

MINISTRY OF HEALTH & FAMILY WELFARE

GOVERNMENT OF INDIA, NEW DELHI

Tender No. MoHFW/ME/NIAHS- DELHI /HLL/ID/2013

Request for Proposal (RFP)

for

**Construction of National Institute of Allied Health Sciences (NIAHS) at
NAZAFGARH, DELHI**

VOLUME - III

TECHNICAL SPECIFICATIONS



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

Phone no: 0120-4071500, Fax no: 0120-4071513

(March, 2013)

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**Civil Works & Plumbing & Sanitary, and, Horticulture Works
(Page no. 1 to 65)**



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Construction of National Institute of Allied Health Sciences (NIAHS) at NAZAFGARH, DELHI

BRIEF TECHNICAL SPECIFICATIONS AND CONDITIONS:

1. GENERAL SCOPE OF WORK :

a. The scope of the proposed work consists of the following Buildings

- | | | |
|-------|--|-------------------|
| (i) | Hospital Block- | Gr + Three Floors |
| (ii) | Academic Block | Gr + Two Floors |
| (iii) | Hostel | Gr + Seven Floors |
| (iv) | Residential Blocks | Gr + Six Floors |
| (v) | Guest House Block | Gr + Two Floors |
| (vi) | Services Blocks | |
| (vii) | Infrastructure Developmental including External Development Works. | |

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

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< 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
- l. Water Treatment Plant/Sewage Treatment Plant/Effluent Treatment Plant

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 B.I.S/ IRC/ BS/ ASTM/ DIN/ NBC.

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. 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.

d. DESIGN MIX CONCRETE (DMC)

- i. The batching and mixing plant shall be fully automatic.

- ii. The contractor has to arrange to erect batching plant for the design mix concrete on his own.
- iii. 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.
- iv. 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.
- v. However samples for testing etc. shall be taken as per the mandatory tests prescribed in latest CPWD specifications.
- vi. 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.
- vii. 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.
- viii. The water will be tested with regard to its suitability for use in CC work and nothing extra will be paid for on this account.
- ix. To receive anchor bolt / foundation for machines to be installed at later date, pocket of size minimum 110x100x300 mm shall be kept while concreting of RCC/ CC members and shall be filled with CC 1:1:2 with plasticizer and as per the direction of Engineer in charge.

e. **REINFORCEMENT:**

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.

3. BRICK WORK

- a. Bricks used in the work shall be FPS to 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 locality. 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. Half brick thickness has to be taken as 115mm. Bricks wall beyond half brick thickness shall be measured in multiple of half brick (ie.115mm) which shall be deemed to be inclusive of mortar joints. In all other respects they shall conform to the provision in CPWD specification 2009.

4. 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. Transparent sheet glass (Float glass) conforming to IS 1761 – 1970 shall be used.
- e. 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

- f. Glazing for toilet and in fixed ventilators shall be of frosted type.
- g. 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.
- h. 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.
- i. 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.

5. STEEL 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.
- c. All welded steel works shall be tested for quality of weld as laid in IS 822-19780 before actual erection.

6. ALUMINIUM WORKS

- a. **Scope: - (Work to be carried out as per latest CPWD specifications of works)**

The scope of the work is the fabrication, supply and erection at site of all types of glazed doors, windows and ventilators in accordance with the drawings and specifications.

- b. It is the responsibility of the tenderer to inspect the site and obtain for himself all relevant information and details in respect of the work including access facilities for stacking and

storage field work in making connections with self-tapping screw assembling etc and take into account all such things in working out his rates for the finished work.

- c. 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.
- d. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

e. 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 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.

f. 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 should 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.

g. Fabrication:

- i. Before commencing the fabrication the contractor shall submit to client 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 client/EIC 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 EIC. A sample of finished door/windows/ ventilator / fire check door / railing etc.shall be fabricated as per the shop drawings approved by EIC/client for final approval before under taking mass production/ fabrication,

- ii. 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.
- iii. 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 EIC/Consultant shall be final and binding on the contractor.
- iv. 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.
- v. 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.
- vi. 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.
- vii. 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.

h. 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.

7. FIRE CHECK DOORS:-

a. FIRE AND SMOKE / HOT GASES CHECK DOORS:-

- 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.
- b. Shop drawing:-** The contractor shall submit including required designing shop drawing for doorframes, shutters complete with
- i. Plan, elevation with relative position of adjacent works

- ii. Glazing details with type size and fixing
- iii. Fitting and fixtures with type size, brand and fixing details.
- iv. Finishing details
- c. **Door Frames:** - Door frame shall be manufactured from 2nd class teakwood (Ivory Coast) door frame of section Max. 120mm x 70mm. 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.
- d. **Door Shutter:-**
 - i. The Door shutter shall be of thickness 50 mm minimum but not more than 55mm, suitable for mounting on the door frame. It shall comprise of two non-combustible boards 12mm to 18 mm thick sandwiching 10 mm to 20 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 comprising of two 12 mm thick calcium silicate board 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 sandwiching 20mm thick fire resistance insulation filler coated with FR silicon sealant and face with 3mm thick commercial ply facing on both side and faced 1.5mm laminate on both sides 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.
- e. **Lock:** - Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.
- f. **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.
- g. **Automatic Door Closer:** - Dual adjustable speed automatic door closer with rack and pinion method shall be provided.
- h. **Smoke Seals:** - Heavy duty smoke seals for smoke check doors shall be provided.
- i. **Acoustic Seals:** - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.
- j. **Opening Width:** - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.
- k. **Measurement:** - Frames and shutters shall be measured in square meter out to out.
- l. **Testing:** - The HLL/ Client 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.

- m. **Rates:** - The rates shall be inclusive of all material, T&P, Labour, etc. complete including the cost of fittings, testing etc. as described above.

8. GLASS ENTRANCES AND GLAZING WITH PATCH FITTING

a. SCOPE OF WORK

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

b. The brief scope of work is:

- 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:
 - i. 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.

9. FLOORING:

- i. 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.
- ii. Wherever Tile flooring is done it shall be with 1st. Quality tiles only.
- iii. 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.
- iv. 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.

10. 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. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of EIC shall be obtained.

11. ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

- a. 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.
- b. The contractor must design the cladding as per the prevalent site conditions and building elevations profiles. No extra claims shall be entertained at any stage for aluminum profile/ wall thickness and size dimensions. The Contractor must quote rates accordingly.
- c. 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).
- d. 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.
- e. 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.
- f. 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).
- g. The Periphery of the framework shall be sealed both from inside and outside with silicon weather sealant to make the cladding watertight.
- h. 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.
- i. 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.
- j. **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.

k. Manufacture

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

l. Installation

- i. The panels shall be fixed in accordance with manufacture's recommendations.
- ii. Technical Properties of Aluminium Composite Panels
- iii. All cladding shall be of 4.0 mm thick aluminium composite panel comprising of high mineral filled core sandwiched between two skins of aluminium alloy.
 1. Mechanical Properties : Tensile strength $\geq 130 \text{ N / mm}^2$
: 0.2 % proof stress 90 N / mm^2
: Elongation 5 %
: Modules of elasticity $70,000 \text{ N/mm}^2$
 2. Vibration and Noise
Damping : Average airborne - Sound
Transmission loss R/N 25db (DIN 4109)
 3. Thermal Transmittance : $R = 0.014 \text{ m}^2 \text{ }^\circ\text{C/W}$
 4. Moment of Inertia : $0.347 \text{ cm}^4/\text{m}$
 5. Panel Weight : 5.5 Kg/m^2
 6. Finish : PVDF stove lacquered (Fluoro carbon) on one side and reverse side in mill finish.
 7. Colour : Colour to be selected by Engineer-in-Charge Representative using standard PVDF colour chart from manufacturer.

m. Protection

Protection should not be removed until after installation.

n. 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.

- o. **Measurement:** The measurement shall be for exposed actual surface area with grooves cladded on plain/ curved surface excluding the concealed trims.

12. 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.

13. 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.

14. 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 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.

15. WATER PROOFING TREATMENT:

- a. 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.

16. 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)

17. CARPET FLOORING/ SKIRTING (Floatex or equivalent) :-

- a. The Carpet flooring / skirting shall be made out of 4.3mm thick X 30m X 2m wide of Floatex or equivalent make. The sheeting shall be butt jointed at edges for seamless finish. The Floatex sheeting shall be brought to site and stored standing on end. The material shall be placed as per jobsite conditions for a minimum of 48 hrs. prior to installation.
- b. The flooring shall be fixed with adhesive having low solvent, solvent free and very low emission properties equivalent to EMICODE.
- c. The finishing accessories such as skirting, profile and stair nozings shall be part of flooring system only.
- d. The Sub floors should be smooth, hard, clean and dry before laying commences. Uneven solid or suspended timber sub-floors may need preparation to meet the required standard.
- e. Prior to cutting, organize the material by roll number to ensure that all rolls and cuts will be installed in consecutive order. Make sure that all rolls are from the same batch. DO NOT REVERSE sheets for seaming. Install with arrows all pointing in the same direction. Wherever possible, run the arrows toward the main light source. Install sheets running lengthwise.
- f. Mixing of sheeting and tiles in the same area is not recommended.

18. Door and Frames for Operation Theatres: Hermetically Sealed Sliding Automatic Door (2100mm x 1500mm)

- a. The scope of work includes providing & fixing Hermetically Sealed Sliding Automatic door for operation theatres which shall be of size 2100mm x 1500mm with vision panels, 300mm X 300 mm and to maintain sterility and the correct air pressure in the room, all doors into and out should be of the sliding, hermetically sealing type. Track system and door blade guide system: Automated and Manual Hand Operated Hermetically Sealing Sliding Main Door on OT, of appropriate size, 2100mm (ht.) x 1500mm (wd).
- b. **Door shutter** shall be of 40mm thickness (33mm tubular chipboard (core) + 3mm MDF (medium-density fiberboard) on both sides + 0,8mm HPL (Steripanel High Pressure Laminate) on both sites). Circumferential profile: Anodized aluminum profile, circumferential 56 mm, V- shaped in the bottom area towards door lead on ground lobes. Surface: 0.8 mm HPL-laminate on 3 mm MDF-board as carrier material; depending on the chosen material a free passage of 1.15 m or more may require a seam in the laminate.
- c. **Sealing** shall be of Rubber gaskets embedded in the door leaves press against the frame and the door, providing a hermetic sealing of the door.
- d. **Rail System Guide rail** shall be of anodized aluminum profile with two countersunk slots at 42° for carrying wheel position in closed condition.

- e. **Carrying wheels** shall be of ball bearing with duroplastic rolls.
- f. **Covering** shall be rounded covering of extruded anodized aluminum.
- g. **Ground Rail** shall be of Duroplastic lead lobes on bottom running rail.
- h. **Operation Handle** shall be of Bilateral (inside/outside) stainless steel lever arm handle with integrated return spring to neutral position
- i. **Frame HPL-system frame** shall be HPL-coated embrasure board with circumferential aluminum corner protection profiles for arbitrary wall strengths. Closed frame- steel : Closed steel frame with additional aluminum corner protection profiles (for sealing he operation side of the door). Closed frame- stainless steel: Stainless steel frame, steel grade 1.4301, polished 240 grain, with additional stainless steel corner profiles (for sealing the operation side of the door).
- j. **Window** shall be integrated 300 x 300mm window, mounted flush with the adjacent area of the leaf.
- k. **Automated drive** shall be process-controlled automated drive for the most diverging kinds of activation.
- l. **Lock** shall be Deadbolt lock, prepared for Euronorm-profile cylinder. Electric lock : Electric lock, 24 V for activation through code locks, switches, key switches or reciprocal interlocking doors.
- m. The **Acoustic Value** of the door shall be about 28dB.
- n. **Weight of the door and door blade** shall be
 - i. **Door leaf** 1560 x 2105 about 40Kg.
 - ii. Door leaf 1060 x 2105 about 28 -30Kg.
 - iii. Canopy shall about 15 to 20 Kg (depending of the door).
- o. Power requirement shall be 230V alternating current 50Hz.
- p. The opening-distances are controlled completely step less. It can be adjusted (according to the switches).
- q. **Speed of the door** shall be adjustable in 5%-steps (opening and closing speed is adjustable separately). It is adjustable from 0,1m/sec. to 0,8m/sec. The time the door stays open is adjustable up to 30 sec. (standard is 8 sec). Foot Switch inside and outside. Elbow Switch inside and outside. Movement Sensors inside and outside. Door profile inside and outside.

19. Door and Frames for operation theatre: Hermetically Sealed Sliding Automatic Door Size (2100mm x 900mm or 1000mm)

- a. The scope of work includes providing & fixing Hermetically Sealed Sliding Automatic door for operation theatres which shall be of size 2100mm x 900mm or 1000mm with vision panels, 300mm X 300 mm, and, to maintain sterility and the correct air pressure in the room, all doors into and out should be of the sliding, hermetically sealing type. Track system and door blade guide system shall be automated and Manual Hand Operated Hermetically Sealing Sliding Main Door on OT, of appropriate size, 2100mm (ht.) x 900mm or 1000mm (wd).
- b. **Door Shutter** shall be of 40mm thick (33mm tubular chipboard (core) + 3mm MDF (medium-density fiberboard) on both sides + 0.8mm HPL (Steripanel High Pressure Laminate) on both sides). Circumferential profile of door of Anodized aluminum profile, circumferential 56 mm, V- shaped in the bottom area towards door lead on

ground lobes. Surface : 0.8 mm HPL-laminate on 3 mm MDF-board as carrier material; depending on the chosen material a free passage of 1.15 m or more may require a seam in the laminate.

- c. **Sealing Arrangement** shall be of rubber gaskets embedded in the door leaves press against the frame and the door, providing a hermetic sealing of the door.
- d. **Rail System Guide rail** shall be of Anodized aluminum profile with two countersunk slots at 42° for carrying wheel position in closed condition.
- e. **Carrying wheels** shall be of ball bearing with duroplastic rolls.
- f. **Covering** shall be of rounded covering of extruded anodized aluminum.
- g. **Ground Rail** shall be of Duroplastic lead lobes on bottom running rail.
- h. **Operation Handle** shall be Bilateral (inside/outside), stainless steel lever arm handle with integrated return spring to neutral position
- i. **Frame HPL-system frame** shall be of HPL-coated embrasure board with circumferential aluminum corner protection profiles for arbitrary wall strengths. Closed frame- steel: Closed steel frame with additional aluminum corner protection profiles (for sealing the operation side of the door). Closed frame- stainless steel: Stainless steel frame, steel grade 1.4301, polished 240 grain, with additional stainless steel corner profiles (for sealing the operation side of the door).
- j. **Window** shall be integrated 300 x 300mm window, mounted flush with the adjacent area of the leaf.
- k. **Automated drive** shall be Process-controlled automated drive for the most diverging kinds of activation.
- l. **Lock** shall be deadbolt lock, prepared for Euronorm-profile cylinder. Electric lock: Electric lock, 24 V for activation through code locks, switches, key switches or reciprocal interlocking doors.
- m. **Acoustic Value** shall be the acoustic value of the door is about 28dB. Weight of the door and door blade: Door leaf 1560 x 2105 about 40Kg.
- n. **Weight** of the door and door blade:
 - i. Door leaf 1060 x 2105 shall be about 28 -30Kg.
 - ii. Canopy shall be about 15 to 20 Kg (depending of the door).
- o. Power requirement shall be 230V alternating current 50Hz.
- p. The opening-distances are controlled completely step less. It can be adjusted (according to the switches).
- q. **Speed of the door** shall be adjustable in 5%-steps (opening and closing speed is adjustable separately). It is adjustable from 0,1m/sec. to 0,8m/sec. The time the door stays open is adjustable up to 30 sec. (standard is 8 sec). Foot Switch inside and outside. Elbow Switch inside and outside. Movement Sensors inside and outside. Door profile inside and outside.

20. Antibacterial Paint

- a. The Antibacterial Paint shall be able to provide anti-Microbial Protection:
- b. The scope of work includes providing & applying approved makes anti-Microbial Paint on wall surfaces as per manufacturer's specifications complete in all respect & as directed by Engineer-in-charge. Following are the desired characteristic of the paint:

- i. Protection: The product hygiene coatings to start the biocidal action as soon as the microorganism land on the surface, and prevents the growth of mould, bacteria and yeasts for at least 5 years.
- ii. Lily Cycle Savings: The unparalleled durability of hygiene coatings should help to extend the maintenance cycle and to minimize all related material, labour and shut down costs.
- iii. Chemical Persistence: The hygiene coatings should be highly resistant to abrasives, detergents and weak acids and alkalis used in cleaning regimes. Furthermore, they can be regularly steam cleaned without any loss of performance or adhesion to the substrate.

21. Stainless Steel Scrub Sink Two Bay

- a. The scope of work includes providing & fixing Stainless Steel Scrub Sink Two Bay as per manufacturers specifications
- b. Stainless Steel Scrub Sink: Scrub stations for each operation theatre should be designed to ensure that surgeons and staff can undergo a thorough aseptic scrub, whether using the count stroke or timed scrub methods. Stainless Steel Scrub Sink. Each fixture is fabricated from heavy gauge, type 304, stainless steel and is seamless welded construction polished to a satin finish. Hands free operation includes infrared sensor with a built-in range of adjustment. The sink shall be able to provide user definable settings of 3, 6, 12, 30 and 45 seconds, 1, 3, 5 and 10 minute. A thermostatically controlled mixing valve automatically maintains water. It should have a foot operated facility.

22. Bumper Guard Stretcher Guard Crash Rail System

- a. The scope of work includes providing & fixing Bumper Guard / Stretcher Guard Crash Rail System of approved make consisting of continuous aluminum retainer, impact absorbing strip (B-ABS), adjustable end cap / corner joint, adjustable adaptor plate and high impact vinyl acrylic cover of desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.
- b. The Bumper Guard / Stretcher Guard Crash Rail System shall be able to protect walls that are susceptible to trolley traffic, preventing unsightly scuffs and costly damage.
- c. This system shall be so designed to withstand impact and provides a cushioned surface with its integrated rubberized absorber, making it ideal for areas like high traffic corridors, loading bays and light cargo lifts.
- d. Bumper Guard shall be manufactured from specially developed vinyl acrylic materials and has the following qualities:
 - i. Able to withstand high impact and abrasion
 - ii. Weather resistant and fire retardant
 - iii. Textured to provide an anti-slip surface
 - iv. Fittings and anchorages that can withstand corrosion when exposed to normal environmental conditions
 - v. Easy to install and maintain
 - vi. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance

- vii. Designed and comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.
- viii. It should consist of the following
 - 1. Continuous Aluminum Retainer
 - 2. Impact Absorbing Strip (B-ABS)
 - 3. Adjustable End Cap/ Corner Joint
 - 4. Adjustable Adaptor Plate
 - 5. High Impact Vinyl Acrylic Cover as per approved colour and shade.

23. 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

24. BORE WELLS

a. Scope of Work

The general character and the scope of work to be carried out under this contract are illustrated in the following specifications. It gives only general guidance as regards design, drilling and construction of tube wells. Before selecting the method of construction to be adopted, the contractor shall give due consideration to site condition and Geological data of the site. The construction and testing of tubewells shall be as per IS 2800- 1979 (Part 1 and 2). This contract is an item rate contract. All payments shall be made for the actual work executed. The Contractor shall ensure the required minimum yield.

b. Selection of Site

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

c. Geological Data

During the drilling operation, contractor shall collect the samples of different strata from suitable intervals or where change in strata is met with. It shall be carefully examined and analysed and the data shall be preserved carefully and handed over to Engineer. The contractor shall make one drilling time log during the execution of work for the bore well.

d. Design and lowering of pipe assembly

The length and diameter of the housing pipe shall be selected on the basis of static water level, the draw down and the discharge expected from the well and the size of the pump to be installed. The size and length of blind pipes and the slotted/ strainer pipes shall be selected according to the expected discharge and the depth of tubewell. The size and distribution of the slots shall be as per IS 8110. After completion of the bore hole the contractor shall assemble the tube well assembly according to the water bearing strata met during boring, after getting the same approved from the Engineer and shall lower in to the drilled hole the same keeping the slotted strainer opposite to water bearing strata from which the water is to be extracted . The bail plug shall rest on firm ground. Before the bail plug is lowered, about one metre depth of the bore hole shall be packed with the gravel to avoid sinking of the assembly. In case part of a bore hole is not proposed to be utilized, it shall be filled with gravel before lowering the assembly. The slotted pipe and other pipes shall be provided with proper guides to keep them in the centre of the bore to ensure uniform gravel packing all around.

e. Gravel Packing

All gravel shall consist of hard rounded particles reasonably uniform in diameter and shall be of size, determined after analyzing the character of the water bearing formation tapped. The gravel shroud around the screen shall be uniform. It should be free from dust, dirt and other vegetable matters. Gravel packing once started shall be carried out continuously until it is completed. Pea gravel/Stone Chips shall be thoroughly washed.

f. Development of Borewell

The well shall be developed either by surging and agitating or by over pumping and back washing with an air lift and high velocity jetting. The tube well shall be developed as per IS 2800 -1979 or latest by air compressor to be arranged by the contractor as required and stipulated in BOQ to obtain the maximum discharge available from the completed tubewell. Another acceptable method may also be adopted. This development process shall be continued until the stabilisation of sand and gravel particles has taken place. The development shall continue until the gravel should stop sinking, discharge of depression ceases to improve and the sand content is not more than 20 parts per million. A record of the hours of working of Air compressor shall be maintained by Employer Engineer which will be signed by the contractor or his authorised representative. Payment for development of tubewell shall be made at the hourly rate indicated in the schedule of quantities for the actual period during which the Air-Condition has worked. A statement showing the quantity of gravel initially filled in the bore and the quantity added during development should be prepared by the contractor and got signed by the representative of the Engineer.

g. Disinfection

The well shall be disinfected after completion of test for yield. All the exterior parts of the pump coming in contact with the water shall be thoroughly cleaned and dusted with powdered chlorine compound. In fact it shall be disinfected every time a new pump is installed or the one installed is replaced after repairs.

The stock solution of chlorine may be prepared by dissolving fresh chlorinated lime. For obtaining an applied standard concentration of 50 ppm, 1 litre of the stock solution shall be used to treat 300 litres of water.

h. Grouting and sealing

Grouting and sealing of tubewell may be done, if required depending upon the site conditions and the quality of the discharge of the strata encountered. To ensure that the grout shall be provided a satisfactory seal, it shall be applied in one continuous operation. Sealing of the tube well may be done by grouting the annular space between bore and the housing pipe, with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 : coarse aggregate 20 mm nominal size) to a depth of 5m below the grouted level.

i. Handing over of the borewell.

