech Systems / Euronics Automat
83.	HDPE Pipes / Moulded Fittings	Emco /Polyefins/Pioneer Plyfab/ Jain
84.	HDPE Solution tank	Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.
85.	Heat Resistant Terrace Tiles	Thermatek or equivalent
86.	Horizontal Centrifugal / Monoblock Pumps	Kirloskar / DP Holland / Wilo/Ground fos/CR Pumps/Ebara/Wilo
87.	Hydro-pneumatic System	HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar/ DP Holland / Wilo
88.	Inbuilt Drip Line	Azud/ Rainbrid-USA/ Netafim
89.	Insulation of Hot water pipes	Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex/
90.	Laminates	Century/Greenlam/Formica/Sunmica/ Merrino
91.	Liquid Level Controllers / Indicators	Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer / 21 st Century
92.	Liquid Soap Dispenser	Euronics/Utec/Kopal
93.	M.S. Pipe	Jindal / Prakash – Surya /TATA
94.	Mainline Isolation Valve	Sant /Leader /Zoloto,
95.	Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware
96.	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird, USA
97.	Night Latch	Godrej /Harrison / Link
98.	Non Return Valve	Sant/ Leader/ Zoloto / AIP / Kirloskar/ IVC/ Leader/ Audco

99.	OT: Bumper Guard Stretcher Guard Crash Rail System	MDD/TSI/LSR/Radius
100.	OT: Wall Guard Grab Rail /Hand Rail System	MDD/TSI/LSR/Radius
101.	OT: Anti-bacterial paint	Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX
102.	OT: Conductive Tile Flooring: ESD-Control Tile Flooring	Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux
103.	OT: Doors	TRILUX/Penlon/LSR/TSI/Metaflex
104.	OT: Stainless Steel Scrub Sink Two Bay	MDD/ LSR/ radius/ TSI
105.	P.R.S. Dials	Rain Bird, USA/ Toro, USA/ Nelson,
106.	P.T.M.T. Fitting	Prince India / Symet
107.	R.C.C Pipes	Indian Hume Pipe / Pragati Concrete Udyog /ISI Marked Pipes/Daya/KK / JSP
108.	Paints - Cement Based	Snowcem plu/, Berger (Durocem Extra)/ Norolac (Super Acrylic)
109.	Paints - Epoxy paint	Nerolac / Cico / Sika / BASF / Berger / Pidilite
110.	Paints - Oil Bound Distemper / Acrylic Washable Distemper	Asian (Tractor)/ Burger (Bison)/ Nerolac (Super Acrylic)
111.	Paints - Other Paints / Primer	ICI Dulux/ Asian/ Berger/ Nerolac
112.	Paints - Plastic Emulsion Paint	ICI Dulux/ Asian/ Berger/ Nerolac
113.	Paints - Synthetic Enamel Paints	ICI Dulux (Gloss), Berger (Luxol Gold), Asian (Apcolite), Goodlas Nerolac (Full gloss hard drying)
114.	Paints - Texture paint	Berger / Spectrum / Unilite heritage /Asian
115.	Paver blocks (All Types)	KK Manholes / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles
116.	PE-AL-PE Pipe and Accessories	Kitec/ Jindal/ Kissan/Vista
117.	Pipe coat material (pipe protection)	RPG Raychem/Pypkote/Makphalt/Lwl
118.	Plastic seat cover of W.C	Commander/Hindware / Parryware
119.	Plywood/Block board/Ply board	Duro/ Greenply/ Century/ Kitply/ Greenply / National / Anchor
120.	Polycarbonate Sheets	Galina/GE Plastic / Vergola / Skyarch/ Polytechno/ FlexyTuff
121.	Poly-sulphide Sealant	Pidilite / Fosroc / Cico / Sika
122.	Pop up Connecting Assembly	Rain Bird/Dura/Lasco,
123.	Popup Spray Head	Rain Bird/Toro, USA/Nelson,
124.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
125.	PP-R Pipes (PN – 16)	Amitex Polymers Pvt. Ltd. / Prince/ Supreme
126.	Pre-coated Galvanised Steel Sheet	Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals
127.	Pre-Laminated Particle Board	Novapan /Century /Green Ply
128.	Pressed M S Doors Frames	West Wind Concepts Pvt. Ltd., Gurgaon/ Shiva Steel Pvt. Ltd., Noida /AGEW Steel Manufacturing, Ahmedabad
129.	Pressure Relief Valve	Omega/ Sant/Leader/ Zolato / Upadhyay / Audco
130.	Pumps	DP Holland / Wilo/ Grund foss
131.	PVC continuous fillet for periphery packing of glazings / Structural/ Glazing	Roop / Anand / Forex Plastic/ Nagalia/Trading Company
132.	PVC Doors	Sintex/ Polyex/ Rajshri