The tubewell shall be handed over in complete shape. The housing pipe shall be closed by a well cap for the period between the completion of the tube well and the installation of the pump set.

The following information shall be furnished by the drilling agency on completion of the tubewell :

- i. Strata chart of the tube well indicating the different types of soils met with, at different depths.
- ii. Samples of strata collected , neatly packed and correctly marked in sample bags.
- iii. Chart of actual pipe assembly lowered indicating the size of pipes, depth ranges, where slotted/ strainer pipes have been used, depth and diameter of housing pipe, reduced level of the top of the housing pipe and the diameter and depth of the bore hole.
- iv. Position of every joint in the well assembly.
- v. Hours of development done by the compressed air, pump sets or by other means.

- vi. Pumping water level at the developed discharge.
- vii. Two copies of test certificates of the water samples results from approved testing agency.
- viii. Results of development along with levels of static subsoil water and depth of draw for steady discharge.
- ix. Results of mechanical (sieve) analysis of samples of aquifer materials wherever applicable.
- x. Yield analysis and recommendation on the safe pumping yield, pump settings and specifications for suitable pumps etc.
- xi. Verticality tests results to be recorded in accordance with IS:2800-1979
- xii. TUBEWELL DATA:- Shall be decided by the Engineer-in-charge.
- j. Water for drilling – Contractor shall make his own arrangement for water required for drilling purposes as well for development purposes.
- k. The design for the tube well indicating the depth range of the aquifer zones to be tapped shall be given after a detailed study of the data collected during drilling operations.
- l. The slotted pipes should have an effective open area of at least 15% and the slotted size should be 1.6 mm. All pipes shall be painted fresh before lowering. The pipes shall be welded thoroughly all round to prevent leakage and breakage. Centering guides may be used to maintain the verticality of the tube wells which shall be tested.
- m. The annular space between the bore well and tube well assembly shall be packed with well-graded pea gravel of good quality, durability and high sphericity.

25. 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.

26. 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.

27. 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.

28. 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 certified and approved by competent central/state Governments or the laboratory set up by the contractor at site as per directions of EIC/ Consultant.

- b. The Engineer-in - charge of work shall check the test results and satisfy himself before allowing any payment in the running /final bill.

29. CONDITION REGARDING THE PAYMENT OF WATER CHARGES IN CONNECTION WITH WATER USED FOR THE CONSTRUCTION PURPOSE AND FOR DRINKING PURPOSE OF CONTRACTOR'S LABOURS RESIDING IN SITE OF WORK.

- a. Both the water charges (if any) incidents to water used by the Contractor for construction purpose and for the drinking purpose for his labours residing in the site of work shall be borne by the Contractor / agency under the following cases:
 - i. In case of temporary water connections from municipal mains.
 - ii. Water charges (including the water used for construction purpose and drinking purpose of the contractor's labours) have to be borne by the contractor / agency.
 - iii. Water used from other source :-
 - 1. Prior permission for using the water for construction purpose and drinking purpose of the contractor's labours has to be obtained from Municipal Corporation / local body by the contractor / agency. Water charges if any and other charges for use of water from other sources for construction purposes/for drinking purposes of the contractor's labours have to be borne by the contractor / agency.
 - iv. Any infringement and / or breach of the above specifications and conditions etc shall render the contractor liable to action under various clauses of the contract and such actions stipulated in the conditions therein.

SPECIAL CONDITIONS / ADDITIONAL SPECIFICATIONS**1. GENERAL**

- a. The contractor shall submit within 30 days of the date of award of the work, a bar chart to the Engineer in charge indicating the duration of various subheads of the work which shall be within the frame work of overall proportionate progress if so required and the work shall be executed as per the program approved by the Engineer in charge.
- b. Unless otherwise specified in the schedule of quantities, the rate tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depth of the building and nothing extra shall be payable to him on any account.
- c. No compensation whatsoever shall be payable to the contractor for any damage by rains, lightening, wind, storm, floods, tornadoes, earthquakes, or any other natural calamities during execution of work and no claim on this account will be entertained such damages.
- d. Before commencement of the work, the contractor shall obtain approval of the Engineer-in charge the location of cement godown, steel stacking and fabrication yard, site office and shall from time to time take instructions from the Engineer – in- charge regarding collection and stacking of materials at the site. No excavated earth or building material shall be stacked on areas where other buildings, roads, services or compound wall or any other structure are to be constructed.
- e. Some restrictions may be imposed by the Hospital authorities or its security staff etc. On the working and/or movement of labour, materials etc. The contractor shall be follow all such restrictions / instructions and nothing shall be payable on this account.
- f. The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards such as day and night boards, speed limit boards, red lights and providing barriers. He shall be responsible for all damages and accidents caused due to negligence on his part. No hindrance shall be caused to traffic during the execution of the work.
- g. The contractor shall give performance test of the entire work as per standards specifications before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the tests.
- h. All operation required for continuing concreting work at the construction joints for better bond are deemed to be included in the rates of the relevant items and nothing extra shall be payable on this account.
- i. Royalty at the prevalent rates whenever payable shall have to be borne by the contractor on the boulders, metal, shingle, sand and bajri etc. Or any other materials collected by him for the work direct to the revenue authority of the District / state Government concerned and nothing extra shall be payable on this account
- j. The rate of all items of work, shall, unless clearly specified otherwise include cost of all labour, materials and all other inputs required in the execution of the item, including octroi, sales tax and any other taxes.
- k. The contractor shall maintain in perfect all works execute till the completion of the entire work allotted to him. Where phased handing over of completed portion of the work is required by the Engineer – in – charge the provisions mentioned in the para will apply to each phase.

- l. The contractor shall obtain approval of Delhi authorities to erect the hutments for labour etc. at the site of work, denial of approval shall not affect the construction activities.
- m. In case the contractor is not permitted to erect the huts for labour at the site of work, the contractor will have to make his own arrangement to provide such accommodation elsewhere and nothing extra shall be paid for this.
- n. The contractor must see the site of the work, its approaches carefully before tendering, No claim of any sort shall be entertained on account of any site conditions. If any approach from main road is required or existing approach is to be improved and maintained, for cartage and materials by the contractor, the same shall be done by the contractor his own cost.
- o. The rates for items of work wherein cement is used are inclusive of cost for curing.

2. CONDITIONS FOR RECEIPT AND STORAGE OF MATERIALS:

- a. **Cement bags** shall be stored in Godowns to be constructed by contractor at his own cost as per sketch of CPWD specifications with weather proof roofs and walls. Godown shall be provided with a single door with two locks. The keys of one lock shall remain with the authorized representatives and that of the other lock with the authorized agent of the contractor at the site of work so that the cement is removed from the godown according to the daily requirement with the knowledge of both the parties. Samples of fresh cement shall be got tested from lab. only tested cement shall be allowed in the work, contractor shall bring cement keeping this in view to maintain progress of the work. No request for extension of time on this account shall be entertained.
- b. The contractor shall be fully responsible for the safe custody of the materials brought at site even if the materials are under double lock system.
- c. The contractor shall construct suitable godowns – yards at the location of the site of work duly approved by the Engineer – in – charge or his authorized representative for storing all other materials so as to be safe against damage by sun, rain, dampness, theft etc. at his own cost and employ necessary watch and ward establishment at his cost.
- d. Measurement of **reinforcement** shall be as per procedure described in CPWD specifications 2009. 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.
- e. 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.
- f. 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 CPWD Specifications 2009.

- g. TMT steel bars manufactured by main producers i.e. SAIL, TISCO, IISCO and RNIL 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.
- h. The contractor shall maintain and render proper account of all material brought by him to the site, consumed by him on the work and balance if any. In respect of steel reinforcement bars, theoretical consumption will be calculated diameter wise.
- i. All material obtained from Government stores or otherwise shall be got checked by the Engineer in charge of the work on the receipt of the same before its use in the work.
- j. 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.

3. TESTING OF MATERIALS:

- a. Samples of various material required for testing shall be provided free of charge by the contractor. All other expenditure required to be incurred like conveyance for taking the samples for testing at the laboratory, packing, etc, shall be borne by the contractor. If the test results do not confirm to the specifications and standards laid down, the materials shall be rejected, the shall remove such materials from site. The lab. for testing of samples shall be decided by the Engineer – in charge, whose decision shall be final and binding.
- b. The contractor shall arrange all required tools , plants, machinery and equipment for execution of the work. The contractor shall also provide suitable weighing and measuring arrangement and testing instruments and machines for testing of materials and cubes at site as per details given in GCC.
- c. All cubes shall be tested for 7 days and 28 days tests.
- d. Material brought at site of work shall not be used in the work before getting satisfactory test result as per relevant mandatory tests, detailed in the latest CPWD specifications.

4. SECURED ADVANCE (Interest free):

a. MATERIALS BROUGHT TO SITE AGAINST WHICH SECURED ADVANCE CAN BE GRANTED

i. CATEGORY ` A` (Items against which secured advance can be granted).

Bricks, stone and brick aggregate, stone, finished product of brass iron, or steel such as doors and windows frame, wire mesh gate, GI sheets etc. Precast RCC products, such as pipes jally, water storage tanks, doors and windows fittings, pipe and sanitary fittings, of CI/SCI and HCI.

ii. CATEGORY ` B` (Items against which secured advance can be granted after obtaining insurance cover).

Glazed tiles, terrazzo tiles, and similar articles, marble slab, asbestos cement products, finished timber product, such as doors, windows, flush doors, particle boards (Subject to mandatory test being satisfactory) etc. Bitumen in sealed drums, bitumen felts, polythene pipes and fittings, sanitary fittings, sanitary fittings, pipes of SW porcelain and chinaware materials, Laminated / Safety, one way vision, and bullet proof glasses, chemicals required for anti-termite treatment (in sealed drums), paints, varnishes, distemper, pigments, spirit etc.

iii. **CATEGORY `C`** (Items against which no secured advance can be granted)

Glass products other than those indicated in category B, sand and moorum, chemical compound other than those under category B.

- b. Secured advance on materials which are admissible as per detailed above and brought to site for use in the work shall be paid only after.
 - i. Receipt of satisfactory test result from the laboratory.
 - ii. Engineer in charge has personally verified that the material brought at site of work for use in the work conforms to the sample approved by him.
 - c. Secured advance shall be allowed for 75% of the value assessed by the EIC for a period of 3 Months only. Advance shall be recovered according to consumption of material in the work. Contractor shall have to sign an Indenture Bond before release of the advance.
 - d. The materials shall virtually stand Hypothecated to Client/HLL but contractor shall be fully responsible for watch & ward/ security of materials for which Secured Advance has been paid by client/HLL.
5. Any infringement and / or breach of the above specifications and conditions etc, shall render the contractor liable to action under various clause of the contract and such action as stipulated in the conditions therein.

TECHNICAL SPECIFICATIONS PLUMBING & SANITARY WORKS

SECTION 1 General REQUIREMENT

1. Scope of work

- a. 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 and/or shown on the plumbing drawings.
- b. Without restricting to the generality of the foregoing the work shall include the following:
- c. **Plumbing Works includes:**
 - i. Supply and Labour rates for Plumbing Fixtures & CP Fittings.
 - ii. Soil, Waste & Vent Pipes & Fittings.
 - iii. Rainwater Pipes & Fittings
 - iv. Internal Water Supply System (Cold & Hot)
 - v. Pump Room work (WTP)

SECTION 2 PLUMBING FIXTURES

1. Scope of work

- a. Work under this section 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

- 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 section 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/Khurra.
 - 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. Pipes
 - 1. 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.
 - 2. Standard weight dimensions and drip seal required for joints shall be as follows:-
 - a. Sand Cast Iron Pipes & Matching Fitting shall be to I.S. 1729
 - b. Centrifugally cast (spun) iron pipes and fittings to I.S. 3989

Nominal diameter		thickness	Overall Weight of 1.83 ms length	Internal Diameter of Socket	Drip seal length
Inches	mm	mm	Kgs.	mm	mm
2	50	5	11.41	76	25
3	75	5	16.52	101	25
4	100	5	21.67	129	25
6	150	5	31.91	181	38

Tolerance as per the I.S. code

- 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) suitable for pre-moulded rubber joints Tyton joints. 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.

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-(Part 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.

5. Flanges

- a. 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.
- b. 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.

c. Trenches

- d. 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

e. Sand filling

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

- f. 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.

g. 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.

h. 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)

6. Insulation

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

7. Valves

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

b. Butterfly Valves

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

c. Non Return Valve

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

8. 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.

9. 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.& with stand 8 hr.
- 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.

10. 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 (Section 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 clause 7.7 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
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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

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 section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section
- 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 section 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)(part 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.

TECHNICAL SPECIFICATIONS HORTICULTURE WORKS:

1. General Requirements

a. Scope of work

- i. 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.
- ii. Without restricting to the generality of the foregoing the work shall include the following:

2. GRASSING

a. PREPARATION

- 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 :

- i. The soil itself shall be ensured to satisfaction of Engineer to be a good, fibrous loam, rich in humus.

c. SOWING THE GRASS ROOTS :

- i. Grass roots (Cynodon dactylon or a local approved by the Engineer) shall be obtained from a grass patch, seen and approved beforehand.
- ii. The grass roots stock received at site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry winds.

- iii. Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained.

d. **EXECUTION :**

- i. Small roots shall be debbled about 15 cms (or at other spacings as per BOQ item) apart into the prepared grounds. Dead grass and weeds shall not be planted.
- ii. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.
- iii. All planting is to be done in moderately dry to moist (not wet) soil and at times when wind does not exceed a velocity of 8 kilometer per hours.

e. **MAINTENANCE OF LAWN**

- i. As soon as the grass is approximately an inch high it shall be rolled with a light wooder, roller in fine, dry weather and when it has grown to 2 to 3 inches above the ground, weeds must be removed and regular cutting with the scythe and rolling must be begun. A top dressing of announce of guano to the square yard on well decomposed well broken sludge manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine. It should be possible to use the inch above the normal level of the first two or three cuttings. That is to day the grass should be cut so that it is from 1 to 2 inches in length, instead of the $\frac{1}{2}$ to $\frac{3}{4}$ of an inch necessary for mature grass.
- ii. In absence of rain the lawn shall be watered every ten days heavily, soaking the soil through to a depth of at least 25 cms.
- iii. Damage failure or dying back of grass due to neglect of watering especially for seeding out of normal season shall be the responsibility of the contractor.
- iv. Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.
- v. The contractor is to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.

f. **ROLING :**

- i. 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 :**

- i. 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 :

- i. 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 :

- i. 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 :

- i. Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

3. MAINTENANCE

- a. The landscape contractor shall maintain all planted area within the landscape contract 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.

4. PRUNING & REPAIRS

- a. 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.

5. TREE GUARDS :

- a. Where tree guards are necessary, care should be taken to ensure that they do not impede movement or restrict growth.

6. NURSERY STOCK :

- a. Planting should be carried out as soon possible after reaching site. Where planting must, of necessity, be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled in as soon as received or otherwise protected from drying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly labeled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.

7. PROTECTIVE FENCING :

- a. According to local environment shrubs may have to be protected adequately from vandalism until established.

8. COMPLETION :

- a. On completion the ground should be formed over and left tidy.

9. RATE:

- a. The rates quoted for the horticulture items listed in BOQ shall provide for the cost involved in all the operations described above.

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

Tender No. MoHFW/ME/NIAHS-DELHI/HLL/ID/2013

**Request for Proposal (RFP)
for**

**Construction of National Institute of Allied Health Sciences (NIAHS)
at NAZAFGARH, DELHI**

THE COMPLETE TENDER DOCUMENTS CONSIST OF THE FOLLOWING:

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

Volume – III

- **Technical Specifications (Services)**



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(March, 2013)

SPECIFICATIONS FOR SERVICES

1.0 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.

2.0 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.

Bidder shall also be responsible for:

- Any other work/activity which is not listed above however is necessary for completeness of electrical system.

3.0 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:	Electrical relays for power system protection.
IEC-255	
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.

4.0 SITE CONDITIONS

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

5.0 DESIGN CRITERIA

5.01 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 | $\pm 10\%$ |

5.02 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. |

5.03 Emergency Lighting (Battery Operated With Self Charger)

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

5.04 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

5.05	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).
5.06	Painting of Panel.	Powder coating of approved shade.
5.07	Painting of Cable Tray And Structure Steel.	Powder coated of approved shade.

6.0 CABLE DETAILS

6.01	Internal Wiring.	Copper conductor PVC insulated 1.1 KV grade as called for in BOQ.
6.02	Power Cables (L.T.).	XLPE insulated Al. Armoured Cable as per BOQ.
6.03	11 KV.	Aluminium conductor XLPE insulated armoured cable.
6.04	Grounding Conductor.	Copper/G.I. strip as per BOQ.
6.05	Lightning Conductor.	G.I. Strip.

7.0 ACCURACY CLASS OF METERS

- a) Revenue Metres. Class-0.5 or as per SEB approved.
- b) Ammeter, Voltmeter and Other Instrument. Class – I Digital / Analogue as per BOQ.

SPECIAL CONDITIONS

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/performance 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 shoved.
- 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 form 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.

Special Conditions of Contract for Green Building (GRIHA) provisions

1. The building is aiming for Green Building Certification under **GRIHA for a Three star** rating.
2. All items to be quoted as per the Green Building provisions and shall adhere to GRIHA Green Building rating system and relevant ASHRAE standards and other Green building standards. This is irrespective of whether the same have been mentioned in the technical specifications or the Bill of Quantities.
3. The vendor to conform during negotiation meetings and before quoting that the MAKE of MATERIAL specified in the tender conforms to Green Building norms and requirements and in case of any queries would clarify during the negotiation meeting. Since we are aiming for the GRIHA 3 Star rating, it is mandated that all products have to be accordingly compliant and if the contractor has not accounted for it in his cost, he WILL NOT be liable for any further compensation and will have to provide in the same cost.
4. The contractor shall submit all TECHNICAL SUBMITTALS in a spiral bound format to the respective engineering/architectural consultant for approval, where all the catalogues of items of the BOQ shall be compiled. This master approval document shall be vetted and duly approved by the Green Building Consultant, before ordering and procurement.
5. Minimum allowable luminous efficacy of all the lamps shall be as per the table below:-

Light Source	Minimum allowable luminous efficacy (lm/W)
CFL (Compact Fluorescent Lamp)	50
FL (Fluorescent Lamp)	75
MH (Metal Halide)	75
HPSV (High Pressure Sodium Vapour)	90
LEDs (Light Emitting Diodes)	50

1. SPECIFICATIONS FOR ELECTRIFICATION

1.1 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.

1.1.1 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

1.1.2 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

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:

- a) 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.
- b) 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.
- c) Between Earth switch & Cable compartment doors, i.e., doors are accessible only when the earth switch is ON, further the main isolator switch/ breaker disconnectors cannot be switched ON unless the doors are closed.

CURRENT TRANSFORMERS

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

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

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

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

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

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

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

POTENTIAL TRANSFORMERS

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

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

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

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

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

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

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

PROTECTIVE RELAYS

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

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

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

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

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

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

SAFETY/PROTECTION INTERLOCKS/FEATURES

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

- a) It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.
- b) Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.
- c) Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.
- d) Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.
- e) 1 no. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB.
- f) Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

- g) Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.
- h) Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.
- i) Annunciation window shall be provided for winding temperature trip / alarm as required.
- j) Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.
- k) All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.
- l) Components within cubicles shall be properly labelled to facilitate testing.

EARTHING

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

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

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

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

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

INSTRUMENT & METERS

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

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

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

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

CONTROL WIRING

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

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

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

All wiring shall be colour coded as follows:

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

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

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

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

FITTINGS AND ACCESSORIES

Indicating Lamps:

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

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

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

Following colors shall be used for the function indicated:

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

R.Y.B	-	Potential indication
Green	-	Earth

Push Buttons:

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

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

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

Control & Selector Switches:

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

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

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

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

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

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

Control Terminal Blocks:

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

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

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

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

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

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

NAME PLATES AND LABELS

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

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

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

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

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

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

SPACE HEATERS:

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

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

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

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

CUBICLE LIGHTING:

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

AUXILIARY SUPPLY:

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

FUSES:

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

CABLE TERMINATION:

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

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

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

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

PAINTING:

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

TESTING & INSPECTION

Four copies of all test certificates and certificates from sub-vendor shall be furnished. After completion of all work at the manufacturer's 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.

1.2 DISTRIBUTION TRANSFORMER

OIL TYPE DISTRIBUTION TRANSFORMER with OLTC

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.

The external surface of transformer shall be painted with epoxy paint shade of IS: 631.

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 operate 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.

1.3 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 Dutro Technical Commission (IEC) Publication, NEMA, IDE & DEMA standard as amended upto date.

- a) IS:13947- 1993/IEC 60947-1989 Air circuit breaker/moulded case circuit breaker.
- b) IS:3156 Voltage transformers.
- c) IS:2705 Current transformers for metering and protection with classification Part-I, II burden and insulation & III 1964
- d) IS:9224 Low voltage fuse and protection.
- e) IS:3231 Specification for electrical relays for power system protection.
- f) IS:8623 Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000-V AC/1200 V-DC.

- g) IS:4237 General requirements for switch gear and control gear for voltage not exceeding gear.
- h) IS:2147 Degree of protection provided by enclosures for low voltage switch gear and control gear.
- i) IS:1018 Switchgear and control gear selection/installation and maintenance.
- j) IS:1248 Direct acting electrical indicating instruments.
- k) IS:375 Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
- l) IS:2959 AC contactors for voltage not exceeding 1000V.
- m) IS:5578 Guide for marking of insulated conductors.
- n) IS:11050 Guide for forming system of marking and identification of conductors & apparatus terminal.
- o) IS:1248 Direct acting indicating analogue electrical measuring instruments and Testing accessories.
- p) IS:600 Code of practice for phosphating of iron & steel.

The board shall be metal enclosed single front, indoor, floor mounted, free standing type or wall mounting type as mentioned in BOQ. The panel shall be designed for a degree of protection of IP-55. However bus bar chamber shall have IP: 42 degree of protection incase bus bar rating exceed 1600 Amps. Keeping in view the operating height of the top switch 1750mm from finish floor. 400mm clear space shall be left throughout the panel at bottom. The cold rolled sheet steel will be of 2mm thick. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 50mm height.

All cutouts and covers shall be provided with synthetic rubber gaskets (preferably neoprene).

The panel shall be divided into distinct vertical sections each comprising of:

- i) Complete enclosed bus bar compartment for running horizontal and vertical bus bars.
- ii) Complete enclosed switchgear compartment one for each circuit for housing air circuit breaker, MCCB/MPCB with starters etc.
- iii) Compartment for power and control cables of at least 300mm width covering entire height provided.
- iv) **The panel shall have sufficient space at least 20% of outgoing feeders for future use.**

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. Isolators and MCCB/ACBs and accessories shall be of fixed/drawout type as per BOQ.

Each feeder shall have compartmentalized or non-compartmentalized for MCB feeders only. Ri-tall type with separate construction cable entry shall be from top/bottom (3mm thick gland plate with suitable numbers & sizes of knockout holes (as called for in schematic/ fabrication drawings) shall be provided.

The panel shall be provided with three phase buses & neutral bus bars of high conductivity electrolytic copper/Aluminium sections throughout the length of the panel & shall be adequately supported and braced to withstand the stressed due to the short circuit current of 35 KA rms. for 1 sec. as called for in BOQ/Data Sheet. Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 40 Deg.C over an ambient temperature of 50 Deg.C. The Current density of Bus Bar shall be 1.0 Amp/mm² for Aluminium and 1.5 Sq.mm/mm² for copper.

The minimum clearance in air between phases and between phases and earth for the entire run of the bus bar connections shall be 32mm minimum. Bus bars support insulators shall be made of non-hydroscopic non-combustible track resistant and high strength SMC or polyester fiberglass moulded material.

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

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

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

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

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 is 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 device for interlocking the door of switchboard. Following shall be included if specified in the drawing or in the schedule of quantities:

- Under voltage trip
- Shunt trip
- Alarm Switch
- Auxiliary switch

CONTACTORS

The contactors should comply with the latest IEC947-4 and the corresponding IS13947-4 standards. They shall have UL and CSA approval. The contactors should be rated for AC3 duty at 415V and 50Hz. The contacts should be fast closing and fast opening type. The making and breaking capacity values of the contactors should be as follows (as per IEC947-4):

For AC3 Duty

- Making Capacity equal to or more than 10 Ie
- Breaking Capacity equal to or more than 8 Ie

For AC4 Duty

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

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

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

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

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

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

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

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

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

NAME PLATES & LABELS

- i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
- ii) All nameplates shall be of non-rusting metal or 3-ply lamincold, 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.

1.4 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.

1.5 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 ohms 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.

1.6 LIGHTNING PROTECTION SYSTEM

Protection of buildings against lightning shall generally be done in accordance with latest IS-Code. The installation shall be done as per routes and location of equipment indicated on the drawing and bill of quantities. The conductors and the earth electrode conductor shall be fixed so that they are free to expand and contract. Special care shall be taken in the fixing of support to allow free movement.

The materials of lightning conductors, down conductors, earth termination etc. shall be reliably resistant to corrosion or be adequately protected against corrosion. All air terminations shall be GI and the conductors shall be GI.

The entire lightning protection system should be mechanically strong to withstand the mechanical forces produced in case of a lightning strike. The system shall be installed such that it does not spoil the architectural or aesthetic beauty of the buildings but on other hand it should meet IS code/safety code.

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 metres away from the nearest horizontal conductor. For a flat roof horizontal air termination along the outer perimeter of the roof is used. For a roof of larger area a network of parallel horizontal conductors shall be installed. Horizontal air terminations shall be laid along contours

such as ridges, parapets and edges of flat roofs and where necessary area flat surfaces in such a way as to connect each air termination to the rest and shall, they form a closed network.

All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flag staff, on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. All air terminations shall be effectively recessed against over turning either by attachment to the object to be protected or by means to substantial braces and fixing which shall be permanently and rigidly attached to the buildings.

Down conductors shall be distributed around the outside walls of the structure. They shall preferably be run along the corners and other projection, due considerations being given to the locations of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors. Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such conductors shall have disconnecting joints. All vertical conductors shall be plumbed before fixing. Insulation shall be provided between down conductors and wall.

The lightning protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. The joint overlap shall not be less than the width of the tape. In the down conductor below ground level there shall be no joint. The joints may be clamped, screwed, bolted, revitted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

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

Where tape are required to pass through roof asphaltting or other waterproofing 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.

1.7 CAPACITORS & CAPACITOR CONTROL PANEL

Power factor correction capacitors shall conform in all respects to IS 2834-1964. The capacitors shall be suitable for 3 phases 415V at 50Hz. frequency and shall be available in units as per B.O.Q. to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper busbars of adequate current carrying capacity having S.C rating of 25 KA for 1 sec. Each capacitor bank shall be for PVC insulated

aluminium conductor armoured cables. Two separate earthing terminals shall be provided for each bank for earth connection. The capacitor bank shall be housed indoor.

The capacitor bank shall be subject to routine tests as specified in relevant Indian Standard and the test certificate shall be furnished. The capacitor shall be suitable for indoor use upto 45 Deg.C over and above ambient temperature of 50degree C. The permissible overloads shall be as given below:

- a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.
- b) Current overloads 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.
- c) Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space with protective guard or fencing. The capacitor bank shall be provided with 7% Detuned reactor filter to compensate third harmonics from being generated.

Capacitors shall be of aluminium foil and craft paper. Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnants. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V A.C. is applied shall not be less than 50 megohms.

- Capacitor bank and switching equipments shall be housed in a cubicle having degree of protection IP-51 and constructed with sheet steel of minimum 2mm thickness.
- Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.
- Necessary discharge resistor shall be provided externally to reduce the terminal voltage to or less then 50V in 60 seconds of disconnection from supply.
- Testing shall be done as per applicable standards for shunt capacitors.

Capacitor Control Panel

The capacitor control panel shall general comprise of the following:

- a) Automatic power factor correction relay.
- b) Step controller with reversing motor.
- c) Time delay and no-volt relays.
- d) Protection MCCB / MCB.
- e) Contactor (AC-3 duty) for individual capacitors of suitable rating.
- f) Change over switch for either automatic operation or manual operation with push button control.

- g) C.T.s with ammeter and selector switch as asked for in BOQ.
- h) Voltmeter with selector switch.
- i) Indicating lights RYB.

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

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

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

Quality Assurance

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

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

Deviations

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

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

SPARES

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

1.8 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.

1.9 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 environment 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"> Max. conc. value - 0.1% by weight in homogeneous material for Pb, Hg, Cr6+, PBB/ PBDE Max. conc. value - 0.01% weight in homogenous material for Cd.
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"> Recovery of minimum 60% by weight of the packaging waste 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% Max. sum of concentration levels of Pb, Cd, Hg and Cr6+ > 100 ppm by weight
91/338/EEC	18Jun91	Restriction on the use of Cadmium pigment (amending for the 10th time Directive 76/769/EEC)	The cadmium content (expressed as Cd metal) exceeds 0,01 % by mass is prohibited in the finished products or components of products manufactured from polymers or copolymers of vinyl chloride and stabilized by substances.

b) Cables

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards:

IS : 8130 Conductors for insulated electric cables and flexible cords.

IS: 7098 XLPE insulation and sheath of electric cables.

IS : 3975 Mild steel wires, strips and tapes for armouring cables.

IS : 7098 Current rating of cables.

IS: 7098 XLPE insulated (heavy duty) electric cables for working voltage upto and including 1100 volts.

IS: 424-1475(F-3) Power cable-flammability test.

Specification for cross-linked polyethylene insulated XLPE sheathed cable for working voltage upto 1.1 KV.

Specification for XLPE insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.

ASTM-D: 2863	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
ASTM-D: 2843	Standard test method for measuring the density of smoke from the burning or decomposition.
IEEE : 383	Standard for type of test Class-IE, Electric cables, field splicers and connections for power generation station.

ASTME:662IEC:754(x) Standard test method for specific optical density of smoke generated by solid materials.

IS : 10418 Cable drums.

c) Technical Requirements:

- i) The cables shall be suitable for laying in racks, ducts, trenches conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- ii) They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
- iii) The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
- iv) The cable should withstand 25 KA for 0.5 sec with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
- v) The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
- vi) Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'FRLS' marking in case of 'FRLS' cables.
- vii) Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
- viii) Allowable tolerance on the overall diameter of the cables shall be + 2mm.
- ix) The normal current rating of all XLPE insulated cables shall be as per IS: 7098.

- x) A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
- xi) Outer sheath shall be provided by extrusion process as per IS: 5831
- xii) The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
- xiii) In plant repairs to the cables shall not be accepted.
- xiv) All the cables shall be supplied in non-returnable drums as per IS: 10418.

d) In Case of FRLS Cables

- i) The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD: 2863.
- ii) The maximum acid gas generation by weight as per IEC: 754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.
- iii) The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD: 2843). In case the test for light transmission is conducted as per ASTM E: 662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTM D: 2843.
- iv) The cable shall pass the fire resistance test as per SS: 42, 41, 475 (I) and flammability test as per EEE: 383.

e) Inspection:

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

f) Joint in Cables

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilisation and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

g) Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

h) Jointing of Cables

All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardwares shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

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

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

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

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the 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
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ELV & LV 230 V/433 V - ELV & LV cable 230 V/433 V	Equal to the diameter of the bigger cable.
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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.

1.10 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).

1.11 INTERNAL ELECTRICAL WORKS

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.

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 adopter. 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 rewireable 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 cost 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.**

1.12 TELEPHONE SYSTEM AND LAN WIRING

Enhanced Category 5 UTP specifications

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

Enhanced Category 5 – TIA/EIA Addendum
 Category 5 – ANSI/TIA/EIA-568, TIA/EIA TSB67
 Class D – CENELEC EN50173
 Class D – ISO/IEC 11801

UTP Outlets

- a) The outlet UTP connection module and its optional cover shall be available in the following colors: grey, almond, white, black, orange, red, yellow, green, blue, purple and brown.
- b) The outlet UTP connection module shall be Power Sum rated, with a power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 5 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.
- c) The eight-position outlet UTP connection module shall accommodate six-position modular plug cords without damage to either the cord or the module.
- d) It shall be possible to inspect and/or re-terminate the UTP cable at the outlet through front access at the face plate.

- e) The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.
- f) The faceplate housing the outlet UTP connection module in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubical) access points using manufacturer – supplied faceplates and/or adapters , equipped with front, side or angled-entry options for modular cords.

UTP System Testing

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

Continuity of the channel to the remote end.

Shorts between any two or more conductors.

Crossed pairs.

Reversed pairs.

Split pairs.

Any other mis-wiring.

TELEPHONE TAG BLACK (TTB / IDF)

CAT-5e (enhanced) unshielded twisted pair cable in MS conduit shall be used to have modern structured cabling network for telephone system, to have latest facilities for Internet and also data cabling. All the telephone Jack must terminated on RJ-11 jacks and installed onto a dual Jack faceplate. Telephone RJ-11 Jacks must be terminated with a **BLACK** Connector/Jack.

For LAN CAT 6 UTP cables shall be used for interconnecting the RJ 45 outlets to Intermediate Switch (Hub) or directly to IT room, if the running length limit permits. These Intermediate switch shall be installed in a rack/cabinet and located in electrical room of the respective floors. Fibre Optic cable or CAT-6 UTP cable shall be used for backbone to interconnect the Intermediate switch to IT room's Server rack, as per the design requirement of the specialised Vendor. All the Data Jack must terminated on an 8 wire, 8-position Jack. Each RJ-45 Data Connection will be terminated with a **BLUE** Data Jack

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

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

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

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

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

- i. Telephone Operator's room
- ii. Telephone Switch room
- iii. Security room
- iv. Fire officer room

1.13 MATV SYSTEM

Co-Axial Cables

1.1 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
1.1 IS Standard IS:14131	5CA4	7CA4
1.2 Centre Copper Conductor Dia	1.02mm	1.63mm
1.3 Dielectric Dia	4.57mm	7.11mm
1.4 Dielectric Material	Cellular PE	Cellular PE
1.5 Outer Dia	7.0mm	10.03mm
1.6 Bending Radius	>75mm	>115mm
1.7 Impedance	75 Ohms	75 Ohms
1.8 Return Loss	>23 dB	>23 dB
1.9 Attenuation at 20 ⁰ 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

1.14 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 requirement 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	:	50 KVA & 40 KVA
Active power	:	40 KW & 32 KW
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 are 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

1.15 DISTRIBUTION BOARDS & MCBs

General

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be constructed out of steel sheet all weld enclosure with double door IP42 protection and shall be powder coated. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry or knockouts plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements. Also on additional/separate adopter box of suitable length and size shall be provided to accommodate wires and cables. No. of conduits etc. and nothing shall be payable on this account. The MCBs shall be mounted on high-grade rigid insulating support and connected by electrolytic copper bus bars. Each incoming MCB isolator shall be provided with solderless cable sockets for crimping. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

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

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

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

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

Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as specified in BOQ. These shall be suitable for manual closing and opening and automatic tripping under earth fault circuit of 30-300mA as specified in item of work. The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardent, anti-tracking, non-hygroscopic, impact resistant and shall withstand 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.

1.16 NURSE CALL SYSTEM

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.

1.17 SOLAR POWER PLANT

This specification is intended to cover supply, installation, testing and commissioning of Solar Power Plant. The Scope covers the following, but not limited to it, to ensure Completeness & Satisfactory operation. It is the responsibility of the Vendor to include all items as required.

This specification defines the basic guidelines to develop a suitable electrical system for solar power system and all data required in this regard shall be taken into consideration to develop a detailed engineering of the system.

The Solar Plant shall be comprises of the following:

- a. Mono-crystalline silicon Type Inter Connected Photo-Voltaic Solar panels.
- b. Support / structure for mounting of panels
- c. Solar Charger Controller
- d. Multi-Strand Copper Wiring/cables for interconnections.
- e. Protections & Indications for Working & Faulty Conditions.
- f. Earthing of all the equipments & structure.
- g. Maintenance Free Valve Regulated Lead Acid Battery as per IS: 15549-2005 of in modules of 12V, 200AH Capacity for 14hours Back-up.
- h. UPS/ Invertors complete with Battery Charger, Protection for O/L, S.C., LCD Display Panel etc Complete with all accessories
- i. MS Rack Coated with Acid-Resistant paint of suitable size as required for Battery bank.
- j. All necessary accessories & hardware as required for commissioning.

No. of Modules: As per Standards to achieve rated Power Output defined in the BOQ for min. 14Hours operation

Site conditions are as under:

Ambient temperature	:	45 Degree \pm 5 Degree
Related Humidity	:	0 – 90%
Altitude	:	225M from sea level

Codes and Standards

NFPA - 99	:	Standard for Healthcare Facilities
IS – 3043	:	Earthing
IS – 732	:	Code of Practice for Electrical Installation not exceeding 660 volts.
IS – 7689	:	Guide for Control of Undesirable Static Electricity.
IS – 3716	:	Insulation Co-ordination Application Guide.

Scope

- Safety to personnel and equipment during both operation and maintenance.
- Reliability of services.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relay system.
- Electrical supply to equipment within design operating limits.
- Maximum interchange ability of equipments.
- Fail safe feature.
- Suitability for applicable environmental factors.

Design Parameters:

a)	Supply Voltage	220V
b)	Phase	Single
c)	Frequency	50 Hz
d)	Voltage Regulation	\pm 3%
e)	Frequency Regulations	\pm 3%
f)	Combined	\pm 10%
g)	Operating Temp. Range	20-90 °C
h)	Operating Hours	14 Hrs. Min.
i)	Efficiency	Not less than 90%

Details to be furnished by Vendor.

- a) Max. Power Rating
- b) Ir
- c) Vr
- d) Open Circuit Voltage
- e) Panel Dimensions
- f) Tech. submittals & Drawings

Individual Warranty as below.

- a) PV Modules 15 years
- b) Battery Bank 3 years
- c) UPS/ Inverter System 3 Years
- d) The whole System shall have 2 years Warranty for satisfactory operation.

Client' Scope

Space for Mounting of Solar Array, Battery Room shall be provided by Client for which Vendor shall furnish the details.

The Output Cable from the Inverter/UPS to Building Lighting DB

1.18 ISOLATION PANEL

This specification is intended to cover supply, installation, testing and commissioning of Isolation Panel for O.Ts, ICCUs etc.

Scope

- Safety to personnel and equipment during both operation and maintenance.
- Reliability of services.
- Minimum fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment within design operating limits.
- Maximum interchange ability of equipments.
- Fail safe feature.
- Suitability for applicable environmental factors.

This specification defines the basic guidelines to develop a suitable electrical system for isolation panel and all data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions are as under:

Ambient temperature	:	50 Degree – 5 Degree
Related Humidity	:	0 – 90%
Altitude	:	350M from sea level

Codes and Standards

NFPA - 99	:	Standard for Healthcare Facilities
UL – 1047	:	Low Leakage Transformer (Hospital Isolated System)
UL – 1022	:	Line Isolation Monitor
IS – 3043	:	Earthing
IS – 732	:	Code of Practice for Electrical Installation not exceeding 660 volts.
IS – 7689	:	Guide for Control of Undesirable Static Electricity.
IS – 3716	:	Insulation Co-ordination Application Guide.

Isolation Transformer

The isolation transformer shall be air cooled double wound core type with copper conductor wound and with secondary neutral for floating network system. The primary and secondary winding shall be made on separate / same limb of core and shall be separated by an electrostatic shield (copper / aluminium earthed screen). The screen shall be earthed (grounded) to equi-potential ground bus. The electrostatic shield shall be designed to prevent direct shorting of primary and secondary winding and shall reduce the harmonic distortion coupling between primary and secondary circuits. The total leakage current from transformer secondary to ground shall not exceed as:

- i) Upto 5 KVA – 60 micro Amps
- ii) Above 5 KVA and upto 10 KVA – 75 micro Amps

The other technical features are given below and the supplier shall conform to the same.

- a) Primary voltage (Vu) : 230 volts with solid earthed system
- b) Secondary voltage : 230 volts \pm 1% between full load to no load with secondary unearthed system i.e. floating neutral.
- c) Primary / Secondary Frequency : 50 Hz.
- d) Spike suppression on level shall not be more than 3db.
- e) Insulation class : H
- f) Overloading capacity : 30% for one hour upto 5 KVA and 50% for one hour above 5 KVA upto 10 KVA
- g) Sound level of complete unit with cabinet shall not be more than 30 db respectively.

Line Isolation Monitor (Leak Guard) (LIM)

The line isolation monitor shall be solid state device monitoring continuously the combined leakage current of primary (Line - 1) and secondary isolated circuit measuring impedance. It shall also capable of measuring all combinations of capacitive or resistive faults including balance / unbalance or hybrid faults. 'LIM' shall not contribute more than 50 micro Amps to total hazard current system.

Technical specifications shall be as :

Supply voltage	:	230 V \pm 10% 50 HZ.
Accuracy	:	5% or better
Alarm Level	:	3 miliamp or 4 miliamp (selectable)
Alarm Load	:	2 to 2.5 miliamp or 4 to 5 mili amp
Alarm hysteresis	:	On – Off (100 micro amp)
Monitor Hazard Current	:	Less than 100 micro amp

Metering cabinet shall have the following as well :

- Scale selection indicator (5 mili amp or 10 mili amp) with selector switch.
- 'Tini' buzzer
- 'Safe' green indication light
- 'Hazard' red indication light
- Test Push button
- Reset (Silent) push button

Scale Range:

Meter Scale	Safe Zone Green Band	Coarse Zone Red Green Band	Hazard Zone Red Band	LIM consists as
5 mA	0 - 2.0 mA	2.0 - 2.5 mA	2.5 - 5.0 mA	Leakage current detector control transformer mother board with relay etc. LIM monitor card.
10 mA	0 - 4.0 mA	4.0 – 5.0 mA	5.0 - 10.0 mA	

Miniature Circuit Breaker

- The MCB suitable for manual closing and opening and auto tripping under over load and short circuit. The MCB shall also be trip free type.
- Single pole / 2 pole and 3 pole version shall be furnished as required.
- The MCB shall be rated for 10 KA fault level.
- The MCB shall be suitable for its housing in isolation panel and shall be suitable for connection at the outgoing side by tinned cable lugs and for incoming side bus connections.

- The terminal of the MCBs and the open / close condition shall be clearly and indelibly marked.
- The MCB shall conform to IS: 8828.
- The MCB rating shall be as per BOQ.

Earth Leakage Circuit Breaker

ELCB shall be 2 pole / 4 pole 230 / 415 volts 50 Hz., 10 – 30 mA sensitivity. These shall be suitable for manual closing and opening and auto tripping under fault condition of 10 – 30 mA. The ELCB rating shall be as per BOQ and shall confirm to IS / IEC.

Line Isolation Module Cubicle

Isolation module cubicle shall be fabricated out of 1.6mm thick Stainless steel to house isolation transformer, LIM (Leakage Current Detector), mother board, buzzer / speaker / push buttons / indication lights, MCBs, busbars etc. in individual compartment. Cubicle shall be so designed that the heat generated by transformer under full load conditions shall not hamper the working of circuit breaker, the isolation monitor etc. The panel shall be dead front, wall mounted type / floor mounted. The isolation panel shall conform to NEPA / UL / IS / IEC code of practice.

Earthing & Wiring

Earthing shall be done as per NEPA / NEC / IS code of practice. Wiring where these panels are being installed the electrical wiring shall be carried out with XLPE LT cables / wires.

General

- A. Quality Assurance: The contractor shall submit the following quality assurance documents within 2 (two) weeks after award of work.
 - * All non-destructive examination procedure, stress relief and weld repair procedure actually used during fabrication and reports etc. including painting.
 - * Design calculation and detailed circuit diagram of equipment.
 - * Factory routine and type test to be carried out with testing procedures and minimum acceptable values as well as for field.
- B. Inspection and Testing
 - * All equipments being supported shall conform to routine and type tests as per recommended code and the price shall be included in bid price and break up of the same shall also be submitted alongwith bid. In case the price is not indicated it will be presumed that the tests (routine and type tests) has been offered free of cost.

- * The contractor shall give Consultant / Owner thirty (30) days' notice in writing about the readiness of equipment for the tests. The cost will be borne by the contractor.
- * No material shall be despatched until and unless the tests material for the physical inspection tests has been carried out by Consultant and Employer jointly.

After installation at site, all the routine / functional tests shall be carried out at site in the presence of Consultant / Owner's Engineer and shall also be witness their presence in writing.

1.19 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 / treys detail, installation mode, starting and termination point of each and individual cable etc.
- d) The shop drawings shall also show all setting out details and physical dimensions of all equipments components used in the system, location of manholes fixing, cutout details etc.

QUALITY

The 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 from which they are being obtained, and the contractor shall give every facility necessary for inspection and examinations and test of the material and workmanship free of cost.