133.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong
134.	PVC flushing cistern	Commander / Parryware / Hindware
135.	PVC Pipes & fitting SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Prince / Supreme / Finolex
136.	PVC Water Stops	Prince /Supreme/ Finolex
137.	Polyethylene Storage Tank	Sintex / Polycon
138.	R.O. System	Ion Exchange/ Sterling India Ltd. / Pentair water
139.	R.O. Water Purifier Unit	Eureka Forbes/ Kent/ Zero B
140.	Reinforcement Steel	SAIL/RINL/TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd.
141.	RQRC Hydrant	Harvel/Alprene/Rain Bird, USA
142.	RQRC Key	Harvel/ Aqua/ Drip& Drip
143.	Sensor Operated Auto Flushing System Urinals	Jaquar / AOS-Robo/U-tec/Angash/Euronics
144.	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes /SK Precast Concrete/ Advent concretevision / Daya concrete
145.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon / Pidilite / Forsoc / Cico /Dow Corning / Sika/
146.	Sluice valve / NRV	Kirloskar/IVC/Kilburn /Zoloto/Castle/ Leader / L&T/Audco
147.	Solar Hot water system	Tata BP Solar / EPL India Limited / Solahart (India), / Edwards (Australia)/ WBS Innovations
148.	Solenoid valve	Rain Bird, USA/Toro/Nelson,
149.	SS Gratings, Soap Dish Towel Rail etc.	Camry/Glacier/Gem
150.	Stainless Steel	Salem Steel or as approved E-in-Charge
151.	Stainless Steel bolts, Washers & Nuts	Kundan / Puja / Atul
152.	Stainless Steel Clamps	Hilti /Intellotech Konzept
153.	Stainless steel CP Grating	Chilly / Camry
154.	Stainless Steel D-handles	D-line / Giesse /Dorma
155.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
156.	Stainless Steel Pressure Plate Screws	Kundan/ Puja/ Atul
157.	Stainless Steel Screw for Fabrication and fixing of Windows	Kundan / Puja / Atul
158.	Stainless Steel Sink	Hindware / Neelkanth / Nirali
159.	Stone ware pipes & Gully Traps	Perfect / SKF/ R.K/ Hind / Anand /Burn
160.	Submersible Drainage pump	Jyoti / Crompton/ Kirloskar/ KSB /Grundfos/ Mather & Platt / JS/Wilo/ITT
161.	Sunken Portion Treatment	Choksey / Sika / Cico, MC Bouchemie / MC Bouchemie / BASF
162.	Super plasticizer	CICO, Roffes Construction Chemicals, Pidilite Industries
163.	Tiles: Ceramic tiles	Somany / Kajaria / Nitco
164.	Tiles: Glass Mosaic Tiles	Mridul / Bisazza
165.	Tiles: Glazed tiles	Somany / Kajaria /Nitco
166.	Tiles: Vitrified Tiles (Double / Multy Charged)	Kajaria / Nitco /RAK /Hindware
167.	UPVC Pipes & fittings	Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral

168.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
169.	Valve Box	Rain Bird, USA/Carson Brook, USA/Dura,
170.	Veneered Particle Board	Duro / Greenply / Century / Novapan / Action Tesa
171.	VFD Pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt
172.	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal
173.	Vitreous China/ Sanitary ware	Hindware / Parryware / Cera
174.	Water Cooler	Blue Star/ Voltas/ Usha/ Godrej
175.	Water Meter	Capstan / Kranti/ Anand/ Kant
176.	Water Proofing treatment Agencies	To be approved by the Engineer-in-Charge
177.	Water Proofing Materials	BASF/ Fosroc / Sika / CICO
178.	Water supply pumps	KSB/ Grunfos/ Kirloskar/ Crompton/ Mather & Platt
179.	White Glazed Fire Clay Sink	Hindware / Parryware / Cera
180.	Wooden Laminated Flooring	Nitco /Euro / Pergo

2. Fuel and HSD Tank

S. No.	Details of equipment/ material	Make/manufacturer
1.	Pipe & Fittings	
a.	Pipes ERW	Tata, Jindal (Hissar)
b.	Pipe Seamless	Tata, Maharashtra Seamless
c.	Pipe Fittings	V.S.Swastic, Unik
2.	Valves	
a.	Ball Valve	Cim, Audco, R-B, KSB
b.	Check Valve/Non Return Valves	Kirloskar, Audco, Leader, Keystone,
c.	Globe Valves/ Gate Valves	Sant, Kirloskar, Audco, Leader
d.	Solenoid Valves	Avcon, , Festo, Indfoss, Blue Star
e.	Pneumatic Control Valves	Intervalve, Continental, Avcon, SMC
3.	Strainers	JP, Sant, Emeralt, Strain Well
4.	Gear Oil Pumps	Tushaco, Rotadel, Strok, Bornneman
5.	Motors	Kirloskar, Cropton Greves, Siemens
6.	Mechanical Seals (For Oils)	John Crane, Sealol, Dura Metallic
a.	Level Switches/Controller	V-Automata, Techtrol, NandShyam, Cirrus, Minilac, Techtrol
b.	Temp. Gauge	H.Guru, Gluck, General Ins.
c.	Pressure Gauge	Flebig, H.Guru, United
d.	Flow Meters	Kent, Forbes Marshal, Eureka
e.	Levels Indicators	V-Automata, Techtrol, Forbes Marshall
8	Welding Electrode	Advani, ESAB, Dewkam