COST OF SAMPLES AND TESTS

The Contractor at his own cost shall supply all samples and the cost of making any test as per specifications shall be borne by the contractor. The Contractor shall submit four copies of all brochures, manufacturers' description data and similar literature. One copy will be returned to the Contractor after approval.

COMPLETION DRAWINGS

The Contractors shall submit to the Owner / Consultant, layout drawings drawn at approved scale in six sets and a reproductive (original) copy clearly showing.

- a) Location of distribution and PLC Panel
- b) All types of cables (L.T. / Control etc.) layout.
- c) Layout of DG Room and switchgears and associated equipments.
- d) Layout of Diesel Generator Sets.
- e) Location of Fuel Tank, Cooling Towers, Pumps and fuel and water piping layout.
- f) As built drawing with equipments operation and maintenance literature.

After the completion of the work and before issuance of certificate of virtual completion.

FOREMAN / SUPERVISOR

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

INSPECTION AND TESTING

Contractor shall employ a full time qualified Engineer who shall be available at all working hours at site for taking instructions and to look after the quality of the work. Instructions given to the Engineer of the contractor shall be construed as issued to the contractor.

Contractor shall maintain at site the following tools and instruments, but not limited to the list below in working conditions.

- a) Clip-on Ammeter and voltmeter
- b) 1000 V Meggar and 5 KV Meggar
- c) Steel tapes of various lengths
- d) Sprit Level
- e) Hydraulic Crimping Tool
- f) Earth Testing Meggar
- g) Pipe bending Tool, thread-cutting die, bench vice etc.
- h) Cable jointing kit

The contractor shall provide at least four permanent benchmark at site, which shall be preserved till the completion of works. These are essential for laying of cables at correct levels.

CLEARANCE FROM LOCAL AUTHORITIES

The Contractor shall get the entire installation tested inspected and approved by Local Authorities like Electrical inspectorate pollution control explosive clearance and any other agency required to take permission for commissioning of the installation. He will also undertake the Liaison work with local Electricity Supply Company for obtaining the Electrical Service Connection.

SCOPE

In general, the contractor shall supply, store, erect test and commission all the equipment required for electrical installation. The contractor shall furnish all the materials, labour, tools and equipment for electrical work, as shown in the accompanying drawings and in the bill of quantities and specifications hereinafter described.

CONTRACTOR

The contractor shall be a licensed electrical contractor, possessing a valid electrical contractor's in the state, employing licensed supervisors and skilled workers having valid permits as per the regulation of Indian Electricity Rules and Local Electrical Inspector's requirements.

1.20 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.

1.21 D.G. SET

625 KVA

The D.G. set shall be provided with Diesel Engine of Model no. & no. of Cylinder as given below, vertical 4 stroke cycle, **Air cooled radiator** having turbo charged after cooled Engine at 1500 RPM under NTP conditions of BS: 5514. The D.G. set shall be provided with electrical starting arrangement and shall give the electrical output of as given below at 0.8 power factor, 415 Volts at the alternator terminal.

ELECTRICAL OUTPUT	Cummins Engine Model no. or equivalent	No. of Cylinder
▣ 625 KVA	MTA 28 G5-I	12

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) 625 KVA
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.

1.22 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 cladded 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.

1.23 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	7 Hr
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 (Hr)	AMBIENT TEMP (°C)	STATOR TEMP (°C)
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- 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:

$$\frac{\text{Rated output voltage} + 1 \text{ Mega Ohms}}{1000 + \text{Rated out in KVA}}$$
- . 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 laid 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 line 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:

Vendor's shall fill in the performance data in the block columns of the attached Data sheets.

1.24 ACCOUSTIC ENCLOSURE**Construction Details**

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

a) Acoustic Insulation :

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

b) Noise Suppressor :

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

c) Exhaust System :

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

d) Thermal Insulation :

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

e) Surface Treatment :

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

f) Air Circulation & Ventilation System:

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

g) Vibration Isolation:

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

h) Hardware:

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

i) Testing / R&D:

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

Technical Data Sheet Diesel Generator (Alternator) 625 KVA		Project: Proposed National Institute of Allied Health Science (NIAHS) at Najafgarh, New Delhi.	
		Date:	
S.No.	Item	Data	
1	Serial		
2	Type		
3	Make		
4	Voltage, Phase, Frequency	415V,3PHASE, 50Hz	
5	Normal Continuous Rating	625 KVA	
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)	1/2 th Full load		
c)	3/4 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:	
SPC Engineers Pvt. Ltd.		Format no:	
		Page 1 of 2	

Technical Data Sheet Diesel Generator (Engine) 625 KVA		Project: Proposed National Institute of Allied Health Science (NIAHS) at Najafgarh, 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)	1/2 th Full load	
c)	3/4 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 :
SPC Engineers Pvt. Ltd.		Date:
		Format no: 7.3/3/00
		Page 2 of 2

2. SPECIFICATION FOR FIRE ALARM

2.1 GENERAL

2.1.1 DESCRIPTION:

- A.** This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.
- B.** The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification, or the stringent one of the two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.
- C.** Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported. The message shall instruct the occupants with emergency instructions. Emergency manual voice override shall be provided.
- D.** The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing for equivalent European standard EN54.
- E.** Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.
- F.** The FACPs shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.
- G.** The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.
- H.** The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

2.1.2 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 a 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.

2.1.3 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.

2.1..4 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.

2.1.5 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.

2.1.6 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).

2.1.7 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.

2.2 PRODUCTS

2.2.1 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.

2.2.2 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 Rates shall be followed:-
 - a) WGMA/BW

2.2.3 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. 1/4 (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) may 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 7/1.06 Cu		2	5	9	11	
10	11 /3.55 Al 7/1.40 Cu			4	7	9	
16	7/1.70			2	4	5	12
25	7/2.24				2	2	6
35	7/2.50					2	5
50	7/3.0 Al 19/1.80					2 2	5 3

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

Table No. 1/4
Colour Coding for Conduits in Wall entry

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

Table 1/5
Colour code of Wires

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

B. Wire:

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

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

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

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

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

All field wiring shall be completely supervised.

2.3 FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:

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

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

Each FACP on the network shall perform the following functions:

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

Then the following functions shall immediately occur:

- a. The FACP alarm LED on the FACP shall flash.
- b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
- c. The 640-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.

- d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

2.3.3 General FACP Configuration & Operation

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

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

- 1. Pre- Signal and Positive Alarm Sequence: The system shall provide means to cause pre-alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-Second time period for acknowledge an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.

2. Smoke Detector Pre-Alarm indication at control panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-Alarm indication shall be available at the control.
 - i) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
 - ii) Action: if programmed for action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition, Sounder bases installed with either heart or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.
3. The system shall be integrated with P.A. System Car Calling system for Emergency evacuation under fire.
4. Each FACP node shall be capable of providing the following features:
 - a) Block Acknowledge for Trouble Conditions.
 - b) Rate Charger Control
 - c) Control-By-Time (Delay, Pulse, time of day, etc.)
 - d) Automatic Day/Night Sensitivity Adjust (high/low)
 - e) Device Blink Control (turn of detector LED strobe)
 - f) Environmental Drift Compensation (selectable ON or OFF)
 - g) Smoke Detector Pre-alarm Indication at Control Panel
 - h) NFPA 72 Smoke Detector Sensitivity Test
 - i) System Status Reports
 - j) Alarm Verification, by device, with tally
 - k) Multiple Printer Interface
 - l) Multiple CRT Display Interface
 - m) Non-Fire Alarm Module Reporting
 - n) Automatic NFPA 72 Detector Test
 - o) Programmable Trouble Reminder
 - p) Upload/Download System Database to BMS
 - q) One-Man Walk Test
 - r) Smoke Detector Maintenance Alert
 - s) Security Monitor Points
 - t) Alpha-numeric Pager Interface
 - u) On-line or Off-line programming

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

GSIDC/FPS/08-09/ Doc1	Standard Data Sheet
Client- GSIDC, Margao	System- Fire Protection system
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 membrane switch keyboard
	1 set control switches
	1 set operator push buttons
	Loop cards
	Remote terminal unit connection port
	LCD display & driver module
Connectivity	To proprietary protocol compatible to analogue addressable detectors of type
LCD display	4 X 160 character alpha numeric LCD auto back-lit with occurrence of event or manual override
Display Format	Alarm/pre-alarm/fault/isolation
	Alarm & event acknowledge
	Commands/report/programming
	Time/day/date
Power supply	SMPS
Back up power supply	As per clause 7.5 of IS 2189
Power pack	SMF lead acid / Nicd 24 V DC 30 AH
Test features	Panel self test
	LCD test
	Fault test
	Detector test
	Battery fault
	Internal hooter test
	External hooter test
	Scroll/next
	Alarm silence
	Fault silence
Control facility	Lamp evacuate
	System reset
	LCD back Lighting
	Trouble Silence
	System normal
	Priority 1 Alarm
	Priority 2 Alarm
Indications	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

Approval	EN/LPCB/UK/ UL listed
Makes	Notifier / Ziton / Morlay / Cooper / System Sensor/ Tyco/ Apollo/ GST/ Honeywell

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:-

GSIDC/FPS/08-09/Doc 2	STANDARD DATA SHEET
Client - GSIDC, Margao	System - Fire protection System
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
LCD display	350 mA max. draw
	Back lit, Alphanumeric, 4 line 160 character display
	RS 485 serial bus driver board
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
Approval	UL/FM/LPCB/UK / UL listed
Make	Notifier / Ziton / Morlay / Copper / System Sensor / Honeywell

2.5 Network Control Station

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 (Not in scope of works)

- 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 (Not in scope of works)

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 it's 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, and 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:

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."

2.5 CLOSED CIRCUIT TELEVISION SYSTEM & PA SYSTEM

2.5.1 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.

2.5.2 INDOOR CCTV DOME CAMERA SYSTEM (COLOR)

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).

2.5.3 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:
- b. 704x576/ch, 704x288/ch, 352x288/ch
- c. 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.
- d. 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.
- e. The recorder shall have 4 audio inputs and 1 audio output (RCA x 4 in, RCA x 1out).
- f. 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.
- g. 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.
- h. The digital recorder shall have motion sensor for each of 16 channels.
- i. 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)

2.5.4 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

2.5.5 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.

2.5.6 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.

3. TECHNICAL SPECIFICATIONS FOR HVAC

3.1 BASIC SYSTEM DESIGN

3.1.1 SCOPE

A central air conditioning system has been designed for air conditioning of National Institute of Allied & Health Sciences at Najafgarh, Delhi.

The system is designed to cater air conditioning requirement with the Centralized chilled water system. The areas to be air-conditioned include Hospital Block and Academic Block. The toilets are mechanically ventilated.

3.1.2 BASIS OF DESIGN

Location: Proposed NIAHS at Najafgarh , New Delhi

Design Parameters

Outside Conditions	Summer	: 43.3°C DB; 23.8°C WB (20% RH)
	Monsoon	: 35°C DB; 28.3°C WB (60% RH)
	Winter	: 10.0°C DB; 6.66°CWB (60% RH)
Inside Conditions (Summer & Winter)	General	: 24.0°C ± 1.0°C DB RH not exceeding 55% in all areas.

Total Tonnage for both the buildings	=	317.77 TR
Total Installed capacity of chillers (Considering diversity @ 90 %)	=	285.9 TR

3.1.3 SYSTEM DESIGN

- i. It is proposed to provide a central Air-conditioning system to maintain the specified inside design conditions during summer, monsoon & winter.
- ii. The total peak air conditioning load works out to **285 TR** for all the floors. To cater to this load, it is proposed to install **3** Nos. Screw type air-cooled chilling machines (2W + 1 S) each having **140 TR** actual capacity.
- iii. Water chilling machines shall work in conjunction with 3 Nos. chilled water pumps (2W plus 1S). The AC plant room is located at Terrace floor.
- iv. Chilled water produced shall be pumped to various Air-handling units and Fan coil units. Chilled water shall be pumped through insulated chilled water pipes installed in basement / ceiling spaces and in vertical risers installed in pipe shafts. At each Air-handling unit balancing valves are provided for balancing. All pipes within plant room shall be supported from floor.

- v. Double skin Air handling units consisting of centrifugal fan, cooling coil and filter section shall be provided for each area. Chilled water supply and return headers shall be tapped and connected to cooling coils. There would be automatic controls provided for AHUs to control inside conditions in summer and monsoon.
- vi. The conditioned air from the AHUs would be supplied through insulated ducts. The air would be diffused through extruded aluminum Grilles and diffusers. The return air would be taken back from the conditioned space to the AHUs through return air ducts or through ceiling spaces.
- vii. The stale air from the common toilets would be exhausted by means of mechanical exhaust system.
- viii. Motorized smoke and fire dampers shall be provided in accordance with ASHRAE/NFPA within supply air ducts and return air ducts/spaces to prevent spread of smoke / fire to adjacent areas.

3.1.4 Indoor air quality:

- Due consideration has been given for good indoor air quality.
- Outdoor air ventilation rates have been maintained as per ASHRAE standard 62.1.2004 (Ventilation for acceptable indoor air quality).
- All utility areas like AC plant room, pump room etc., will be mechanically ventilated.
- It is proposed to use centrifugal type blower for basement car parking ventilation.
- All fire escape staircases and lift shafts shall be provided with pressurization system consisting of fans installed on terrace. These fans shall be actuated by smoke sensors in case of detection of fire on any affected floor.

3.2 AIR COOLED WATER SCREW CHILLING UNITS

3.2.1 GENERAL

The contractor shall furnish and install where indicated on plans air cooled Rotary Screw water chilling units. Each unit shall be guaranteed by chilling unit manufacturer to produce a capacity of not less than specified tons of refrigeration at specified leaving water temperature with the temperature of ambient air entering the condenser not exceeding 110°F.(44 °C). The construction and rating of the chillers shall be in accordance with latest ARI standard 590 and shall comply with ANS. B 9.1 safety code, National Electrical code and ASME code. Necessary 3 ph.50 Hz, 220/415 volts, A.C. Power supply shall be made available for all units.

3.2.2 CODES & STANDARDS

ASHRAE 15	Safety code for Mechanical refrigeration
ASHRAE 23	Methods of testing and rating positive displacement refrigerant compressors and condensing units
ASHRAE 30	Methods of testing liquid chilling packages
ASME SEC VIII DIV I	Boiler and pressure vessel code
ANSI B 31.5	Code for refrigeration piping

AHRI 550/590 (2003)	Standard for Air Cooled Screw water chilling packages
AHRI 575	Standard for method of measuring machinery sound within an equipments space
ISO 1940	Mechanical vibration – Balance quality requirements of rigid rotors
ISO 10816-1	Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines
TEMA – C/R	Heat Exchanger with acceptable deviation
ASTM: C591	Specification for Polyurethane/ Polyisocyanurate Foam

3.2.3 BASIC UNIT

Each unit shall consist in general of multiple semi hermetic screw/scroll compressors, air cooled condenser coils, DX type water chiller, condenser fans, outer weather proof casing, automatic control panel and accessories.

3.2.4 COMPRESSOR (SCREW)

Each unit shall have multiple rotary, double bolted hermetic screw compressor

The rotary screw shall be manufactured from forged steel with precision cast male and female profiles which are asymmetrical. The profile of screws shall permit safe operation up to a speed of 3000 RPM for 50 Hz operation. The compressor shall unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve positioned over both the male and female rotors.

The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the rotors and the housing.

The rotors shall be mounted on antifriction bearings designed to reduce friction and power input. There shall be multiple cylindrical bearings to handle the radial and axial loads.

There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.

There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and coasting for shut down. An oil sump header shall be provided in the casing.

The units shall be complete with automatic capacity control mechanism, by use of slide valve to permit modulation between 20% to 100% of capacity range.

3.2.5 COMPRESSOR MOTOR

The driving motor shall be Hermetic squirrel cage type protected against damage by means of built in protection devices.

3.2.6 CONDENSER

Condenser coil

The condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes. The coil shall be circuited for sub-cooling. The coils shall be minimum 3 rows deep with at least 12 fins per inch.

Condenser fans

The units shall be furnished with necessary number of direct driven propeller type fans arranged for horizontal or vertical discharge. Condenser fan motor shall have class 'B' motor insulation, inherent protection device and shall be permanently lubricated type with resilient mounting. Each fan shall have a safety guard and shall have a low noise level.

3.2.7 COOLER

- The cooler shall be direct expansion shell and tube type, with steel shell and seamless copper tubes. The refrigerant head shall be removable type. The tubes shall be supported in the shell by adequate stiff supports to eliminate vibrations and noise. The tube ends shall be fixed firmly into the tube sheets to prevent leakage of refrigerant gas.
- The cooler shall be tested and stamped against leaks in accordance with ASME code for the refrigerant being used and otherwise tested and constructed in accordance with ASME or equivalent approved code requirements.
- The cooler shall have a minimum of 2 independent direct expansion refrigerant circuits.
- The cooler shall be factory insulated with 19 mm thick closed cell polyvinyl chloride and further protected by means of heater cables.

3.2.8 CONTROLS

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

3.2.9 WATER CHILLING MACHINE CONTROL SYSTEM

The water chilling unit shall be complete with microprocessor based type control system, which shall have the following features:-

- i. Electric expansion valve for economic operation of the system

- ii. Self diagnostic capability to locate faults and give early warning.
- iii. Leaving chilled water temperature control and reset capability, with provision to accept over ride commands from a central BMS system.
- iv. Automatic sequencing of various functions for starting, running and stopping of the various components of the unit based on demand.
- v. A programmable microprocessor complete with key pad and LED display window to perform the above functions.
- vi. The control package shall also consist of, but not limited to, the following components:
 - Low control voltage to unit.
 - Field power and control circuit terminal blocks.
 - ON/OFF switch.
 - Replaceable relay board.
 - Leaving chilled water set point board.
 - Diagnostic digital display module.
 - Microprocessor board.

Temperature reset board.

- vii. The control system shall have an extended module for control and monitoring from a central BMS including the reset of chilled water temperature, ON/OFF / Fault etc.

3.2.10 REFRIGERANT CIRCUIT

The refrigerant piping between compressors, chiller and condenser shall be of heavy gauge copper with brazed joints. The circuit shall include sight glass, moisture indicator, solenoid valves, electronic expansion valves, filter driers and necessary shut off valves with charging connections.

3.2.11 UNIT CASING

All the above components shall be housed in an outer casing fabricated from galvanized steel, zinc phosphate with multiple coats of baked enamel paint to make the whole casing weather proof for outdoor installation. Removable panels shall be provided for access to all working parts.

3.2.12 AHRI/ EUROVENT CERTIFICATION

The chilling unit shall be AHRI certified as per AHRI 550 / 590 – 2003 STANDARD. All suppliers shall furnish computer printouts along with their technical bids, giving details of capacity output at design conditions as given in tender.

3.2.13 MISCELLANEOUS

Each system shall be provided with the following:-

- Necessary charge of refrigerant gas and lubricating oil.
- Spring vibration isolators below the unit rated by the isolator manufacturers to absorb 90% of unit vibration and as approved by the engineer.
- Dial type thermometers and pressure gauges for the inlet and outlet of the chilled water lines.
- Flexible connectors between chilled water lines and cooler inlet and outlet.
- Water flow switch at the outlet of chilling unit
- Butterfly valve at the outlet and balancing valve at the inlet of the chillers

3.2.14 LIMITATIONS

The fouling factor for the cooler shall be not more than 0.0005. (FPS units).

TITLE

CHILLER PACKAGE – DATA SHEET A

S.N.	Description	Requirement
1	Number Required	3 (2W+1S)
2	Location	As per drawing
3	Duty	Continuous (18 hrs/day) (Approximate)
4	Capacity required at specified design conditions per chilling package	140 TR actual capacity
5	Refrigerant	R134a
6	Full load IKW (maximum)	1.4 KW/TR
7	Maximum noise level at a distance of 1.5 meters	75dBA
8	Compressor – type	Semi-hermetic/hermetic
9	Lubrication	Forced feed with an oil pump / differential pressure
10	Capacity control	Automatic in stages
11	Static and dynamic balancing of screws	As per ISO 1940
12	EVAPORATOR	
12.1	Type	Shell and tube, flooded/DX
12.2	Liquid to be cooled	Water
12.3	Chilled water quality	Potable water
12.4	Chilled water inlet temperature	54 Deg.F
12.5	Chilled water outlet temperature	44 Deg.F
12.6	Minimum chilled water flow per chilling package	420 USGPM
12.7	Fouling factor-water side (FPS unit)	0.0005
12.8	Chiller and suction line insulation	Closed cell polyvinyl chloride foam
12.9	Maximum water side pressure drop	20 Ft of water
13	CONDENSER	
13.1	Type	Air cooled
14	Motor	415 V +/- 10%, 3 phase, 50 Hz

15	Control Panel	Microprocessor based control panel
16	Control panel to be interfaced with building automation system	Provision to be available
17	Type of starter	Star Delta- Closed transition type

**CHILLER PACKAGE -DETAILS TO BE FURNISHED
BY TENDERER ALONG WITH OFFER – DATA SHEET B**

S N.	Description	Tenderer To Furnish
1.0	Water Chilling Unit	
	General Data	
1.1	Number of chillers	
1.2	Location	
1.3	Make and country of origin	
1.4	Model number and year of introduction model	
1.5	Detailed list of installations of that model in India	
2.0	Operating Parameters	
2.1	Minimum refrigeration capacity (TR)	
2.2	Minimum chilled water flow rate (USGPM)	
2.3	Maximum chiller pressure drop (Feet of water)	
2.4	Entering chilled water temperature (deg F)	
2.5	Leaving chilled water temperature (deg F)	
2.6	Evaporating temperature (deg F)	
2.7	Fouling factor for chiller	
2.8	KW/TR at full load conditions	
2.9	Entering Air temperature (deg F)	
2.10	Leaving Air temperature (deg F)	
3.0	Compressor	
3.1	Manufacturer	
3.2	Model	
3.3	Type of compressor	
3.4	Speed (operating)	
3.5	Speed (maximum)	
3.6	Refrigerant used	
4.0	Evaporator	
4.1	Manufacturer	
4.2	Model (No)	
4.3	Shell dia. (mm)	
4.4	Tube length (m)	
4.5	No of tubes (No.)	
4.6	Material of tubes (Name)	
4.7	Dia. of tubes (mm)	
4.8	No of integral fins / cm (No.)	

4.9	No of refrigerant circuits (No.)	
4.10	No of water passes (No.)	
5.0	Compressor Motor	
5.1	Manufacturer	
5.2	Type	
5.3	Motor Voltage	
5.4	Rated output	
5.5	Power characteristics	
5.6	No of Motors	
6.0	Starter for Compressor Motor	
6.1	Manufacturer	
6.2	Type of starter	
7.0	Miscellaneous Details	
7.1	Type of capacity control	
7.2	Noise level of chiller (in dBA) at 1.5 m distance	
7.3	Equipments size (LXBXH)	
7.4	Equipments operating weight (kg) / pounds	
7.5	Full refrigerant charge quantity	
8.0	Documents to be furnished with bid.	
8.1	Computerized printout (certified) from chiller manufacturer indicating power consumption in IKW/TR at full load and various part load conditions as per AHRI format	
8.2	Catalogues furnishing detailed technical data for compressor, evaporator, condenser, microprocessor or micro-computer control panel etc.	

3.3 PUMPS - SPECIFICATIONS

3.3.1 SCOPE

1.1 This section of specification covers the supply, installation, testing, commissioning of water pumps along with accessories conforming to these specifications and in accordance with requirement of drawings, 'Technical Schedule of Equipments' and of the 'Schedule of Quantities'

3.3.2 CODES AND STANDARDS

2.1 The design, materials of construction, manufacture, inspection, performance and testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipments will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. The equipments supplied shall comply with the latest applicable Indian, American, British or equivalent standards.

3.3.3 TYPE

All chilled, condensing water pumps shall be of capacity and size in accordance with the requirements indicated in the drawings and 'Schedule of Quantities' Pumps shall conform to relevant IS standards/codes.

3.3.4 MATERIAL OF CONSTRUCTION

The pumps shall be of centrifugal back pull out / monoblock type as specified in "Schedule of Quantities" with the following material of construction.

Type	Horizontal / End Suction Back Pull Out	Monoblock
Duty	Chilled / Condenser water	Chilled / Condenser water
Casing	Cast Iron	Cast Iron
Impeller	Bronze / Gunmetal machined to close tolerance	Bronze / Gunmetal machined to close tolerance
Shaft	High quality alloy steel EN8 grade	High quality alloy steel EN8 grade
Bearings	Heavy duty ball/roller	Heavy duty ball/roller
Base plate	Cast iron/fabricated MS channel in all welded construction	Cast iron/fabricated MS channel in all welded construction
Seal	Mechanical	Mechanical
Flanges	Standard companion As per IS standards IS -1536/1960	Standard companion As per IS standards
Speed (Max)	1450 RPM	2900 RPM
Drive	TEFC Motor upto 7.5 HP	TEFC Motor upto 7.5 HP
Starter	DOL below 7.5 HP ; Star Delta for 7.5 HP and above	DOL below 7.5 HP: Star Delta for 7.5 HP and above
Other Components	Wearing rings, sleeves and any other standard accessories	Wearing rings, sleeves and any other standard accessories
	Pumps shall be back pull out type upto 5.5 KW rating and axial split casing type casing for 7.5 KW and above	

3.3.5 ACCESSORIES AND FITTINGS

Pump shall be complete with

- Lubrication fittings.
- Gland drain (25mm min) piping upto nearest floor drain point.
- Test and air vent cocks.
- Water seal piping connections
- Suction, discharge pressure gauge (not less than 150 mm diameter) of appropriate range, with globe valves.
- Suction and discharge shut off valves.
- Discharge check valve
- Y type strainer at suction of each pump
- Flexible couplings (at suction & discharge) with control rods.
- However quantities of item (e) to (i) are separately quantified under 'Schedule of Quantities' and as such, cost of these valves should not be included in the cost of pump.

Also GI gland drain piping (Item b) upto nearest drain point will be paid under piping item, as such cost of same should not be included in the cost of pump.

3.3.6. INSTALLATION & TESTS

The pump sets shall be mounted on cement concrete foundation, which shall be provided by other agencies. However, grouting nuts, bolts, channels, shims etc shall be provided by the HVAC contractor.

3.3.7 MECHANICAL BALANCING

The impeller shall be statically and dynamically balanced.

3.3.8 VISUAL INSPECTION

8.1 Pumps shall be offered for Visual inspection (if specifically asked for) before dispatch. The components of the pumps shall not be painted before inspection.

3.3.9 MATERIAL TEST CERTIFICATE

Materials of the various pump components shall be tested in accordance with the relevant standard and Test Certificates shall be furnished along with the Pumps.

3.3.10. FIELD TESTING

After installation, the pumps shall be subjected to testing at site also. If the performance does not meet the requirements regarding capacity, power consumption, vibration and noise etc. as specified, then the equipments shall be rectified or replaced by the VENDOR, at no extra cost to the CUSTOMER.

3.3.11 TENDER DRAWINGS

The following drawings shall be submitted by the tenderers along with their Bids: -

- Preliminary outline dimensional drawing of pump. (Suction and discharge connections and foundation details shall also be indicated).
- Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

Pump Catalogues.

3.3.12 NAME PLATE

Each pump shall be provided with a name plate indicating the following details:-

- a) Design capacity
- b) Total head
- c) Speed

- d) Motor rating
- e) Model number
- f) Manufacturer's serial number
- g) Weight of equipments
- h) Tag number

3.3.13 PAINTING

13.1 All ferrous surfaces shall be painted with one coat of red oxide primer paint followed by two coats of synthetic enamel paint (approved shade).

3.3.14 INSULATION

The Pump casings for chilled water along with its accessories and fittings shall be insulated as specified in section on insulation. The cost of this insulation should be included in the cost of the pump.

Pumps shall be insulated only after they have been tested and test results have been approved by the engineer.

Note:- All the hardware required for the installation and equipments required for testing & commissioning shall be supplied by the Contractor.

CENTRIFUGAL PUMPS-DATA SHEET A

Design Parameters	S.N	Pump Designation	Chilled Water Pumps
	1	No. of Pumps	3 (2W + 1 S)
	2	Design Capacity	336 USGPM
	3	Total Head	100 Ft
	4	Location	As per drawings
	5	Max. Rated Sped (AT 50 Hz)	1450 RPM
	6	Liquid Handled	Water
Features of Construction	7	Type of Pump	End Suction Back Pull Out
	8	Seal	Mechanical
	9	Nozzle Orientation	End Suction - Top Discharge
	10	Flange Drilling	As per ISI
Materials of Construction	11	Parts	Material
	11.1	Impeller	Bronze IS 318GR2
	11.2	Casing	CI-IS210 GR FG 200
	11.3	Shaft	Steel
	11.4	ST. Box Packing	Graphite Asbestos
	11.5	Base Plate	Cast iron / Fabricated steel

**CENTRIFUGAL PUMPS- DETAILS TO BE FURNISHED
BY TENDERER ALONG WITH OFFER –
DATA SHEET B**

S. N.	ITEM DESCRIPTION	
1.	Make	
2.	Model	
3.	Design Capacity USGPM (M ³ /Hr)	
4.	Total Head FT WG (MWC)	
5.	Shut off head FT WG (MWC)	
6.	Hydrostatic test pressure KG/SQCM (MWC)	
7.	Pump efficiency at duty point %	
8.	Power input to pump at duty point (BHP) (KW)	
9.	Motor efficiency at duty point %	
10.	Power input to motor at duty point (HP) (KW)	
11.	Rated speed RPM	
12.	NPSH required FTWG(ML C)	
13.	Material of construction as per specification, If no, indicate deviations	YES / NO
14.	Suction size	
15.	Discharge size	
16.	Impeller type	
17.	Pump weight Kg	
18.	Pump set weight Kg	
19.	Pump size Mm	
20.	Pump Foundation size Mm	

3.4.0 SPECIFICATIONS FOR HOT WATER GENERATOR

3.4.1 SCOPE

This section of the specification covers the supply, installation, testing and commissioning of hot water generator along with its accessories, conforming to these specifications and in accordance with requirements of drawings and of the 'Schedule of Quantities'.

3.4.2 CODES AND STANDARDS

The design, manufacture, testing and performance of the Hot Water Generator shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The Hot water generator shall also conform to the latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

3.4.3 CONSTRUCTION

The hot water generator shall be vertical/horizontal type comprising of steel shell, heating elements, controls, control panel, mounting frame etc.

- **SHELL:** The shell shall be of welded construction, fabricated from 10mm thick MS sheet. The shell shall be complete with baffles to provide adequate velocity to water.
- **MOUNTING FRAME:** The hot water generator shall be mounted on a robust fabricated steel frame of 16SWG MS sheet and complete with hinges, locks to make a compact assembly. The base frame shall be fabricated out of ISMC 100x50 and shall be suitable for level foundation.

3.4.4 HEATING ELEMENT

- Heaters shall be of approved make and made of chromium coated mild steel mounted in electrically resistant u-tubes and shall be immersion type to be in direct contact with water.
- These shall be easily removable without opening the terminal plates.
- Heaters shall be of adequate rating and equally distributed for uniform heat transfer.
- Heating elements shall be suitable for 415 V +/- 10% , 3 phase, 50 HZ, AC supply and conforming to IS.4159.

- The Hot water generator should have at least 5% spare heater capacity, which can be used in case of failure of running heater.

3.4.4 CONTROL PANEL

The control panel shall be fabricated out of 14-gauge MS sheet built in with the hot water generator.

3.4.5 INSULATION

- The hot water generator shall be insulated with 50-mm thick fiberglass of density 32 kg/cu.mt. and cladded with 0.63 aluminium sheet on MS frame welded to generator body.
- The hot water generator shall be provided with lifting lugs on top for easy transportation and handling.

3.4.6 PRESSURE TESTING

The Boiler Shall Be Tested In The Factory For Leak At a Hydraulic Pressure of 350psig

4.7 CONTROLS AND ACCESSORIES

- One 100 mm dial type thermometer, mercury in bulb type, at inlet and outlet with tubing. Range of thermometer shall be 0-100 Deg c.
- One dial type pressure gauge with globe valve at inlet and outlet of the boiler with tubing. Pressure gauge shall have range of 0-10 kg/sq. cm.
- Spring loaded safety valve for pressure relief in case of high-pressure build up in the Hot Water Generator. The outlet of safety valve shall be piped to the nearest drain.
- Inlet and outlet connections with matching flanges.
- Drain connection with 25mm-gate valve.
- De-scaling valve
- Automatic air vent valve
- Step controller.
- High temperature cutout

- Electronic low water level switch.
- Vibration isolators with at least 90% efficiency.

3.4.8 CONTROL PANEL

The hot water generator shall be provided with electrical control panel, factory mounted directly on mainframe, completely wired and tested. The panel shall conform to Indian I.E rules.

The panel shall be provided with accessories. Conforming to the approved list of makes. The panel shall be suitable for 415 V +/-10%, 3ph, 50 Hz AC electric supply.

The control panel shall comprise of: -

- (a) Incoming MCCB of suitable rating.
- (b) Copper bus bar
- (c) Ammeter with current transformers and selector switch.
- (d) Voltmeter with selector switch
- (e) Contactors
- (f) On/ Off indication lamps for individual banks.
- (g) Phase indication lamps with control fuses.
- (h) Fault indication lamps.
- (i) On/Off toggle switch for operating individual banks.
- (j) Alarm with reset push button.
- (k) Push button for lamp test and heater reset.
- (l) Copper connection with cables and control cabling.

The doors of electrical controls panel shall be operable only when incoming power supply is cut off.

3.4.9 PAINTING

All external welds should be de-rusted, cleaned and applied with two coats of necessary red oxide primer. Then it shall be powder coated in approved shade.

3.4.10 TESTING

The unit shall be tested at site to ensure the specified output of hot water generator after satisfactory installation.

HOT WATER GENERATOR - DATA SHEET A

S. N.	Description	Requirement	
1.0	Design Features	General Areas	OT's
1.1	Application	Winter Heating	Heating
1.2	Minimum capacity	150 KW	20 KW
1.3	Location	Terrace	Terrace
1.4.	Numbers Required	(1W)	(1W + 1 S)
2.0	Features of Construction		
2.1	Type	Vertical / Horizontal	Vertical / Horizontal
2.2	Heaters	Chromium Coated MS	Chromium Coated MS
3.0	Material of construction		
3.1	Shell	10 mm thick MS	10 mm thick MS
3.2	Dished ends	15 mm thick MS	15 mm thick MS
4.0	Insulation		
4.1	Material	Fiberglass	Fiberglass
4.2	Thickness	50 mm	50 mm
4.3	Density	32 KG / cum	32 KG / cum
4.4	Finish	24 G Aluminium cladding	24 G Aluminium cladding
5.0	Testing		
5.1	Hydrostatic test	At 350 PSIG for leaks	At 350 PSIG for leaks
5.2	Performance test	Standard running test	Standard running test

HOT WATER GENERATOR - DATA SHEET B

S.N.	Description	
1	Application	
2	Make	
3	Design Capacity	KW
4	Type	
5	Model	
6	Banks	No / KW
7	Vessel size	Mm
8	Thickness	
8.1	Shell	(mm)
8.2	Dished ends	(mm)
9.0	Insulation	
9.1	Material	
9.2	Thickness	(mm)
9.3	Density	(Kg/CUM)
9.4	Finish	
10.0	Dimensions (L x W x H)	(mm)
11.0	Heaters	
11.1	Make	
11.2	Model	

12.0	Electrical Characteristics	
13.0	Test Pressure	
14.0	Controls	
14.1	All provided	YES / NO
14.2	Any deviation from specification (Please indicate specifically)	YES / NO
14.3	Qty: Reqd.: Nos:	
14.4	Mandatory service clearance required.	

3.5 HORIZONTAL FLOOR MOUNTED AIR HANDLING UNITS

3.5.1 SCOPE

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

3.5.2 TYPE

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

3.5.3 CAPACITY

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

3.5.4. CONSTRUCTION

3.5.4.1 AHU HOUSING / CASING:

- The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type with 0.6mm pre painted GSS/ pre-plasticised on the outside and 0.6 mm galvanized sheet inside with 25 mm thick PUF insulation material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.
- Framework for each section shall be joined together with soft Neoprene rubber gasket in between to make the joints airtight. Suitable airtight access doors /panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on roller-formed GSS channel framework having pressure die cast aluminum jointers.

3.5.4.2 DRAIN PAN

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

3.5.5 COOLING / HEATING COIL

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 21-kg/sq. cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be complete with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

3.5.6 FAN SECTION WITH FAN

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

3.5.7 FILTER SECTION

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

3.5.8 FRESH AIR INTAKES

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

3.5.9 ACCESSORIES

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

- (a) Stem type thermometer at each AHU coil inlet and outlet with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'
 - (b) Pressure gauge with globe valves at inlet and outlet of each AHU coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.
 - (c) Butterfly valves at inlet and outlet of the each coil.
 - (d) Balancing valve at the outlet of each coil.
 - (e) Y strainer at inlet of each coil.
 - (f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.
 - (g) Motorized three way mixing valves located in chilled /hot water lines connected to the coil. This valve shall be operated by the cooling/heating thermostat and shall control the flow of chilled/hot water as per section 'automatic controls and instruments'.
 - (h) Cooling /heating thermostat as per section
- 'Automatic Controls and Instruments' shall be located in return air stream.
- (i) Flexible connection between the fan outlet and duct.
 - (j) Vibration isolators of at least 90% efficiency.

3.5.10 SAFETY FEATURES

Each handling unit must have safety features as under:-

- (a) The fan access door must have micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

The access door shall further have wire mesh screen as an added feature, bolted on to the unit frame.

- (b) Fan and motor base shall be properly earthed from the factory.
- (c) All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

3.5.11 DRIVE

Fan drive shall be 3phase-squirrel cage totally enclosed fan cooled motor suitable for $415 \pm 10\%$ V, 50 HZ AC supply. Motor shall be specially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement with required no. Of belts for power transmission without slippage. Belts shall be of oil resistant type of approved make only.

3.5.12 DESIGN DATA FOR AIR HANDLING UNITS

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

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

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

3.5.13 INSTALLATION

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

3.5.14 PERFORMANCE DATA

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

3.5.15 TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

3.5.16 VARIABLE FREQUENCY DRIVES (For AHUs):

Product compliance – The drive shall have comply to the following standards

- Low Voltage Directive 73/23/EEC with supplements

- EMC Directive 89/336/EEC with supplements

- Quality assurance system ISO 9001 and ISO 14001

- CE, UL, ULc and C-tick

Mechanical Protection

The enclosure shall be plastic type and tested in UL tests according to the ball impact test stated in UL746C.

The protection class shall be IP21.

Operating Parameters

The drive shall be suitable for an ambient temperature of 40 deg C.

The drive shall give an alarm signal when the heat sink temperature of the drive reaches 90 deg C and shall trip when the temperature reaches 95 deg C.

To predict the noise level of the motor switching frequency shall be user selectable and can be selected according to the load conditions: 4 kHz or 8khz (for low noise operations)

Overload Capacity: The drive shall be able to deliver 100% of the nominal current and 110% for 1 min. every 10 mins. (if repeatability is not mentioned, the drive shall be selected to ensure the proper RMS current rating)

The drive shall have at least 2 critical frequency (band) selection to avoid the mechanical resonance problem.

The drive shall have at least 7 programmable constant speeds ranging from 0-250 Hz.

Programming

Control Panel : The drive shall have an alphanumeric control panel with LCD display and multiple languages. The control panel can be connected to and detached from the converter at any time. The panel can also be used to copy parameters to other converters with the same software revision.

It shall be possible to view the Output Current, % Torque, the reference Frequency and one output variable (frequency, voltage etc. as per requirement. If Not, then separate display shall be provided to view the above parameters.

At any point of time the status of the drive can be known through the Control Panel, i.e. remote/local, run/stop/fault etc.

The drive shall have a sleep function to provide energy saving at low frequency. When the reference falls below a certain level, the drive shall go in energy optimizing mode.

The drive shall have a **Built-in Pump and Fan controller**. The automatic pump alternation shall be possible. Thus each pump can be run with an equal duty time.

Protection features

- Over current
- Over voltage
- Under voltage
- Over temperature
- Output earth fault
- Output short circuit
- Input phase loss (3 phase)
- I/O terminal short circuit protection

Motor overload protection: If the motor current I (out) exceeds nominal current I_N of the motor for a prolonged period, the drive shall automatically protects the motor against overheating by tripping. The trip time shall depend on the extent of the overload (I out / I_N), the output frequency and f_{nom} . Times given shall also apply to a “cold start”. Drive shall provide overload protection in accordance with the National Electric Code (US).

Output over voltage protection: In the event of an overload, the drive shall first show an alarm and then trip.

- Stall protection
- Under load
- Stall protection
- Output over current
- Output short circuit
- Ground fault, motor cable
- Under load
- Network failure
- Low input signal level ($AI < \min$)
- Panel fault
- Over voltage

Under voltage
 External fault
 Automatic fault reset, under voltage
 Automatic fault reset, over voltage, over current
 Fault history 3

Functions

Start; normal/flying/torque boost
 Start; premagnetising
 Stator resistance (IR) compensation
 Stop; ramp/coasting
 Stop; DC brake
 DC hold
 U/f -ratio; linear/square
 Acceleration/deceleration 1 (s) 0.1 ... 1800
 Acceleration/deceleration 2 (s) 0.1 ... 1800
 S-ramp; fast/medium/slow
 7 Preset speeds
 2 Critical frequencies
 Slip compensation
 Parameters in logical menus
 Motor field optimization for energy optimization
 Selectable switching frequency 4 / 8 kHz

Mains Connections

Voltage: 3-phase, 380-480V +/-10%
 Frequency: 48-63hz
 Power Factor: 0.9

Motor Connections

Voltage: 3-phase from 0 – U supply
 Frequency 0-250hz
 Acceleration time: 0.1 to 1800 secs
 Deceleration time: 0.1 to 1800 secs

Programmable control connections:

The drive shall have atleast the following inputs and Outputs

Two analog inputs:

- Voltage signal: 0 (2) to 10 V, 200 kW single-ended
- Current signal: 0 (4) to 20 mA, 500 W single-ended
- Potentiometer reference value: $\sqrt{10}$ V $\pm 2\%$ max. 10 mA, 1 kW $\leq R \leq 10$ kW
- Response time: ≤ 60 ms
- Resolution: 0.1%
- Accuracy: $\pm 1\%$

One analog output: 0 (4) to 20 mA, load < 500 W

Auxiliary voltage: 24 V, max. 250 Ma

Five digital inputs:

- 12 V... 24 V DC with internal or external supply, PNP and NPN
- Input impedance: 1.5 Kw
- Response time: \leq 9 ms

13.9.4 Two relay outputs:

- Switching voltage: 12 to 250 V AC or max 30 V DC/0.5 A
- Maximum continuous current: 10 mA to 2 A

Serial communication for the control panel or external control: Seamless communication with Modbus or N2 protocol on RS485

Design features

The drive shall have an in-built choke at the DC input side.

The distance between the motor and the drive is approximately 100 mts. An output choke shall be used as applicable.

HORIZONTAL FLOOR MOUNTED AIR HANDLING UNITS – DATA SHEET B

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

3.6 VERTICAL FLOOR MOUNTED AIR HANDLING UNITS

3.6.1 SCOPE

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

3.6.2 TYPE

The air-handling units shall be vertical double skin, comprising, pre filters, chilled water coil, fan as per details given in Drawings and Schedule of Equipment.

3.6.3 CAPACITY

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

3.6.4 CONSTRUCTION

3.6.4.1 AHU HOUSING / CASING:

The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type with 0.6mm pre painted GSS/ pre-plasticised on the outside and 0.6 mm galvanized sheet inside with 25 mm thick 40 kg / m³ PUF insulation material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight. The corner joints shall be nylon glass fiber reinforced.

3.6.4.2 DRAIN PAN

The drain pan shall be of 18 G aluminum/stainless steel with necessary slope to facilitate fast removal of condensate. It shall be provided with drain connection of suitable size complete with 25 mm rigid insulation. Necessary arrangement will be provided to slide the coil in the drain pan.

3.6.5 COOLING / HEATING COIL

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 21-kg/sq cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

3.6.6 FAN SECTION WITH FAN

Fan section shall have two Nos. blowers.

The fans shall be backward curved, double inlet double width type. The fan shall be selected for a speed not exceeding 1000 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM. Fans & motor shall be mounted above the coil /sections. The fan outlet shall be connected to casing with the

help of fire retardant canvas. The fan shall be selected for a noise level less than 70 DB (A) 1M away from the unit.

3.6.7 FILTER SECTION

Each unit shall be provided with a factory assembled filter section containing 48 thick synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

3.6.8 FRESH AIR INTAKES

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

3.6.9 ACCESSORIES

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

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

flow of chilled/hot water as per section 'automatic controls and instruments' for detailed specification.