3. SOLAR POWER

S. No.	Details of equipment/ material	Make/ Manufacturer
a.	Solar system	Tata BP Solar / EPL India Limited / Solahart (India), BHEL, BEL

4. **FIRE ALARM SYSTEM:**

Note: All fire alarm components/ Panels shall be UL listed & confirm to NFPA standard.		
S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Fire Alarm System	Zicom, FirePro, Honeywell, Siemens, Schneider, Bosch, Notifier, Tyco
2.	Fire Alarm Detectors, Hooters, Manual Call Point UL Listed	Zicom, FirePro, Honeywell, Siemens, Schneider, Bosch, Notifier
3.	Data Cables	Molex/ Awaya/ Delton/Hua-wei
4.	Switcher	Clipsal/ Crabtree/ Legrand/ Hua-wei
5.	Cable TV Cables	Skytone/ Bonton/ Finolex/ Delton/ Hua-wei
6.	Termination Control Cable	Dowell's/ Elemex/ Wago/ Phoenix
7.	Cable Tray	Pilco/ Slotco/ Needo
8.	Control Cable	RR CABLE/ Bonton
9.	Photo Chromatic Switch	Bajaj/ Wipro
10.	Splitter Box	Shyam Antenna/ CAT vision
11.	Panic Button	Eureka Forbes/Fire Pro
12.	Response Indicator	MORLAY/SEIMENS FINDER/NOTIFIER
13.	Fibre Optic	BELDEN/SIMONE/ SYDSTEMAX
14.	Change Over Switch	HPL/ L&T
15.	Luminaires	Philips/ Surya / Bajaj/Pierlite
16.	Mica Tape Cable	Bonton,Skytone,Radox,FRTEK,

5. LIFTS:

S. No.	Details of equipment / material	Make/ Manufacturer
1	Lifts	OTIS/ Kone / Mitsubishi/ Schindler/ Johnson Lifts Pvt. Ltd., Chennai

6. LV Package

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	PA Speaker	Bosch/ Ahuja/ Evacpro/ Ateis
2.	Amplifier	Bosch/ Ahuja/ Evacpro/ Ateis
3.	CD Player	Bosch/ Ahuja/ Evacpro/ Ateis
4.	RG 6, RG 11/Wire	Belden/ Skytone/ Bonton/ Finolex
5.	CAT 6 Wire/Accessories -Jack panel , Face Plate	Huwavei/ Belden / Panduit/ Ststemax / Simone
6.	Ethernet / Switch	Huwavei / Avaya / Alcatel /Cisco
7.	Telephone Exchange	Avaya /Alcatel /Cisco
8.	Handsets	Avaya / Alcatel / Cisco / Beetal
9.	Speaker Wire	Belden / Canare /Extron /Leoni
10.	CCTV Camera/ DVR , Other Items	Honeywell / Pelco / Vicon
11.	Partition Track/ Curtain	TSI/Trilux/LSR/MDD/Biomed

7. HOT WATER GENERATOR SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Hot water generators	Enmax/ sunmax/ goodsun / tata bp solar/ Thermax/ voilation projects
2.	Recirculating pumps	Grundfoss/ ebara /Wilo

3.	Ball valve	Rb/ itap/ leader,
4.	Check valve	Caliber/ leader / peco
5.	“Y” – strainer	Caliber/ leader/ flowtech /strainwell
6.	Air release valve	Rb/ tbs/ cimbrio
7.	GI/MS pipes	Tata / jindal / BST/ SAIL
8.	Insulation	Vidoflex/ almafex
9.	Temperature indicator	H-guru/ omicron / scientific
10.	Pressure indicator	H-guru/ fiebig/ scientific
8. <u>WATER TREATMENT PLANT, DRINKING WATER PUMPING SYSTEMS AND PRETREATMENT FACILITIES</u>		
S. No.	Details of equipment/ material	Make
1.	Raw water pump set/ Treated water pump set/ Drainage pump set	Grundfos/ WILO/ Ebara/ Kirloskar
2.	Sodium hypochlorite dosing system	Asia LMI/ Grundfos/ Seiko/ E - Dose
3.	Chain pulley block	Indef, Ardee, J.K. Morris
9. <u>SEWAGE / EFFLUENT TREATMENT PLANT</u>		
1.	Pump Sets i/c Water transfer and sludge disposal/transfer pump	Grundfos/ WILO/ Ebara/ Kirloskar
2.	Chemical dosing system	Asia LMI/ Seiko/ E - Dose
3.	Filter Press/ Plate	Pharmatec/ Sachin
4.	Air Blowers	Beta/ Everest/ TMVT
5.	UV Systems	Alpha UV, Creative UV, AM Ozonic
10. <u>BUILDING MANAGEMENT SYSTEM</u>		
S. No.	Details of equipment/ material	Make/ Manufacturer
1.	2-way Motorized Valve	Johnson/ Sontay Siemens /Honeywell/ Schneider/Belimo
2.	Air ,Water Pressure, Velocity Sensors	Johnson / Sontay/ Greystone/ Siemens/ Honeywell/Belimo
3.	Air / Water DP switches	Johnson /Sontay/ Greystone / Siemens /Honeywell/Schneider
4.	CO2 / CO Sensor	Honeywell / Siemens / Sontay/Belimo
5.	Central Processing Unit	HP/DELL/Lenovo/Toshiba
6.	Colour Printer	Cannon / Epson/ Hewlett Packard
7.	Colour Monitor	Dell(Ultra Sharp) / HP(Pavillion) / ASUS