- (h) Cooling /heating thermostat as per section

'Automatic Controls and Instruments' shall be located in return air stream.

- (i) Double Flexible connection of fireproofs material between the fan outlet and duct.

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

3.6.10 SAFETY FEATURES

Each handling unit must have safety features as under:-

3.6.11 PERFORMANCE DATA

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

3.6.12 TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

VERTICAL FLOOR MOUNTED AIR HANDING UNITS – DATA SHEET B

1.0	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	

2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

3.7 HIGH STATIC AIR HANDLING UNITS DOUBLE SKIN TYPE SPECIFICATIONS

3.7 1. GENERAL

The air handling units shall be complete in all respects and shall generally comply with the specifications as given in the following paragraphs.

3.7.2 AIR HANDLING UNITS (SPECIAL HIGH STATIC TYPE)

The air handling units shall be double skin sectional, draw through type and shall include flat filter section, fan section, coil section, Microvee and HEPA filter sections, humidifier etc. The AHU shall be two tier type with the microvee and HEPA filter sections on the upper tier.

3.7.3 FAN SECTION

The fan shall be backward curved, double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame & pillow block heavy duty ball bearings. The fan shall be selected for a speed not exceeding 1800 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM. Fan housing with motor shall be mounted on a common aluminium base mounted in side the air handling housing on anti-vibration springs mounts or cushy foot mount. The fan outlet shall be connected to casing with the help of fire retardant canvass. The fan shall be complete with multi 'V' belt drive and adjustable motor mounting base (Aluminium). The fan section shall have an access panel of adequate size with double synthetic rubber sealing gasket and locking arrangement. The opening shall be provided with micro switch and galvanized iron protection mesh. The fan outlet shall be provided with an opposed blade volume control damper.

3.7.4 COIL AND FILTER HOUSING

The cooling coils, special and standard filters, humidifier, etc., shall all be housed in a separate enclosure of suitable size and length.

The enclosure shall be sized to accommodate the HEPA and high efficiency microvee filters. The inspection doors, shall have double neoprene rubber T-section seals, hinges and locking arrangements. The gaps between filter frames and housing shall have synthetic rubber packing, to eliminate any air leakage. All filter frame shall be epoxy painted. The HEPA filter and Microve filter sections shall be provided with an inclined manometer for taking filter pressure drop readings.

3.7.5 COOLING/HEATING COILS

The cooling and heating coil shall be of seamless copper tubes, not less than 0.45 mm thick and 12 mm O.D. the bends shall be ready made with solder rings on both ends the coil shall have continuous 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 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 2 hours. No drop should be observed indicating any leaks. The water headers shall be of heavy class copper pipes, to connect all the tubes. The headers shall be complete with water in/out connections, vent plug on top and drain at the bottom, and designed to provide water velocity between 0.6 to 1.8 m/s (2 to 6 FPS). The coil shall be designed at an operating air velocity of 500 FPM (2.5 m/s).

3.7.6 HUMIDIFIER SECTION

The humidifier shall be pan type with built in heaters to evaporate water in the air stream.

The humidifier shall be made of 2 mm aluminium plates of welded construction.

The tank shall be fitted with a 9 kw thermostatically controlled, immersion water heater, safety thermostat, steam vent, inlet water etc.

3.7.7 FILTER

Each system shall have three type of filters as follows and conforming to specifications given elsewhere.

- Pre filter of 90% efficiency by weight with synthetic media down to 10 micron particle size.
- High efficiency filters with efficiency of 99% down to 5 micron particle size.
- HEPA filters with efficiency of 99.97% down to 0.3 micron particle size.

3.7.8 DRAIN PAN

The drain pan shall be of 1.25 mm welded or 0.80 mm pressed stainless steel sheets, externally insulated with 12 MM thick closed cell polyethylene foam insulation with necessary slope to facilitate fast removal of condensate.

3.7.9 AHU ENCLOSURE / HOUSING

- The AHU enclosure shall be double skin design with the main frame work made of extruded aluminium thermal break structural section.
- The panels shall be double sandwich type with 0.80 MM precoated galvanised sheet on the outside and 0.80 MM aluminium sheet on the inside. The insulation shall be 25 MM thick foam injected polyurethane foam.
- Each section shall be provided with separate access panel of suitable size. The access panel shall be hinged type with heavy duty hinges and handles made of nylon. The handles shall be self tightening type to ensure leak proof closing.
- The opening for access doors and gaps between sections shall be provided with the neoprene rubber T-gaskets fixed in grooves in the extruded sections.
- The sandwich panels shall be fixed to the frame work with self and tapping stainless screws and both ends of the screw shall be provided with rubber caps.

3.7.10 FAN MOTOR & STARTER

The totally enclosed fan cooled squirrel cage fan motor shall have a minimum rating given as under "schedule of equipment" and described under "motor etc...". The starter rating shall match the motor rating and will conform to specifications under "motor and switch gears.

3.7.11 FRESH AIR CONTROLS

An adjustable damper of GI sheet of 1.25 mm thick blades along with bird screen, air inlet louvers and 50 mm thick prefilter shall be provided in the AHU rooms along with the AHU.

3.7.12 ACCESSORIES

- Each air handling unit shall be complete with
- Stem type thermometers at coil inlet and outlet, with tubing and gauge cocks.
- Pressure gauge with cock at inlet of the coil, with tubing and gauge cocks.
- Butterfly valves at inlet of the coil and balancing valve at outlet of coil.
- Drain line from the unit upto floor trap.
- Automatic air Vent Valves on pipes.

- Flexible connection between the fan outlet and duct.
- Vibration isolators of 90% efficiency between AHU and foundation.
- Inclined manometer with tubing with HEPA filter section.

3.7.13 TESTING

The air handling unit shall be tested to measure air quantity and coil performance by measuring temperature difference, water pressure drop across coil, air quantity and then calculating the capacity.

3.7.14 LIMITATIONS

The air velocity across the cooling coil shall not exceed 500 FPM (2.52 m per sec.).

The fan outlet velocity shall not exceed 1800 FPM (9.14 m per sec.).

The air velocity across the filters shall not exceed 500 FPM.(2.52 m per sec.)

3.8 FILTERS

3.8.1 General

The various types of filters to be used in the different systems to achieve the required degree of air purification shall confirm to the following specifications :

3.8.2 HEPA (Absolute) Filters

- The point to point scanned and Di-Octyl Pthalate (D.O.P) tested flange type HEPA filters shall have an efficiency of 99.97% for a particle size of 0.3 microns. Flange width not to exceed 20 mm.
- Each filter shall be sealed from all sides in aluminium filter frame and joints sealed with ductile epoxy resin, having impact strength 2.5-4.0 kg/cm² & modulus of elasticity strength 750-780 kg/ cm².
- The filtering media shall be of micro fibre glass paper to provide the required filtering efficiency.
- Each filters shall carry a test report from suitable agency, certifying the efficiency of the filter according to D.O.P test.
- The initial pressure drop (IPD) should be more than 15 MM WG at rated CFM. Supplier shall indicate the pressure drop in choked condition.

3.8 3 Microvee Filters

- Microvee filters in flange type construction shall be made out of polyester/polypropylene media shall have an efficiency greater than 99% down to 5 micron or less particle size according to D.O.P. Test method.
- The filter element shall be housed in aluminium anodized frame. Media shall be supported on one side with hdpe mesh & on their side with aluminium mesh.
- Media/hdpemesh/aluminium mesh shall be stiched together. Edge of the filter to be duly protected with polyster beading. Number of folds shall be 11 folds/ft. of actual face area of the frame.
- The initial pressure drop shall be in between 6.5-8.5 MM WG and it should not exceed 20 MM WG in dirty condition.
- The filters should be cleanable and washable.
- The filter element should be properly sealed with frame with the help of epoxy so that there is absolutely no air bypass after no. of washes. Foam between folds & frame shall not be used.
- Minimum 4 No. Aluminium anodised combs shall be inserted for keeping the pleats separated from each other.

3.8 .4 Pre Filters

- The pre filter in box type construction shall have an efficiency of 90% down to 10 microns.
- The frames shall be made out of aluminium anodised extruded sections.
- The filtering media shall be polyester/polypropylene.
- The frame shall be of properly sealed so that there is absolutely no air by-pass.

3.8.5. Microvee Filters Mounting Plenum

- The microvee filters shall be housed in a separate plenum of 1.25 mm G.I. sheet. The plenum shall be factory fabricated.
- The plenum shall be compartmentalized to receive the required number of filters.
- The plenum and frame work after derusting shall be provided with two coats of epoxy paint inside.
- All filters shall be installed in the same plane. No zigzagging shall be permitted.
- The inspection cover for convenient servicing of the filter should be 100% air tight. It shall be of double skin construction and factory fabricated.

3.9 CEILING MOUNTED AIR HANDLING UNITS

3.9.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and of the 'Schedule of Quantities'.

3.9.2 TYPE

The air-handling units shall be double skin ceiling mounted, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and Schedule of Equipment.

3.9.3 CAPACITY

The air moving and coil capacities shall be as shown on the drawings and indicated in 'Schedule of Quantities'.

3.9.4. UNIT CONSTRUCTION

The ductable unit shall be ceiling mounted type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self-supporting frame work for various sections.

25mm thick double skin panels shall be made of 0.63 mm pre-plasticized GSS sheet on outside and 0.63 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 38 Kg./m³ density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 25mm thick thermo Cole or 12mm thick closed cell Nitrile rubber.

5. FAN AND MOTOR

The fan shall be DIDW centrifugal backward curved fan having single-phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA certification.

The fan motor shall be single-phase squirrel cage suitable for 415V +/- 10%, 50 Hz, 3-phase AC supply as specified in "Schedule of Quantities". Fan and motor may be directly coupled or may be belt driven.

6. COIL

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

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

7. FILTER

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Filters shall have aluminium frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

8. ACCESSORIES

Each air-handling unit shall be provided with manual air vent at highest point in the cooling coil. In addition; the following accessories may be required at air handling units. Their detailed specifications are in individual sections and quantities separately identified in 'Schedule of Quantities' (except items I to L).

Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'

Pressure gauge with globe valves at inlet and outlet of each coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.

Butterfly valves at inlet and outlet of each coil.

Balancing valve at the outlet of each coil.

Y Strainer at inlet of each coil.

Union and condensate drain piping from the unit up to the drain trap as described in section piping.

Motorized three way mixing valves located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot water as per section 'Automatic Controls and Instruments' for detailed specification.

Cooling /heating thermostat as per section

'Automatic Controls and Instruments' shall be located in return air stream.

Double Flexible connection of fire retardant Hessian between the fan outlet and duct.

Vibration isolators of minimum 90% efficiency.

Motor & drive package

Air purge valve on top of coil header and drain valve at bottom.

9. DESIGN DATA FOR AIR HANDLING UNITS

Fan outlet velocity shall not exceed 550 MPM.

The air velocity across coil shall not exceed 150 MPM.

The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specified HP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated under Technical Schedule for Equipment'.

10. INSTALLATION

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation.

11. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing & commissioning of the installation.12.

TESTING

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

CEILING MOUNTED AIR HANDING UNITS
DATA SHEET B

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

9.0 FAN COIL UNITS – SPECIFICATIONS

1. SCOPE

This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the requirement of the drawings and 'Schedule of Quantities'.

2. TYPE

The fan coil unit shall be horizontal type to be mounted within ceiling space. The units shall have horizontal discharge and complete with chilled water coil, one or more centrifugal fans and motors, cleanable fabric filters, double skin insulated condensate drain pan. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

2.1 Capacity

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

2.2 Cabinets

Cabinets shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

2.3 Interior Chassis

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

2.4 Fan Section

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced.

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

A GI plenum shall connect fan outlet to the coil.

2.5 Cooling Coil

The coil shall be of seamless copper tube of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/ hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper

2.6 Drain Pans

Primary drain pan shall be of double skin construction fabricated from 18 gauge stainless steel with all corners enclosed. An additional inner bottom panel of 18 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves.

The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

2.7 Motor

Motor shall be $220 \pm 6\%$ volts, 50 cycle, single phase, six poles, shaded pole type, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

3. Air Filter

The filter shall be cleanable type 12mm thick AL. wire mesh and mounted behind the pan in a filter plenum of GI sheet.

4. Painting

The fan coil units shall be powder coated in approved colour.

5. Controls

All units shall be complete with following controls

Motorized two way valve in water lines

Wall mounted thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning

'Y' strainer, ball valve and globe valve as shown on drawings and 'schedule of quantities'

6. Performance Data

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium / high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

7. Testing

Cooling capacity of various fan coil unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury -in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

CEILING MOUNTED FAN COIL UNITS – DATA SHEET B

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

10.0 EVAPORATIVE COOLING UNIT - DOUBLE SKIN SPECIFICATIONS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction evaporative cooling packaged type unit, conforming to these specifications and in accordance with requirements of drawings, 'Technical Schedule of Equipment' and of the 'Schedule of Quantities.'

2. TYPE

The evaporative cooling unit shall be double skin construction draw through type comprising of various sections such as filter section, humidifier section, supply air fan section, fine filter plenum, factory fabricated (wherever required) as per details given in Drawings and 'Schedule of Quantities.'

3. CAPACITY

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

4. CONSTRUCTION

HOUSING/CASING

The housing /casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self –supporting framework for various sections.

25 mm thick double skin panel shall be made of 0.6 mm plasticized /pre coated PVC sheeted GSS on outside and 0.6mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

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

5. DRAIN PAN

Drain pan shall be constructed of 18 g stainless steel with necessary both way slope to facilitate fast removal of drain water.

6. **MOTOR DRIVE**

Fan motors shall be suitable for $415 \pm 10\%$ volts, 50 cycles 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. 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.

7. **FAN**

The fan shall be backward curved, double inlet, double width type. The wheels 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 noise level less than 85-DB (A). The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 7.62m/sec. Fan housing with motor shall be mounted on a common extruded aluminium base mounted inside the housing on anti vibration mounts. The fan outlet shall be connected to casing with the help of double fire retardant fabric acting as a flexible connection for anti vibration.

8. **WET DECK HUMIDIFIER**

Wet deck humidifier pads shall be of cellulose paper minimum 200 mm deep to provide at least 90% saturation efficiency at 2.5 MPS or less air face velocity. The cellulose paper pads shall be housed in a galvanized steel casing complete with water distribution header and interconnecting heavy duty flexible PVC / GI pipes between pump and distribution header.

9. **WATER CIRCULATING PUMPS**

Water circulating pumps shall be vertical type. The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless steel drain pan. The pump shall be suitable to operate at $415 \pm 10\%$ V, 50 HZ AC supply.

Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless steel drain pan to bleed small percentage of total circulated water in order to ensure compulsory water change over during running of the system.

10. **FILTERS**

Each unit shall be provided with a factory assembled filter section containing washable air filter having bonded expanded aluminium media with aluminium frame. Filter media and frame shall be rust proof and corrosion resistant. Filter face velocity shall not exceed 150 meter per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held with in the frames by sliding the cells between guiding channels.

11. **FRESH AIR INTAKES**

Anodized extruded aluminium construction (20 microns and above) fresh air intakes louvers with bird screen and extruded aluminium low leakage construction damper shall be provided for FA. Blades shall be made of extruded aluminium. Construction shall be rattle free. Fresh air fans and fresh air intakes shall be as per the requirement of 'Schedule of Quantities'.

12. SAFETY FEATURES

Each evaporative unit must have following safety features:-

The fan access door shall be equipped with micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

13. PERFORMANCE DATA

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

14. TESTING

Performance of evaporative cooling unit shall be computed from the measurements of air flow and dry and wet bulb temperature of air entering and leaving the unit. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

11.0 INLINE & PROPELLER FANS – SPECIFICATIONS

1 SCOPE

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

2 TYPE

Centrifugal and inline fans shall be of type as indicated in drawings and 'Schedule of Quantities'

3 INLINE FANS

Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

4 PROPELLER FANS

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for $415 \pm 6\%$ volts, 50 cycle 3-phase power supply and for smaller fans shall be suitable for $220 \pm 6\%$ volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and

Schedule of Quantities.

Propeller fans shall be provided with following accessories: -

Wire guard and bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor.

Single-phase preventors for 3 phase fans.

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

5 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6 TESTING

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

12.0 VENTILATION FAN SECTIONS – SPECIFICATIONS

1. SCOPE

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

2. TYPE

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

3. UNIT CONSTRUCTION

3.1 Housing

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas.

3.2 Fan

Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced. Fan shall conform to specifications as given in specification No.SPC/CF – PF/01

3.3 Motor

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

3.4 Back draft Damper

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

4. VIBRATION ISOLATION

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

5. **PERFORMANCE DATA**

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6. **TESTING**

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

13.0 AXIAL FLOW FANS – SPECIFICATIONS

1.0 SCOPE

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in ‘Schedule of Quantities’ and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following: -

(a) Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type). Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).

Gravity louvers

2.0 APPLICABLE SPECIFICATIONS STANDARDS AND CODES.

Documents listed below should be read along with the technical data given in the ‘Schedule of Quantities’ and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.

- (a) I.S.S.: 3588 – 1986; specifications for electric axial flow fans.
- (b) ANSI/ASHRAE: standard 51
- (c) ANSI/AMCA: standard 210 for preparing performance curves, charts and testing of fans
- (d) IS-2312 – Propeller type A.C ventilation fans
- (e) BS – 848 – Methods of performance test for fans

3.0 DESIGN & MANUFACTURING

Fan and Components

- 3.1 The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have optimum efficiency at operating conditions and shall have performance characteristics to match the approved performance curves.
- 3.2 The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quiet, stable and vibration free operation at the prescribed conditions of flow, static and speed.

- 3.3 The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.

Impeller & Blades

The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

3.4 Drive

The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0– class F and suitable for $415 \pm 10\%$ V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in 'Schedule of Quantities'. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

3. TECHNICAL SPECIFICATIONS

- 3.1 The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

4. GENERAL REQUIREMENTS

- 4.1 Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.
- 4.2 **NOISE LEVEL:** The tendered shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard.

5. PAINTING

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

6. PACKING

The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

7. INSPECTION & TESTING

All fans shall be subjected to inspection and testing requirements as given below. The contactor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of Client may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves

Airflow capacity

Static head developed

BHP requirement

Vibration and noise level

14.0 AUTOMATIC CONTROLS AND INSTRUMENTS – SPECIFICATIONS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and 'Schedule of Quantities'

2. PRODUCTS

2.1 Two / Three Way Valve

Two way or Three way motorized / modulating valve for each air handling units shall be provided in chilled water line at each air handling units as shown on the Drawings and included in Schedule of Quantities. Each valve shall be actuated by a space or duct mounted thermostat. Constant space condition shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall revert to fully by pass position when fan is shut off. Motor shall be proportional modulating motor. Motor shall be suitable for 24 volts supply and shall have a cover mounted 220/24 volts transformer factory- installed. The unit shall be suitable for outdoor installation in the open space.

Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

2.2 Flow switches shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.

2.3 Thermostats shall be electrical mode, fixed differential type with sensing element located in the return air stream.

2.4 Proportional control thermostats for air conditioning application for actuating the two ways or three way modulating valve at each air-handling units, as shown on drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell model T921B/T92A or equivalent, line voltage-cooling thermostat. Range shall be 56-84 degree F, differential shall be 3 degree F.

2.5 SNAP acting fixed differential thermostat for FCU shall be of Honeywell make and model T649A or T4039 cooling thermostat or any approved equivalent with temperature range of 13-29 degree C differential 37 deg C with ON/OFF, HI/LOW fan switch, normal-cool setting switching off must break fan circuit.

3. INSTRUMENTS

3.1 **Thermometer:** Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0 deg C to 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded on pipes shall be provided with thermometer. Thermometer shall be installed of chilled water supply and return at each air handling unit, supply and return of each chiller, condenser.

3.2 **Pressure gauge:** shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mm range 0-10 kg per sq cm (0-150 PSI) Pressure.

15.0 SHEET METAL WORKS AND ACCESSORIES - SPECIFICATIONS (MANUAL FABRICATION)

1. SCOPE

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts, supply, installation, testing & balancing of all grills & diffusers as per specifications & drawings.

Except as otherwise specified all ductwork and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

2. DUCT MATERIALS

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) and with a galvanizing thickness of nominal 120 gm. per SQM surface area.

2.1 Only new, fresh, clean (unsoiled) and bright GI/Aluminum sheets shall be used. The Owner / Consultants reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.

2.2 All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with Amendment-I (1971 Edition)

Longer size of Duct	Sheet Thickness GI(MM)	Type of Joints	Bracing
Up to 750	0.63	GI Flange	-
751-1000	0.80	25x25x3 mm angle iron frame with 8 mm Dia nuts & bolts	25X25X3 MM @ 1M
1001-1500	0.80	40x40x5 mm angle iron frame with 8 mm Dia nuts & bolts	40x40x5 MM @1M
1501-2250	1.00	50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.2m to be braced diagonally.
2251 & above	1.25	50x50x6 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.6m diagonally braced

2.3 Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.

2.4 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.

2.5 All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom

3 INSTALLATION

3.1 All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration

3.1.1 Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated in 'Schedule of Quantities. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in 'Schedule of Quantities'.

3.1.2 Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.

3.1.3 All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.

3.1.4 Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.

3.1.5 Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.

3.1.6 All sheets metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.

3.1.7 Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.

3.1.8. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.

3.2 During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.

3.2.1 Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.

3.2.2 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.

3.2.3 The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

3.2.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.

3.2.5 The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge. The Contractor shall verify all measurements at building and shall notify the Engineer-in-Charge of any difficulty in carrying out his work before fabrication.

3.2.6 Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.

3.2.7 All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels 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. Hanger rods shall then hang through the cleats.

3.2.8 Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.

3.2.9 All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent

supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

3.2.10 Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

3.2.11 The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

4 DAMPERS

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

5 ACCESS PANEL

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided: -

Near each smoke sensor

Any other place specifically mentioned in the drawing or if asked by Owner/Consultants during execution stage.

6 MISCELLANEOUS

Sponge rubber gaskets also to be provided behind the flange of all grills.

Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Engineer-in-Charge.

Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-Charge.

All duct supports, flanges, hangers and damper boxes etc. Shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

All angle iron flanges are to be welded electrically and holes to be drilled.

All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

7 GRILLS / DIFFUSERS

SUPPLY AND RETURN AIR DIFFUSERS

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

The diffusers shall be provided with removable central core.