		/Samsung(Sync Master) / LG (Flatron)
8.	Communication Cables / Signal Cable/ Control Cables	Finolex / Elektron / Delton / Fusion Polymers / Polycab / Excel / Varsha/ Teleflex/ Finecore/Skytone
9.	Current Relay	Veris / Seto / Mamac/Omron / ABB
10.	Damper Actuator	Johnson/ Siemens /Schneider/ Siemens/ Belimo
11.	DDC Controllers	Johnson/ Cylon/ Siemens/ Honeywell/ Schneider
12.	Duct, Room Temperature/ RH Sensors /Humidity Sensor	Johnson / Sontay / Greystone/ Siemens/ Honeywell/ Alerton/ Schneider
13.	Duct Static Pressure Sensor / Temperature Sensor	Honeywell / Alerton / Siemens/ Schneider
14.	Flame Proof Level Switch / Level Transmitter	Veksler / Filpro / Sontay / Techtrol/ Belimo
15.	Flow Meter	Schenitech / Honeywell / Kampstrup
16.	Immersion Type Temperature Sensor	Honeywell / Alerton / Siemens/ Johnson / Sontay / Greystone/ Schneider / Belimo
17.	LAN cables for BMS Network	Belden / D-Link / Avaya
18.	Operation Workstation Hardware Software	IBM / HP/ Dell/ Johnson/ Cylon/ Siemens/ Honeywell
19.	Outside Air Temperature Sensor / Outside Temperature & RH sensor	Honeywell / Alerton / Siemens / Johnson / Sontay / Greystone /Schneider / Belimo
20.	Personal Computer	HP / DELL / LENOVO / TOSHIBA
21.	PH Sensor / TDS Sensor	Honeywell / Hach / Greisinger
22.	Pressure Transmitter – Water/Differential Pressure Transmitter	Honeywell / Alerton / Siemens/Schneider/ Belimo
23.	Room Temperature & RH Sensor	Honeywell / Alerton / Siemens/Schneider/Belimo
24.	Room Thermostat for FCU	Johnson / Siemens/ Anchor/ Honeywell
25.	Voltage / Current / Power Factor Transducer	SETO / ABB / L&T / Enercon / SETCO
26.	Water Flow Switch	Honeywell / Alerton / Siemens/Anergy / Johnson
27.	Web Based BMS Software with unlimited user license	Siemens(Design Insight) / Honeywell-(WEBs / Alerton/Trend) / Schneider
28.	Web Based Router / Network Area Controller	Honeywell-WEBs / Alerton / Siemens / Schneider
29.	Mouse	HP/EPSON/CANON
30.	UPS	Delta /Uniline/ Toshiba/ Intellipower/ Luminous / Microtek
31.	Indoor Air Quality Sensors	Honeywell/Seimens/ Sontay
32.	Occupancy Sensors	Honeywell/ Schneider/Siemens/
11. HVAC		
S. No.	Details of equipment/ material	Make/ Manufacturer
1.	2-way Motorized Valve	Johnson/ Sontay Siemens /Honeywell/ Schneider/Belimo
2.	Accoustic Lining for Ducts /AHU Room	UP Twiga/Owens Corning/Kimmco
3.	Acoustically Insulated Inline Fans	Humidin / Airflow /Alfa Therm / Caryaire/Wolter/Kruger/Nicotra

4.	Adhesive	Fevicol/Superlon or Equivalent
5.	Air Distribution, Ducting GI Sheets	Sail , Tata , Jindal
6.	Air Handling Unit/fan sections	Flaktwoods / DRI / Edgetech / Zeco/ Balance Air / Waves / Fedders Lloyd/ Caryaire/ Airflow/Systemaire/VTS/brightflow
7.	Air-washer Fans (AMCA Certified for Sound & Performance)	Comferi / Kruger / Yilida / Greenheck / Nicotra
8.	Aluminium Sheet/ Sections	Hindalco / Balco / Nalco/ Jindal
9.	Auto Air Vent Valve	Anergy / Rapid Cool / Sant/ Rapid control
10.	Automatic Air Vent	ABB/ Seimens/ Anergy/ Rapid Control/Emerald/CIM
11.	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	System Air / Kruger / Airflow / ABB / Humidin / Alfa Therm / Nicotra
12.	Balancing Valves (Water Duty), Butterfly Valves (W D), Check Valves(W D), Purge Valve, Drain Valve	Audco, Advance , Castle, Inter Valve,Danfoss/Belimo,C&R/SKS/ Econosto
13.	Ball valves (with & Without strainers)	Rapid control, Leader ,Castle/CIM/Festo/Oventrop/Intervall
14.	CAV / VAV Boxes	Titus / Carrier / Trox
15.	Centrifugal Fans, Fan Section	Nicotra, Krugger, Humidin, Brightflow/VTS/comefrei
16.	Change Over Switch	Elecon / L&T/ Siemens
17.	Check Valve double flanged	Advance/Audco/SKS/Belimo/Danfoss/C&R
18.	Closed Cell Fire Retardant XLPE (For Duct Insulation)	Supreme / Trocellene / Paramount / armacell/aeroflux
19.	Cooling / Heating Coil (AHU & FCU – ARI Certified Coil)	Waves / Caryaire / Suvidha Savier / Zeco/ International. Coil Company/ Roots/ Cooling/ Waves/ Edgetech/ Humidin/VTS
20.	Cooling Towers	Bell / Paharpur / CORON/Delta/CASE
21.	Copper Refrigerant Piping	Totalline/ Diamond / Star /Rajco
22.	Current Transformer	A.E. / Kappa / Precise/ C&S
23.	Dash Fasteners	HILTI , Fischer , Cannon, Bosch
24.	Digital Thermostat / Humidistat	Siemens / Johnson / Honeywell / Danfoss / Belimo / Anergy/Schneider
25.	Dual Plate Check Valve	Advance / Honeywell / Larsen Toubro
26.	Duct / Pipe Support	Easyflex / Resistoflex / Diamond
27.	Duct UVGI System (Ultra Violet Germicidal Irradiation System)	Ruks / Trimed / Magneto
28.	Ducted Inline fans	Systemaire/Caryaire/Pineair
29.	Electric Motors	Siemens , ABB , Crompton,Kirloskar
30.	Electrical Panel & Sub-panels	EAP / Adlec / Advance / Ace Autotmation/ABb,L&T/Siemens/KEPL
31.	Evaporative Cooling Unit, Exhaust Scrubber Unit	Roots Cooling, Waves , Edgetech, Humidin
32.	Expanded Polystyrene Insulation	Mettur/ Beardsell / Styrene Packing / Toshiba / Malanpur/ Indian Packaging Services
33.	Expansion Tank	ITT / Grundfoss / Anergy/ Armstrong/Wessels
34.	Extruded Aluminium Grills, Diffusers	Caryaire /Ravistar /Servex / Airflow

		/Titus/Trox/Airmaster
35.	Factory Fabricated Duct & Flanges	Rolastar / Zeco / G P Spiro / Aircon/ Ductofab / Technofab
36.	Fan Coil Unit (AMCA Certified Fan for Sound & Performance)	Carrier / Caryaire / Edgetech / Waves / Zeco / Fedders Lloyd /Daikin / VTS / Flaktwood/Brightflow
37.	Fibre Glass Rigid Board	U.P.Twiga / Owen corning / Kimco/ Lloyd insulation
38.	Fire /Smoke Damper	Caryaire / Ravistar / Titus / Trox / Airflow/Ruskin/ Systemair/ Airflow
39.	Fire Damper Actuator	Belimo / Siemens / Danfoss / Honeywell
40.	Flexible Duct Connection	Airflow/ Pyroguard or Equivalent
41.	Flexible Pipe Connection	Resistoflex/ Kanwal/Dunlope
42.	Galvanised MS Sheet	SAIL / Tata / Jindal/ESSAR
43.	Globe valve / Gate valve	Leader / Sant / Zoloto / Rapid Cool / L&T / Kirloskar / Econosto
44.	Heat / Energy Recovery Wheel	DRI / Novelair-Sevcon / Bryair / Ostberg / Flaktwoods/APPIDI/Vikram Hitech/Heatex
45.	Hot Water Generator & Pan Humidifier	Sant / Enmax / Rapid Control / KEPL/ Emerald/Sandhu Engg.
46.	HRC Fuse and Fittings	L&T / Siemens / GE/ C & S
47.	HVAC Contractor	ETA / Blue Star / Voltas / Dyna Aircon/sterling Wilson
48.	HVAC Panel	EAPL/KEPL/Tricolite/Advance/CWS
49.	Indicating Lamps	Siemens / L&T/ Emco
50.	Industrial Type Thermometer	Emerald / Guru /Waaree/Fie big/ H-Guru
51.	Insulated Flexible Duct	Caryaire / Atco / GP Spiro
52.	Insulation Fibre Glass – Aluminium faced, and, XPS	UP Twiga , Owens Corning , Kimmco, Supreme, Lloyds
53.	Laminar Flow Diffusers	Ravistar ,Systemair, Airflow
54.	Manual / Automatic Balancing Valves	Advance / Sevcon / Technoflow (Frese) / TA / Honeywell
55.	Modulating Motor	Honeywell , Johnson , Belimo , Rapid Control
56.	MS / GI Piping (Chilled / Drain/Condensate)	Jindal, TATA/ SAIL/ Mukut
57.	MS Painted / GI Cable Tray (Factory Fabricated)	Indiana / Slotco / Pilco / Kepl / Ricco
58.	Nitrile Rubber Insulation (For Pipe Insulation)	Armaflex / Superlon / K-flex
59.	Packaged Type Scrubber / Air Washer	Waves / Airflow / Humidin / Ambassder / Zeco / Balance Air
60.	Paints	Shalimar / Asian / Nerolac /Burger
61.	Panel for sec VFDs	EAPL/Tricolite/Trident/KEPL/CWS
62.	PID balancing cum motorized valve For AHUs and FCUs	Danfoss/Oventrop/Flowcon
63.	Power & Control Cables	Havells / Finolex/ Power Age/ Gloster / Universal / Polycab / National/CCI
64.	Pre, Fine & Hepa Filters	Thermodyne / Shree Multitech Engineers / Purolator / Spectrum / Dyna Filters ,Macro scientific/Anfilco