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

LINEAR GRILLS:

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

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

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

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

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

EXHAUST AIR REGISTER:

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

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

MULTI SLOT CEILING DIFFUSERS:

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation.

Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

LINEAR CEILING MOUNTED DIFFUSERS:

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

FRESH AIR INTAKE LOUVERS:

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

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

8.0 MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

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

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

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

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

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

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

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

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

9 PAINTING

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

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

10 TESTING

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

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

16.0 SHEET METAL WORKS - (FACTORY FABRICATED)

1. General

1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

1.3 Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. Duct Materials

2.1 The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).

2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

Governing Standards

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

3. Raw Material

3.1 Ducting

3.1.1 All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates.

3.1.2 Galvanizing shall be of 120gms/sq.m. (total coating on both sides).

3.1.3 In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

3.1.4 The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

3.2 **Duct Connectors and Accessories**

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

3. **Fabrication Standards**

3.1 All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be Rolastar factory-fabricated or Techno Fabriduct. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.

3.2 Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

3.3 All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.

3.4 All edges to be machine treated using lock formers, flanges and roller for fuming up edges.

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

4. **Selection of G.I. Gauge and Transverse Connectors**

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

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

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

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

5. **Duct Construction**

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

6 **Dimensional Tolerances:** All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.

6.1 Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

6.2 Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.

6.3 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.

6.4 Plenums shall be shop/factory fabricated panel type and assembled at site.

6.5 Factory Fabricated ducts shall have the thickness of the sheet shall be as follows

Sl.	<u>Size of Duct</u>	Sheet Thickness	Fastner Size			Bracing with GI rods tie of following sizes	Support Angle
				For Rolastar duct & Rolamate flanges	For Techno Fabriduct and flanges		
6.5.1	Upto 750 mm	0.63 mm	3/8"	Fabricated out of G.I. sheet of 24 gauge at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	25x25x3 mm
6.5.2	751 mm to 1000 mm	0.80 mm	3/8"	E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal.			25x25x3 mm

6.5.3	1001 mm to 1500 mm	0.80 mm	5/8"	E-22 type flange, shall be fabricated out of 22 G sheet at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	40x40x5 mm
6.5.4	1501 mm to 2250 mm	1.00 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			40x40x6 mm angle
6.5.5	2251 mm and above	1.25 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			50x50x6 mm with MS rods of 12 mm dia.

6.6 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

6.7 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

6.8 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

6.9 All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

7. **Installations**

7.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

7.2 Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

7.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

7.4 The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

7.5 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

7.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

7.7 Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

7.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

7.9 Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

7.10 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

7.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

7.12 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

7.13 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

8. **Documentation to Measurements**

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

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

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

9. **Testing**

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

17.0 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.		

18.0 PIPING AND FITTINGS – SPECIFICATIONS

1 SCOPE

The scope of this section comprises the supply and laying of pipes required for chilled water; condenser water & drain water conforming to these specifications and in accordance with the requirement of the 'Technical Schedule of Equipments' and 'Schedule of Quantities'

2 WATER PIPING

MATERIAL

Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below.

<u>Chilled Water Pipes</u> <u>UPTO150MM</u> 200MM & ABOVE	MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992 Welded Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589 (LATEST)
<u>Condensate Water Pipes</u> <u>UPTO150MM</u> 200MM & ABOVE	MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992 Welded Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589 (LATEST)

All welding shall be done by qualified welders and shall strictly conform to Standard Code of practice for manual metal arc, welding of Mild Steel.

First butt weld of each welder shall be fully radio graphed by HVAC contractor under guidance of Client/Consultant for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All jobs welding shall be done by the electric arc welding process in accordance with the following: -

All joints shall have 45-degree bevel type, pipe mill-beveled or machine-beveled by the contractor.

All scale and oxides shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

GATE & GLOBE VALVES

Make: As approved shall be heavy duty non rising spindles as per IS 780, 778 and flanges as per IS 1536 and factory tested for 10Kg/ sq cm test pressure

S.No	Size	Construction	Ends
A	15 TO 40 MM	Gun metal body	Screwed
B	50 MM and above	Cast Iron Body & spindle valve, seat wedge etc., of Brass or Gun Metal	Flanged

BALANCING VALVES

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings.

15-50 mm Size: Gunmetal ASTM B-6 2 Screwed ends conforming to BS 5154
 65mm and above: Cast iron, flanged ends with stainless steel trim.

The valves shall have PTFE/SS disc with special erosion/corrosion proof sealing. The valves shall have temper proof adjustable and lockage arrangement for required water quantity after commissioning. The valves shall be complete with pressure test cock and drain cocks.

To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs to provide the following functions:-

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)

To printout saved data in computerized measurement protocol (CMP) consisting of:-

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV
- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

BUTTERFLY VALVES

Body: Cast Iron

Seat: Resilient lining moulded black nitrile rubber

Disc: SG Iron conforming to IS: 1865 SG 400/12 & BS 2789 GR 420/12 Nylon Coated

The handle shall have arrangement for locking in any position.. Valve shall be suitable for 16 Kg/Cm² working pressure.

BALL VALVES

Ball valves without Y strainers and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

NON RETURN VALVES

Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications

Size	Construction	Ends
50 to 150 mm	Body cast iron, gun metal plate	Flanged
200 to 450 mm	Body cast iron, plate carbon steel with 13% chrome overlay	Flanged

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be suitable for not less than 10 Kg per sq. cm. gage working pressure.

STRAINERS

a. Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm² and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at in let of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet / outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and included in BOQ. The strainer body shall have two

separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as detailed below:-

Size (mm)	Pot Dia. (mm)	Pot HT (mm)	Element Dia. (mm)	Element HT (mm)	MS Plate Thickness (mm)
50	300	400	200	240	6
80	350	450	250	250	6
100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8
300	1000	1105	750	580	8
350	1190	1300	895	678	12
400	1350	1500	1020	785	12
450	1518	1700	1060	890	12
500	1690	1800	1100	900	12
600	2000	2200	1500	1160	12

Each pot strainer shall be provided with a Test Certificate.

- b. All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".

AUTO AIR VENT VALVES

- a. Air vent valves shall be provided at all higher points in piping system for venting and of following sizes:-

Up to 100 mm dia pipes : 25 mm dia.

- b. Air vent valves shall be Gun metal and tested up to pressure of Class I pressure rating.

FITTINGS

The dimensions of the fittings shall conform to IS 1239/69 Part II (as per latest amendment) unless otherwise specified in specification.

All bends in sizes up to and including 150 mm dia shall be readymade of heavy-duty, wrought steel of appropriate class.

All fittings such as branches, reducers etc in all sizes shall be fabricated from pipes of same dia and thickness and length at least twice the dia of pipe.

The branches may be welded straight to main line.

Blank ends are to be formed with flanged joints and 1 mm thick blank insertion of rubber gasket between flange pair for 150 mm and over in case where a future extension is to be made

otherwise blank end discs of 6 mm thickness are to be welded on with additional cross stiffeners.

The tender drawings show schematically the size and location of pipes but this is for contractor's guidance only. Pipe runs may be changed to meet the site conditions.

3 PIPING INSTALLATION

- a. All piping work shall be carried out in workman like manner causing minimum disturbance to the existing services.
- b. Piping shall be of steel, primer coated with rust preventive paint and finished with approved shade. Pipe supports shall not exceed the following spacing: -

MAXIMUM SPACING OF PIPE SUPPORTS

Pipe Size (MM)	Spacing (Mtr)	Rod Size
25	2	10 mm
30 to 75	2.5	10 mm
100 and above	3.0	12.5 mm

Pipe hangers shall be fixed on walls and ceiling by means of metallic Raw bolts or approved shear fasteners.

- c. Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddle, anchors, clamps and hangers and be responsible for their structural sufficiency.
- d. Vertical risers shall be parallel to walls and columns. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 10 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall also have a duck foot elbow or steel support welded to the pipe at the lowest point. On risers drain valves shall be provided at heels.
- e. Pipe sleeve of 50 mm larger than the pipe diameter shall be provided wherever pipes pass through walls and the annular space filled with felt and finished with retaining rings. In case of an insulated pipe the diameter shall be inclusive of insulation.
- f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. Metal sheet shall be provided between the insulation and clamp, saddle or roller extending at least 150 mm on both sides of clamp, saddle or roller.

PRESSURE GAUGES AND THERMOMETERS

- a. *One pressure gauge each shall be provided to measure pressure at the inlet and outlet of each cooling coil, shall be not less than 100 mm Dia and shall be complete with shut off (globe) valve. Care shall be taken to protect pressure gauge during pressure testing, range shall not exceed 50% above normal measurement.*

- b. Thermometer shall be stem type and shall be provided at inlet and outlet of each cooling coil.

4 TESTING

- a. All water piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 10 kg/sq cm for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Consultant.
- b. Pipes repaired subsequent to above pressure shall be retested in same manner.
- c. Piping may be tested in section and such sections shall be securely capped.
- d. The Contractor shall ensure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipments in the system concerned. If proper circulation is not achieved due to air bound connections, the 'Contractor' shall rectify the defective connections. He shall bear all the expenses for carrying out above rectifications involving tearing up and refinishing of floor walls etc as required.
- e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Engineer in- charge at site.
- f. The contractor shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser / chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.
- g. After the piping has been installed, tested and run for at least three days of eight hours each, all un-insulated exposed piping in plant room shall be given two finish coats, 3 mills each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.
- h. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral. The contractor shall make a report conforming the above to Engineer in charge for records.
- i. The Contractor shall provide all materials tools equipments, services and labour required to perform the test and to remove water resulting from cleaning and testing.

5. BALANCING

- a. After completion of the installation, all water systems shall be adjusted and balanced to deliver water quantities as specified.

- b. Instruments required for the water balancing (computerized balancing instrument) shall be accurately calibrated in an approved manner before taking any measurements. Calibrated orifices and portable flow meters shall be used to balance the water flow. Orifices used for testing and balancing shall be installed with straight length upstream and downstream as recommended by the manufactures and shall be left permanently installed in the system.
- c. Automatic control valve and three way valves shall be set for full flow conditions during balance by procedure. Water circuit shall be adjustable by balancing cocks provided for balancing. These shall be permanently marked after balancing is completed so that they can be restored to their correct positions of disturbed.

6 PAINTING

- a. In case of pipes to be insulated after thorough anti grease and rust removal treatment, clean the pipe and then apply two coats of epoxy primer before applying in insulation treatment as specified elsewhere. All uninsulated pipes after de rusting will be provided with two coats of epoxy primer followed by epoxy paint of approved shade.

19.0 INSULATION – SPECIFICATIONS

1 SCOPE

The scope of this section comprises supply and fixing of insulation conforming to these specifications

2 MATERIAL OF INSULATION

The insulation material of following kind shall be used for insulation. The product shall have temperature range of -50°C to $+115^{\circ}\text{C}$.

2.1 Duct Work Insulation

Insulation material shall be closed cell chemically cross- linked polyethylene foam. The thermal conductivity of the insulation material shall not exceed 0.031 W/MK at an average temperature of 23°C and density shall be not less than $30+3 \text{ KG/Cubic Meter}$ (Shall be as per ECBC code-2007). Material shall have self extinguishing and non dripping property. Thickness of the insulation on ducting shall be as detailed below: -

	Conditioned Space	Unconditioned Space
1 Supply Air Duct	12 mm insulation.	20 mm insulation
2 Return Air	Nil	20 mm insulation
(a) Conditioned Exhaust Air	To be completely insulated with 12 mm thick insulation	
(b) Plenums	To be insulated from outside with 12 mm –20 mm thick insulation or lined internally with 12-50 mm thick insulation.	
(c) Fresh air duct	To be completely insulated with 12 mm thick insulation	

2.2 Application Of Insulation

The application of insulation shall be carried out as under: -

DUCT INSULATION

- a) Duct surface to be cleaned thoroughly. Apply the adhesive by brush or spray on the both surfaces of duct and insulation sheet.

- b) All joints lateral and circumferential shall be sealed with same material. The tape shall be minimum 2.5mm thick and 50mm wide.
- c) The insulation material to be finally secured with same material straps of 2.5 mm width at every 400 mm center to center.
- d) The material should not be wrapped but should be applied in segments so that the insulation does not get compressed at the edges.

3. DUCT ACCOUSTIC LINING

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

3.1 Material for Duct Lining

The material to be used for duct lining shall be 12/25 mm thick resin bonded glass wool having a density of 32 kg/cu.mt and covered with 26 gauge thick perforated aluminum sheet with at least 20% perforation. The value at 32°C shall not be less than 0.034 KCAL / HR / MTR / Deg C

3.2 Application

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

4. FIRE BREAKS INSULATION

Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

5. PIPE INSULATION

5.1 Chilled Water Pipe Insulation (Type-I : Plant Room Piping)

The insulation for chilled water piping, pump, expansion tank etc. shall be carried out from rigid polyurethane foam having a 'K' value of 0.018 W/MK at mean temperature of 10°C and a density of 27.2 to 39.9 kgs/cum. The material shall be factory faced on one side with aluminium foil on the outside, reinforced with kraft paper and fused to the insulation material. The aluminium foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints.

The aluminium foil facing shall be replaced with kraft paper facing wherever the pipe is to be covered with tar felt.

The thickness of the insulation for chilled water pipes shall be 30mm upto 250mm dia. and shall be 50mm for pipes above 300mm dia.

Preformed piped sections shall be used for pipes upto and including 350mm dia.

Pipes above 350mm dia. shall be insulated with insulation slabs cut in mitered sections.

5.2 Chilled Water Pipe Insulation (Type-II : Balance Piping)

The insulation for chilled water piping shall be carried out from flexible pipe sections/sheets of closed cell cross- linked polyethylene foam having a 'K' value of 0.031 W/mK at a mean temperature of 23°C and a minimum density of 30±3 KG/Cubic Meter.

The thickness of insulation shall be 19 mm upto 80 mm dia. and 25 mm sheets above 80 mm dia. pipes.

6. OVER DECK INSULATION

1. Clean the surface and apply a coat of Primer.
2. Apply Waterproofing membrane.
3. Loosely place Insulboard (XPS) of minimum thickness of 50mm.
4. Seal the joints with tape.
5. Cover the Insulboard with plastic film (100 micron) as vapor barrier.
6. A plastic net is then fixed over the vapor barrier over which a layer of PCC/Screed is laid to maintain proper slope.

A layer of Kota stone or cement tile or a layer of gravel can be put depending upon the requirement with suitable grouting.

7. DRAIN VALVE & PURGE VALVE

Type – Threaded, Manually operated

Material of construction – Brass of IS 6912

Air Purge valve shall be mounted on top coil header to purge out air bubbles and Drain valve at the bottom of the coil header to remove scale or dust particles settled in the bottom.

8. DRAIN PIPING:

Material of construction – Galvanised Iron of IS 1239

Drain pipes shall be connected to the drain pan from where drain water shall be taken to the nearby toilets or to the shaft going down at ground floor.

Drain pipe shall be insulated with 12 mm thick Polyurethane Foam to avoid condensation on the pipe surface. PUF has K value of 0.018 W/mK at mean temperature of 10°C and a density of 27.2 to 39.9 Kgs/cubm.

9. ACOUSTIC LINING INSIDE AHU ROOM:

The material to be used for AHU room lining shall be of 50 mm thick resin bonded glass wool having a density of 32 kg/[cu.mt](#) and covered with 26 gauge thick perforated aluminum sheet with at least 20% perforation. The value at 32°C shall not be less than 0.043 W/ MTR /K.

10. FLEXIBLE COUPLING:

Flexible couplings (at suction & discharge) with control rods shall be provided for the connection of all pumps with respective pipe headers. Flexible couplings are made up of rubber or plastic that allows for the temperature growth or axial movement.

20.0 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.

21.0 TECHNICAL SCHEDULE OF EQUIPMENTS

city/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)	

22.0 TEST READINGS**22.1 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.					

22.2 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 Δp				
Final GPM				
Voltage				
Amperage				

REMARKS

TEST **DATE** _____

BY _____

READINGS

Note : Please Furnish test report for all CHW & CDW pumps.

22.3 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.

22.4 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													

22.5 GRILLES AND DIFFUSERS TEST REPORT

PROJECT _____

SYSTEM _____

OUTLET	MANUFACTURER
1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20
21	22
23	24
25	26
27	28
29	30
31	32
33	34
35	36
37	38
39	40
41	42
43	44
45	46
47	48
49	50
51	52
53	54
55	56
57	58
59	60
61	62
63	64
65	66
67	68
69	70
71	72
73	74
75	76
77	78
79	80
81	82
83	84
85	86
87	88
89	90
91	92
93	94
95	96
97	98
99	100

TEST APPARATUS

[illegible]

REMARKS.

TEST BY _____ DATE _____ READINGS _____

Note : Please Furnish above report for all grills/diffusers with S.No. marked on respective drawings

23.0 MODES OF MEASUREMENTS

1. UNIT PRICES IN THE SCHEDULE OF QUANTITIES

- 2.1 The item description in the 'Schedule of Quantities' is in the form of a condensed resume. The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
- 2.2 THE UNIT PRICE OF THE VARIOUS ITEMS SHALL INCLUDE THE FOLLOWING:
- 2.2.1 All equipments, machinery, apparatus and materials required as well as the cost of any tests which the Consultant may request in addition to the tests generally required to prove quality and performance of the equipments.
- 2.2.2 All the labour required supplying and installing the complete installation in accordance with the specifications.
- 2.2.3 Use of any tools, equipments, machinery, lifting tackle, scaffolding, ladders etc. Required by the Contractor to carry out his work.
- 2.2.4 All the necessary measures to prevent the transmission of vibration.
- 2.2.5 The necessary material to isolate equipments foundations from the building structure, wherever necessary.
- 2.2.6 Storage and insurance of all equipments apparatus and materials.
- 2.3 The Contractor's unit price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

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

3.1 SHEET METAL DUCTS

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

3.1.3 For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

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

3.2 GRILLES/DIFFUSERS

3.2.1 Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

3.2.2 Diffusers - cross section area for airflow at discharge areas, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

3.2.3 Linear diffusers - shall be measured by cross - sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

3.2.4 Fire dampers - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel No special allowance shall be payable for extension of cross section outside the air stream.

3.2.5 Flexible connection - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

3.2.6 Exhaust Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipments. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

3.3 DAMPERS

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

4 MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

4.1 Pipes

4.1.1 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, reducers, elbows etc. Deduction shall be made for valves in the line.

- 4.1.2 The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specifications and 'Schedule of Quantities'.
- 4.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces. Wherever specified or required by the project engineer.
- 4.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter with no additional allowance being made for providing the same.
- 4.1.5 The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all through the 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 for the fittings for valves and flanges section 3.2 below applies.

4.2 Valves and Flanges

- 4.2.1 All the extra CI & CM flanged 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.
- 4.2.2 All gun metal (gate & globe) valves shall include two nos. Of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves and other welded to the MS Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp., grade and all items specified in the specifications.
- 4.2.3 The rates quoted shall be inclusive of making connections to the equipments, tanks, pumps etc. And the connection made with an installed pipe line shall be included in the rates as per the 'Bill of Quantities'.

4.3 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'.

4.4 Insulation

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centerline measurements described herewith.

- a) Pipe Insulation

This service shall be measure be measured in units of length along the centerline of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation.

It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centerline of pipe and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b) Duct Insulation and Acoustic Lining:

This service shall be measured on the basis of surface area along the centerline of insulation thickness. Thus the surface areas of externally thermally insulated or acoustically lined duct shall be based on the perimeter comprising centerline (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centerline length including tapered pieces, bends, tees, branches etc. as measured for bare ducting.

24.0 FORMATS FOR INFORMATION TO ACCOMPANY BIDS

24.1 DEVIATIONS

This is to confirm that our bid is strictly in conformity with the general conditions of the Contract, technical specifications, special conditions, bill of quantities and tender drawing except to the extent of deviation given under:

.....		
Reference	Extent of Deviation	
Section	Page	Clause No. of BID Document
.....		

1. Technical

2. Contractual

Company Seal

Signature _____

Designation _____

Company _____

Date _____

24.2 CONTRACTOR'S CONFIRMATION

1.0 SAFETY CODES

We confirm that we shall strictly follow the safety codes as given in subsection 2.3

2.0 DESIGN CONFIRMATION

- 2.1 Except for the deviation contained in enclosed format 3.1, we agree to all the conditions of the Contract, special conditions, technical specification, makes and BOQ
- 2.2 The design on which this bid is prepared has been verified by us and we guarantee to maintain the inside conditions as stipulated in the Contract documents with the system offered. We further confirm that design meets with the requirements of all government, semi-government, municipal, local and other authorities, whose permission would become necessarily for completion of the project. In our opinion the design is economical and safe and we have nothing further to suggest either by way of effecting further economy or providing additional safety.
- 2.3 The space allocation shown on the drawings for the various equipments has been checked by us and it will be possible for us to install our equipments in the space allocated.
- 2.4 Routing of ducting as shown in tender drawings is feasible and can be executed by us without any additional space requirements.
- 2.5 The technical information on the equipments / material offered by us and any other information / clarification required by you or your Consultants will be furnished strictly in conformity with the tender documents within two weeks from date of receipt of letter of intent.

**24.3 DETAIL OF WORKS OF SIMILAR NATURE &
MAGNITUDE CARRIED OUT DURING LAST 3 YEARS.**

S. N.	NAME OF WORK DONE	ESTIMAT ED COST	WHEN STARTED	WHEN COMPLE TED	DATE OF COMPLET ION AS / CONTRAC T	PERSONS TO WHOM REFERENCE MAY BE MADE
----------	-------------------------	--------------------	-----------------	-----------------------	--	--

SEAL OF COMPANY

SIGNATURE OF THE BIDDER

DESIGNATION _____

COMPANY _____

DATE _____

24.4 TRAINING OF OWNER'S PERSONNEL

1. The Vendor/Contractor shall train the Owner/Purchaser's engineering personnel in the shops, where the equipments will be manufactured and or in their collaborator's works and where possible, in any other plant where equipments manufactured by the Vendor/Contractor or his collaborator is under installation or test to enable those personnel to become familiar with the equipments being furnished by the Vendor/Contractor, either at his works or at his Sub-Vendor's/Sub-Contractor's works or at site.
2. The period of training shall be adequate and mutually agreed upon by the Owner/Purchaser and the Vendor/Contractor.
3. The training shall be so oriented as to make the Owner's/Purchaser's personnel proficient in operating the equipments.
4. The Owner's/Purchaser's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing and replacement procedures to be adopted for the equipments offered.
5. The Vendor/Contractor shall train the Owner's/Purchaser's personnel in carrying out minor repairs, if need arises, during the operation of the equipments.
6. The charges for training the Owner's/Purchaser's personnel, if any, be included in the price for supply of erection, testing and commissioning.