65.	Pre-Insulated Fabricated Ducts	Pal / P3 / Kingspen/Spiro/Techno/Rolastar/Zeco
66.	Pressure Gauges	Feibig / Emerald / Waaree/H Guru
67.	Pressure Independent Balancing Cum 2-way Control Valve (Single Body)	Sevcon / Technoflow (Frese) / TA / Honeywell /Belimo /danfoss
68.	Primary chilled water Pumps & Condenser water Pumps	ITT/ Armstrong/ Grundfoss/ Mather & Platt/ WILO/Xylem
69.	Propeller Fans	Caryaire / CG/ Magneto/Khaitan/ Alstom/Systemaire/Greenheck
70.	Proportional Thermostat	Honeywell , Johnson ,Anergy Controls
71.	Red Oxide, Zinc Chromate Primer	ICI , Berger or Equivalent
72.	Rotary Switches	L&T / Siemens / GE / BCH
73.	RP Tissue	UP Twiga , Styrene Packing
74.	Scale Preventer System	Scale Guard (Aqua Treat) / Crystallo / Scaloid
75.	Selector & Toggle Switch	Kaycee / L&T/Siemens/Schnieder
76.	Single Phase Preventer	L&T / Minilec / Siemens
77.	Starters, Contactors, Push Buttons, Overload Relay	L&T / GE / Siemens / BCH / Schneider / Hager
78.	Suction guide	Anergy/ ABB/ Sandnu
79.	Tar felt / CPRX compound	Shalimar tar product/Asian
80.	Terminal Block	Elmex/Siemens/Schneider
81.	Thermometers	H.Guru/ Emerald/ Japsin/ Fiebig/Taylor
82.	Three phase motors	ABB / CG / Siemens / Bahrat Bijli / Kirloskar
83.	Time Delay Device	Siemens / L&T/ BCH
84.	Two Way, Three Way Valves	Honeywell , Johnson , Sauter, Landis & Staefa, Anergy
85.	Vacuum Degasser/ Air & Dirt Separator/ Air Separator	Spirotech / Spirotherm /Comfort/Anergy
86.	Variable Frequency Drive	Johnson / Siemens /Emerson /Honeywell / ABB/Danfoss/Schneider
87.	Variable Frequency Drive	Danfoss / ABB / Schneider /Siemens/ Allen Bradley
88.	Variable Speed Pumping System (For Secondary Chilled Water Pumps Motors)	ITT / Armstrong / Grundfoss/WILO/ Siemens/Danfoss/Honeywell/ABB
89.	VAV Boxes	Trox/Belimo/Barcolair
90.	Vibration Isolation Spring & Flexible Pipe Connector	Resistoflex / Diamond/ Kanwal/Dunlope
91.	Voltmeter / Ammeter	A.E. / IMP./ Conzerve /ABB /L&T
92.	Water / Air Cooled Screw Chilling Machine	Carrier/Daikin-McQuay/Climaveneta Dunhambush/Trane/York/Hitachi/Clivet
93.	Water Flow Switch	Anergy / Rapid Cool / Honeywell / Rapid control/Danfoss/Honeywell
94.	Welding Rods	Advani / L&T or equivalent
95.	Y-strainer / Pot – strainer	Rapid control/ Sandhu Engg/ Emerald /Maharaja/ Sant / DS Engg

12. 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 (Analogue), Energy Meter	AE/ Enercon/Conserve
7.	Ball Valve	Rb / Zoloto / Leader / Danfoss / Sant /Rapid / Castel/ Emerald /Audco
8.	Battery	Exide/ Amco/ Amaraja/ Chabbi/Statcon
9.	Butt welded fitting (UL Listed)	V.S.Forge /True Forge / DRP-M
10.	Butterfly valves / C.I. Double flanged sluice Valves & check valves	Audco / Zoloto / Safex/ Intervale/ Leader/ Audco / Sant/ Kirloskar / Advance
11.	Cable lugs and glands	Comet/Dowell/Lotus/Jainson/Baliga/ Stripwel
12.	Cables	Universal / CCI /Gloster/ Elektron/ Polycab/ Finolex
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 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 / BST / SAIL/Praksh Surya
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	Intervale /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

13. EPABX & TELEPHONE SYSTEMS

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

14. PUBLIC ADDRESS SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Amplifiers	BOSCL ,Philips ,PLENA ,ATE ,AHUJA
2.	Speakers	BOSCL ,Philips ,PLENA , ATE ,AHUJA
3.	Cables / Control cables	Universal , CCI , Gloster, Elektron, Polycab, Finolex

15. 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

16. NURSE CALL SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1	NURSE CALL SYSTEM	Pes Installation Pvt.Ltd, Prime Automation, Aras Medical, Datax Omeda, System-Tek, Siemens, Notifier

17. Electrical Works

S.No	Description	Make/manufacturer
1.	11 KV VCB	L&T, GE,ABB , Areva , Schneider , Siemens
2.	11KV, 433 V OLTC oil type transformer	GE ,ABB, Siemens, Areva, kirloskar, crompton. schneider
3.	A/C cutlet 32 Amps with MCB	Hensel/ North West/ Crabtree
4.	A/C Outlets	North West/ MDS-Legrand/ Crabtree
5.	ACB (TP,4P) with variable microprocessor based releases (O/C, S/C & E/F) compatible with PLC	L&T (u-power), Siemens (Sentron), Schneider (Nw Masterpact), GE(entelliguard),ABB (emax).
6.	APFC Panels	L&T, Siemens (Siepan), GE, Schneider, ABB
7.	APFC-Relay	L&T, 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, Chhabi, Statcon
12.	Battery Charger-cum-DCDB	Amaraja, Volstat, Chabbi Elect, Caldynes, Expo-Fyn, BCH, HBL
13.	Brass compression gland (Heavy duty)	Commex, Gripwell or equivalent
14.	Bus bar	Jindal/ Hindalco or equivalent
15.	Bus trunking , rising mains, end feed unit, top-off box(plug-in type)	L&T, ABB, Siemens, Schneider , GE, C&S
16.	Cable lugs & gland	Dowel, Jhonson, Gripwell, Comex, Hex, Comet
17.	Capacitors with harmonic filters	Epcos, L&T, GE , Siemens (Siepan), Schneider, ABB
18.	Ceiling fans	Crompton, Usha, Orient, Bajaj, Havells, GE, Khaitan, Alstom
19.	CFL lamps	Philips, Crompton, Wipro, GE, Osram, Bajaj
20.	Coaxial wires	Finolex, Delton, Skytone, Anchor, L&T, Beldon,
21.	Colour Monitor	Samsung , Philips, LG
22.	Contactors	ABB, L&T, Schneider, GE, Siemens
23.	Control Cables	Polycab, Nicco, Ecko, UIL, Elektron,KEI ,
24.	Control fuse base with HRC fuse /	L&T, GE, Siemens, ABB, Alstom

	HRC Fuse	
25.	Conventional fire alarm panel	Edwards, Honeywell, GST, Johnson control, System sensor, cease fire
26.	Conventional detectors & hooters & accessories	Edwards, Honeywell, GST, Johnson control, System sensor, Cease fire
27.	Copper control cable (FRLS)	Havell's, RR Cables, Elektron Harsh
28.	Crimping lugs/thimbles	Dowells, Hex, Commet
29.	CT/PT's	Meher, CGL, Kappa, Maxwell, Areva, L&T, AE, Jyoti,
30.	CT's (Cast resin)	L&T, AEI, Kappa, Pragati, Gilbert
31.	Cubical type Synchronizing & capacitor control panel (Bolted / Folded fabrication)	L&T, ABB, Schneider, GE, Siemens (Siepan), GE
32.	Cubicle type fuse unit	Siemens, L&T, ABB, Schneider, GE
33.	Data Outlets	SYSTEMAX, amp, clipsal
34.	MCBs, RCCB & DBs	Legrand, Schneider, Siemens, GE, ABB, L&T (Hager),
35.	DG Set- Alternator	Stamford, Lorey Somer, kirloskar, toyo denki, avk
36.	DG sets package	Jakson Engineers, TIL, Caterpillar, Sterling generators ltd., Perkins, Kirloskar
37.	Diesel engine	Cummins, Mitsubishi, Perkins, Kirloskar,
38.	Digital lighting control system	Aura dimming, relux controls, lightolier control, effectron, Philips, Schneider.
39.	Digital Numerical Relays	L&T, ABB, Siemens, Schneider, GE, Areva
40.	DWC HDPE Pipe	DURA-LINE, REX, CARLON, EMTELLE
41.	Energy / Digital meters	Enercon, L&T, Rishabh, Secure, Trinity, Schneider Electric, Havells, HPL, GE, Siemens, ABB, Conzerv
42.	Exhaust fan	Usha, Crompton, Havells, GE, Bajaj, Alstom
43.	Feeder pillars, Meter cubicle Panels, Floor panels for upto 400A i/c switchgear	ABB, L&T, GE, Siemens, Schneider
44.	Fiber Optic Cable	Sterlite Industries, Finolex
45.	Fire extinguisher	Ceasefire, Exflame, Minimax, Life Guard, Safex, Peter Autokit
46.	FRLS - PVC/Aluminum / copper 1.1 KV grade /cables & wires	Elektron, Havells, Polycab, Finolex, RR
47.	G.I. pipes	Jindal (Hissar)/ Tata
48.	G.I./Cu. Strip & earthing material)	Bharati, Indiana, Slotco
49.	Glands	Comet/ Stripwel/ Baliga
50.	H.T. Cables	Cable corporation of India, Universal, KEI, Havells, Nicco, Polycab, Finolex, Rallison, Gloster
51.	H.T. Panel	ABB, Alstom, GE, Siemens, Schneider, L&T
52.	Hand gloves & rubber mat	Premierpolyfim Ltd, Polyelectrosafe, Challenger, Electromat, Safe Hold
53.	Indicating Lamp(LED)	BCH/ L&T/ Rank/ MG
54.	Indicating lamps	AE, Kaycee, Vaishnav, L&T, Siemens, Emco
55.	Industrial socket outlets	GE, ABB, Hager, Legrand

56.	Insulators	Jaya Shree, Modern, IEC, WSI.
57.	Intelligent detectors & hooters & accessories	Notifire, Honeywell, Johnson Control, Schneider, edwards
58.	Intelligent fire alarm panel	Notifire, Honeywell, Johnson Control, Schneider, edwards
59.	Inverter	Microtek , Luminous , Su-Kam
60.	Isolators	Siemens, L&T, ABB,GE
61.	Jointing kit	Reychem, Xicon, Birla 3M
62.	Light fittings/ Lamps	Philips, Wipro, Bajaj, Havells, Keslec, Pierlite
63.	Lightning arrestor	Indelec, Gersom, Helitta, MDS, Hager, Duval Messin, L&P Electro, LPI
64.	LT cables (XLPE,PVC)	Cable Corporation Of India, Universal, Havells Nicco, Polycab, Finolex, Rallison, Gloster, Elektron,KEI
65.	LT panels	ABB, L&T, GE, Siemens, Schneider
66.	Lugs	Dowell's/ HAX
67.	MCCB with variable Microprocessor based (O/C, S/C, E/F) / Thermo magnetic releases	L&T D-sine , Siemens(3VL) , Merlin Gerin (NSX compact) , GE(Record), ABB-T Max
68.	Measuring instruments (Digital type)	L&T, Ducati, Konzerv, HPL, Siemens
69.	Modular switches, socket outlets and wiring accessories with moulded cover plate	Anchor (ave), MK (wraparound) , Siemens, legrand (mosiac), L&T, clipsal (neo`c` metro), Havells (piccadilly)
70.	MS Conduit	BEC, AKG, Steel Craft
71.	MS Conduit accessories	Rama, Novel, BEC, AKG, steel craft
72.	Multi-function Meter	L&T, ABB , Siemens, Schneider, Ducati,
73.	Overload relay single phase preventer	ABB, L&T, GE,Siemens, Areva
74.	Panel accessories	L&T,Rishab, Siemens, BCH
75.	Poles- Light	Bajaj, Transrail ,Power control corp, National tubing co, sancube, Hilite
76.	Power capacitor with batter than 14% harmonic filter at 525 V (long life mixed Dielectric)	L&T(Meher) , EPCOS (Siemens), DUCAT, GE, Schneider, ABB
77.	Programmable timer (self-powered electronic digital)	L&T, Siemens, Hager, MDS, Legrand
78.	Projection system	Aties, Harmonpro, JBL
79.	Protective relays (Microprocessor based compatible with PC & PLC)	Siemens, L&T, ABB, GE,Areva
80.	Push button, indicating lamps (led type)	Siemens, L&T, ABB, Schneider , C&S
81.	PVC conduit	Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG
82.	PVC conduit Accessories	Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG.
83.	Race ways/ Cable Trays/ Floor trunking / wall channels	MK, Legrand, Needo, Rico Steel, Pilco, Slotco
84.	Relay and Control Panel	Siemens , L&T, GE, Schneider, ABB
85.	Relays- Auxiliary / Numerical /Bi metal relay	L&T, GE, ABB, Alstom, Siemens, Areva.
86.	Sandwiched bus-duct	Siemens, ABB, GE,Schneider, L&T, C&S

87.	Selector switch	Salzer, Kaycee, Siemens, HPL, L&T, BCH
88.	Selector Switch	Kaycee / Salzer
89.	Starters	Siemens, L&T, GE,ABB, Schneider , Areva
90.	Surge diverter	Tercel, ABB, Siemens, Emerson, Hager, Phoenix, Legrand
91.	Tap-off, Splitter box	Zinwell, Novatron, Catvision
92.	Telephone cables/ wires	Polycab, Finolex, Havells, RR Kabel, L&T, Bonton, Skytone, Rallison, Cable corporation of India, Gloster
93.	Telephone tag block	Krone, Tvs, R&M, Phoenix, Wago
94.	Telephone wires	Bonton / Delton/ Polycab/ Connect well/ Phoenix/ WAGO
95.	Terminal strip	Connect well, Phoenix, WAGO
96.	Termination Kits	Raychem, Birla, 3M
97.	Trivector - Meter (Digital type) only for SEB supply.	L&T, Secure, Enercon, Siemens,
98.	UPS	Emerson , A.P.C ,Socomec, GE, Mistubishi, Eaton
99.	Voltmeter and ammeter	AE, Meco, Universal, Rishab, Yokins
100.	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.