25.0 TECHNICAL INFORMATION **REQUIRED WITH BID**

Technical Data Shall be furnished as follows along with manufacturers Capacity charts, Catalogues and Selection Data		
1.	FAN (CENTRIFUGAL) FOR TOILET EXHAUST	
1.1.1	Manufacturer And Model No.	
1.1.2	Fan Discharge Position	
1.1.3	Double or Single Inlet	
1.1.4	Fan Impeller DIA (INCH)	
1.1.5	Forward/Backward Curved	
1.1.6	CFM	
1.1.7	Fan Speed (BHP)	
1.1.8	Motor (HP) And Speeds	
1.1.9	Static Pressure (INCH WG)	
1.1.10	Balance (Static And Dynamic)	
1.1.11	Performance Curves	
2	FAN (PROPELLER)	
2.1.1	Manufacturer And Model No.	
2.1.2	Blade Dia (INCH)	
2.1.3	CFM	
2.1.4	Fan Speed	
2.1.5	Motor (HP)	
2.1.6	Static Pressure (INCH WG)	
2.1.7	Accessories	
a)	Speed Regulator	
b)	Gravity Louvers	
c)	Bird Screen	
d)	Wire Guard	
3	FILTERS (FOR AIR HANDLING UNITS)	
3.1	Type and Material	
3.2	Gross Filter Area (SQFT)	
3.3	Velocity Through Filter (F.P.S.)	
3.4	Pressure Drop Through Filter When New (INCHWG)	
3.5	Efficiency	
4.0	INSULATION	
4.1	Manufacturer and Type	
4.2	Material	
4.3	K Value Density at 10 Deg C Mean Temp.	
4.4	Thickness	
4.5	AHU Room Insulation	
4.6	Under deck Insulation	
5.0	DUCT LINING	
5.1	Manufacturer and Type	
5.2	Material	

5.3	K Value density at 10 Deg C Mean Temp.	
5.4	Thickness	
6.0	INLINE FANS	
6.1	Manufacturer	
6.2	Type	
6.3	Capacity (CFM)	
6.4	Fan dia	
6.5	Fan make	
6.6	Fan Type	
6.7	Motor make	
6.8	Overall dimensions	
6.9	Motor Electrical characteristics	
6.10	RPM	
6.11	Operating Weight	
6.12	Noise Level	
6.13	Type of Drive	
7.0	CONTROLS	
7.1	THERMOSTAT (EACH TYP	
7.1.1	Quantity	
7.1.2	Make & Type	
7.1.3	Model No.	
7.1.4	Range and Differential	
7.1.5	Voltage Requirement	
7.1.6	Pipe insulation	
7.2	MODULATING MOTOR	
7.2.1	Quantity	
7.2.2	Make & Type	
7.2.3	Model No.	
7.3	MODULATING VALVES	
7.3.1	Quantity	
7.3.2	Make & Type	
7.3.3	Size	
7.3.4	Capacity	
7.4	OTHER CONTROLS	
7.4.1	Quantity	
7.4.2	Make & Type	
7.4.3	Model No.	
8.0	GRILLS	
8.1	Make	
8.2	Material	
8.3	Gauge	
8.4	Grills	
8.5	VCDs	
8.6	Fire Dampers	

9.0	ELECTRIC MOTORS	
9.1	Name of Manufacturer	
9.2	Type of Motor & Frame Size	
9.3	Rated Output (KW)	
9.4	Range or Working Voltage	
9.5	NO of Phases & Phase Connections	
9.6	Nominal Frequency	
9.7	Rated Speed (RPM)	
9.8	Rated Current (AMPS)	
9.9	Class of Insulation	
9.10	Temp. Rise With Ambient Air AT 40 DEG C	
9.11	Efficiency & Power Factor At	
	100%	
	75%	
	50%	
	25%	
10.0	PIPING	
10.1	PIPES & FITTINGS	
10.1.1	Manufacturer	
10.1.2	Class	
10.1.3	MS OR GI	
10.1.4	ISI Makes	
10.2	VALVES	Make & Material
	Pressure	Test Standard (IS/BS)
10.2.1	Gate Valve	
10.2.2	Globe Valve	
10.2.3	Check Valve	
10.2.4	Balancing Valve	
10.2.5	Butterfly Valve	
10.2.6	Pot Strainers	
10.2.7	'Y' Strainers	
10.2.8	Ball Valve and w/o Strainers	
10.2.9	Pot Strainers	
Note:	Contractors shall submit manufacturers test certificates of all equipments and material with delivery of respective lot	

**26.0 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

27.0 SYSTEM TESTING ADJUSTMENT AND BALANCING

1. SCOPE

- a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
- b) Testing, adjusting and balancing of HVAC Hydronic system at site.
- c) Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

ASHRAE: 1999 HVAC Application

SMACNA: Manual for the Balancing and Adjustment for air distribution System

2. PERFORMANCE

- a) Verify design conformity.
- b) Establish fluid flow rates, volumes and operating pressures.
- c) Take electrical power readings for each motor.
- d) Establish operating sound and vibration levels.
- e) Adjust and balance to design parameters
- f) Record and report results as per formats specified.

3. DEFINITIONS

Test: To determine quantitative performance of equipments.

Adjust: To regulate for specified fluid flow rates and air patterns at terminal Equipments (e.g. reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

4. TESTING, ADJUSTING AND BALANCING (TAB) PRECEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Project Manager about his ready to conduct the TAB procedures in the format given in these specifications.

5. DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems
- All chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems

6. AIR SYSTEMS

a) Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results.

- Inlet air Dry and Wet bulb temperatures.
- Outlet air Dry and Wet bulb temperatures.
- Air leaving dew point temperature
- Sensible heat Pickup
- Latent heat Pickup
- Sensible hat factor

b) Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

c) The Preparatory work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

All outside air intake return air and exhaust air dampers are in proper position.

All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

7. **HYDRONIC SYSTEM BALANCING**

The Hydronic system shall involve the checking and balancing of all water pumps. Piping network (main & branches), the heat exchange equipments like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

The essential preparation work, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

Availability of co-ordinate drawings and approved submittals and system sketch with design water flows specified thereon.

Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.

Hydronic system is vented.

The contractor shall confirm completion of the basic procedures and prepare checklists for readiness of system balance.

Check pumps operation for proper rotation and motor current drawn etc.

Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the Consultant / Project manager for approval.

8. **READINESS FOR COMMENCEMENT OF TAB**

Prior to commencement of any test, the readiness to do so should be recorded as per the prescribed checklist.

9. **TAB INSTRUMENTS**

1. Air measuring Instruments

- a) For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
- b) For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air Volume readings.

- c) Pitot tube.
- d) Electronic Rotary Vane Anemometer TSI make or equivalent.
- e) Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have NIST testification (US Institute of Science and Technology) Calibration Certificate]

2. Hydronic Measuring Instruments

For measurement of water flow differential pressure and temperature, CBI measuring instrument Tour & Anderson AB Sweden or equivalent shall be used. The instrument shall have a built-in-microcomputer capable of giving readings for pressure differential flow rate and temperature.

3. Rotation Measuring Instrument

Electronic Digital Tachometer

4. Temperature & RH Measuring Instrument

TSI VelociCalc model 8386 and VelociCalc model 8345 or equivalent.

5. Electrical Measuring Devices

Clamp on Volt ammeter
Continuity Meter

6. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipments vibration, bearing housing vibration, and other test as directed by the Project Manager.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Project Manager. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The contractor shall submit test equipments data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of Consultant / Project Manager.

5 TECHNICAL SPECIFICATIONS FOR LIFTS

TECHNICAL DATA SHEET

Hospital Block: (Bed Lift): Speed Proposed: 0.5 m/sec for both the lifts, Car height:2.2m

Sl. No.	Details	No. of Stops/ Floors	Travel Distance (m)	Lift Well Size (in mm)	Car Inside Size (in mm)	Quantity	Capacity	Speed (m/sec)
1.	G+3	4	15.8	2400 (W) x 3000 (D)	1600 (W) x 2400 (D)	2	26 Persons	0.5

Academic Block: (Passenger Lift): Speed Proposed: Car Height:2.3m

Sl. No.	Details	No. of Stops/ Floors	Travel Distance (m)	Lift Well Size (in mm)	Car Inside Size (in mm)	Quantity	Capacity	Speed (m/sec)
1.	G+2	3	11.9	1900 (W) x 1900 (D)	1300 (W) x 1100 (D)	2	8 Persons	1

Residential Block: (Passenger Lift): Speed Proposed: Car Height:2.3m

Sl. No.	Details	No. of Stops/ Floors	Travel Distance (m)	Lift Well Size (in mm)	Car Inside Size (in mm)	Quantity	Capacity	Speed (m/sec)
1.	Staff Acco. G+6	7	22.4	2500 (W) x 1900 (D)	2000 (W) x 1100 (D)	2	13 Persons	1
2.	Girls/ Boy's Hostel G+7	8	25.6	2500 (W) x 1900 (D)	2000 (W) x 1100 (D)	4	13 Persons	1

TECHNICAL SPECIFICATIONS

1. **Sizes:**
For all lifts: Lift well size, Car size, Car opening as per Technical Data Sheet

2. **Drive:** Variable voltage variable frequency drive

3. **Material:**
 - a. Car walls shall be made up of stainless steel (minimum 1 mm thick) with Moon rock / Etched pattern/ Honey Comb finish and car ceiling shall be made of stainless steel with 'Hairline' finish.

 - b. Floor: 2mm thick anti skid PVC tiles flooring for all Lifts (Passenger & Bed Lifts).

4. **Ventilation:**

Suitable no. of fans with steel grills shall be provided inside the car. Separate inverters of suitable capacity with maintenance free batteries shall be provided in each machine room. The same inverter shall feed the lighting & alarm bells of the lifts also which are housed in this machine room.

5. **Lighting:**

Each car shall have a minimum of 4 Numbers LED fittings for lighting suitable to provide 200 lux in the car.

6. **Car Position Indicator:**

Digital car position indicator shall be provided inside the car at a height of at least 2000 mm from floor level.

7. **Car Operating Panel:** Car operating panel shall have the following:
 - i. Key operated switch marked to indicate 'attendant' / automatic operation.
 - ii. Micro stroke push buttons for each floor.
 - iii. Emergency stop push button.
 - iv. Emergency alarm push button.
 - v. Up / Down direction push buttons.
 - vi. Non-Stop push button.
 - vii. Overload warning audio visual indicator.
 - viii. Suitable press & speak intercom for communication from the car to respective machine room and control room at ground floor.
 - ix. Door open and door close push buttons.
 - x. Suitable emergency light with maintenance free battery with suitable battery charger.
 - xi. Telephone outlet: One plug in socket in lift car with necessary cable pair in trailing cable and the terminal outlet provided in machine room.

8. Lift instructions:

Steel plate containing following instructions shall be provided inside each lift car:

- i. Lift number _____
- ii. Capacity _____ Kg, _____ persons.
- iii. No smoking.
- iv. Operate push buttons/ switches correctly.
- v. Do not lean against the lift door.
- vi. Watch before stepping out.
- vii. Do not panic in the event of break down. Press alarm button & follow instruction of the authorized staff.

Steel plate containing following instructions shall be provided / outside each lift car, on all floors:

- i. Lift number _____
- ii. Capacity _____ Kg, _____ persons.
- iii. Please stand in 'Q'.
- iv. Smoking not permitted inside the lift car.
- v. Passenger travel at their own risk.
- vi. Please keep the lift neat and clean.
- vii. Do not force open the landing door.
- viii. Watch before you step into and out of the lift car.
- ix. Heavy article/ luggage not allowed. (only outside the passenger lifts)
- x. Avoid use of lift during fire.
- xi. Complaints if any may be sent Assistant Engineer (Electrical).

9. Car Door:

Horizontal sliding, power operated (AC/ DC gearless), stainless steel doors with Moon rock / Etched pattern/ Honey Comb finish, operation of door shall be automatic & car door shall have re-opening arrangement by electronic door detectors / Infrared curtain covering the entire width & height of the door and door pressure limiter as secondary door safety..

10. Landing door:

Stainless steel door with Moon rock / Etched pattern/ Honey Comb finish with centre opening/ side opening, power operated horizontal sliding doors (matching with the respective car door). The landing door and car door shall be mechanically connected so as to open or close simultaneously.

The landing door shall have fire rating of ONE hour.

11. Sill Projection:

Necessary sill projection of M.S. shall be provided by the firm along with facia plate as required as per relevant code.

12. Control & indicators on landings:

- a. Two number Micro stroke push buttons (One with 'UP' arrowhead & other with 'DOWN' arrowhead) for all intermediate landings and Single Micro stroke push button (with 'UP' / 'DOWN' arrowhead) for terminal landings.
- b. Hall lantern to indicate the Up / Down direction of motion of lift at the time of car's arrival along with electronic chime, separate for each lift.
- c. Digital car position indicator at all landings separate for each lift.
- d. Alarm bell, separate for each lift, at ground floor landing with stainless steel cover and shall be fed from inverter.
- e. Fireman's switch (toggle switch) at ground floor landing with break glass cover, separate for each lift.

13. Motor:

Motor shall be squirrel cage induction motor with high starting torque, insulation class – 'F'.

14. Electrical protection:

Suitable protection to protect the machine against phase reversal and failure of any one phase shall be provided. Over current, under voltage, over voltage and earth leakage protection shall also be provided.

15. Electrical wiring and cabling:

All electrical wiring shall be with copper conductor wire with flame resisting, moisture proof insulation and will run in heavy gauge metal conduit/ G.I. casing. The trailing cable between the car and lift well will be multi core type, designed for lift services and will have flame resisting, moisture proof covering. Cables should be with ISI mark. All wiring and earthing etc. shall conform to IE Rules and Regulations.

16. Leveling accuracy:

Every lift car shall stop at landing (other than car switch control) with car sill fairly in level (+ 5 mm) with landing sill.

17. Counter weights:

All counter weight sections shall be carried in a structural steel frame and secured by at least two tie rods passing through holes in all the sections. The factor of safety of counter weight sections of wrought iron and steel shall not be less than five. All counter weights shall be of metal and shall travel between rigid guide rails. (Note: Manufacturer's test certificate will have to be supplied)

18. Terminal buffers:

Terminal buffers shall be installed as a means of stopping the car and counter weights beyond the limits of travel as per Lift Rules and shall be spring or oil buffers. Buffers in the pit shall be mounted on steel channel or on suitable concrete blocks.

19. Guide:

Steel 'Tee' section guide shall be provided for the car and counter weights. At least the guides for the car shall be machined.

20. Safety gear and over speed governor:

Every lift shall be provided with one or more safety devices, attached to the lift car. The safety devices shall be capable of stopping and sustaining the lift car with full rated load in the car at governor tripping speed. Each lift shall be equipped with an over-speed governor device which operates to apply the safety gear in the event of the speed of the lift car in the descending direction exceeding a predetermined limit.

21. Ropes:

Chain shall not be used for the suspension of a lift. Not less than three independent suspension ropes shall be used for car or counter weights of any lift. The minimum diameter of the ropes for cars & counter weights of passengers and goods lifts shall be 12mm. The factor of safety of suspension ropes shall not be less than 11. (Note: Manufacturer's Test Certificate will have to be supplied)

22. Automatic rescue device:

ARD shall provided to move the car automatically (with the help of maintenance free battery) up /down to bring it to the nearest landing in case of failure of power supply.

23. Lift Announcement:

The lift shall be provided with floor announcement system with volume control.

24. Load weighing device:

Elevator shall be provided with load weighing device, overload indicator and announcement in the car as mentioned above. The car doors will not close in case the overloading.

25. Steel Ladder: A Steel ladder should be provided in the pit.

26. Vibration Isolation:

Vibration isolation arrangement shall be provided to prevent transmission of vibration to the building and structure.

27. General:

- a. Work shall be carried out as per CPWD specifications unless otherwise specified.

- b. All lift equipment and installation shall conform to the relevant IS Standards, as under:

Outline dimensions	IS 14665 (Part 1): 2000
Installation, operation and Maintenance	IS 14665 (Part 2): 2000
Safety rules	IS 14665 (Part 3): 2000
Components	IS 14665 (Part 4): 2000
Flexible cables	IS 4289 (Part 2): 2000

And list of IS codes for Lift installations applicable is given below:

- | | |
|--|----------|
| 1. Code of Practice for installation, operation and Maintenance of electric passenger & goods lifts. | IS-1860 |
| 2. Code of Practice for installation, operation and Maintenance of electric service lift. | IS-6620 |
| 3. Specification for electric passenger & goods lifts | IS-4666 |
| 4. Electric service lift. | IS-6383 |
| 5. Online dimension for electric lifts | IS-3534 |
| 6. Code of practice for installation and maintenance | IS-4591 |
| 7. Specification for steel wire suspension ropes for lifts & hoists. | IS-2365 |
| 8. Glossary of terms relating to wire ropes | IS-2363 |
| 9. Specification for lifts cables | IS-4289 |
| 10. Glossary of terms for electrical cables & conduits | IS-1591 |
| 11. Specification for rubber insulated cables | IS-434/1 |
| 12. Specification for varnished, cotton cloths & tape for electrical purpose | IS-3352 |
| 13. Specification for lift door locking devices and contracts | IS-7759 |
| 14. Specification for hot rolled and slit steel bars | IS-1173 |
| 15. Method of loading rating of worm gear | IS-7443 |
| 16. Code of practice for selection for selection of standard worn and helical gear box | IS-7403 |
| 17. Isometrics screw threads | IS-4218 |
| 18. Degree for protection provided by enclosure for low voltage switchgear and control gear | IS-2147 |
| 19. Specification for HRC cartridge fuse links upto 650 volts. | IS-2208 |
| 20. Code of practice for electrical wiring installation (system voltage not exceeding 650 volts). | IS-732 |
| 21. Voltage & frequency for AC transmission & distribution system | IS-5850 |

- | | |
|---|----------|
| 22. Specification for AC contractors voltage not exceeding 1000V | IS-2959 |
| 23. Heavy duty air break switched & composite unit of air break | IS-4047 |
| 24. switches & composite unit of air break switches and fuses | |
| 25. for voltage not exceeding 1000 volts. | |
| 26. General requirements for switch gear & controller for voltage | IS-4237 |
| 27. not exceeding 1000 volts. | |
| 28. Specification for motor starter of voltage upto 650 V | IS-1822 |
| 29. Nomenclature of floors & storeys | IS-2332 |
| 30. Code of practice for sound insulation of non industrial building | IS-1950 |
| 31. Code of practice for installation & maintenance of inducting motors | IS-906 |
| 32. Specification for three phase induction motor. | IS-235 |
| 33. Guide for testing three induction motor | IS-4029 |
| 34. Specification for degree of protection provided by enclosure | IS-4691 |
| 35. for rotating electrical machinery | |
| 36. Designation of method of cooling for rotating electrical machines. | IS-6362 |
| 37. Classification of insulating materials for electrical machinery and | IS-1271 |
| 38. apparatus in relation to their thermal stability in service. | |
| 39. Code of practice for earthing. | IS-3043 |
| 40. Electrical installation fire safety of building | IS-1646 |
| 41. Code of practice for the protection of buildings and allied | IS-2309 |
| 42. structures against lightning | |
| 43. Specification for hoist way door locks | IS-7754 |
| 44. Rules for the design, installation, testing and operation of the | IS-1735 |
| 45. lifts, escalator and moving parts. | |
| 46. Electrical Traction Lift. | IS-14665 |
- c. Suitable scaffolding in the hoist way, cutting work and all minor civil works, if any, required shall be done by the firm without any extra cost.
- d. All steel items in machine room and hoist way shall be provided by the firm without any extra cost. However, lifting arrangement in the lift machine room shall be provided by MOHFW/HLL.
- e. After handing over of the site to the firm, all the landing door openings shall be suitably protected by the firm to avoid any miss happening.
- f. All exposed metal parts will be painted with good quality anticorrosive paint after erection and before commissioning of the lift.

6 TECHNICAL SPECIFICATIONS FOR BMS

1.0 SYSTEM DESIGN DATA

1. GENERAL

The details given in this part describe the design, brief outline of the equipment and other general requirement of the system. The specific requirements are given separately. The subsequent parts lay down the specifications of different components as required for a complete installation.

2. LOCATION

The proposed Microprocessor Based Building Management System (BMS) is to be supplied and installed at the Proposed National Institute of Allied Health Sciences, at Najafgarh New Delhi.

3. SCOPE OF WORK

- 3.1 The scope of work consists of supply, installation, testing & commissioning of Building Management System (BMS) for the Control of HVAC Systems, Lifts, Water Supply (WTP) & Fire Fighting Systems, Internal & External Lighting System, DG sets, HT & LT Panels etc.

4 BUILDING MANAGEMENT SYSTEM

- 4.1 It is proposed to install a comprehensive integrated Microprocessor based “Distributed Digital Control (DDC)” and “Building Management System (BMS)”.
- 4.2 The BMS shall use a series of Dedicated Controllers, located in different parts of the Building to perform the following functions:
- 4.2.1 Provide a common data base for all the Systems.
- 4.2.2 To provide for energy management and control.
- 4.2.3 To control the HVAC System with regard to requirement and its control, both at the High Side and Low Side points.
- 4.2.4 To operate HVAC equipments prior to occupation of areas so as to condition the areas suitable for specified comfort levels.
- 4.3 The various controllers shall be connected to a PC in the control room / Server room. The PC shall have software for Dynamic Graphics to display the status of various services, beside capacity to write programmed logics and down loading them, to the sub controller.

5. **ITEMS TO BE PROVIDED BY OTHER AGENCIES**

- 5.1 The following items of works shall be provided through other agencies.
- 5.2 Provision of main 3 phase 4 wire 50 Hz, 415 V supply shall be given at one point through the main UPS.
- 5.3 All works related to fixing of motorized valves in ducts, pipes, sensors in sockets shall be carried out by the contractor.

6. **CUSTOM DUTY**

All customs and countervailing duties as regular leviable on imported Items shall be included by bidder in their quoted prices. All charges for clearance, handling and delivery of the imported equipment up to the site, shall also be included.

7. **FOREIGN EXCHANGE**

The contractor shall make his own arrangement to provide the foreign exchange and permits, as required, for the import of various items of foreign origin.

8. **TEST DATA**

The System shall be tested and made fully functional as per specifications given elsewhere and complete test and performance data shall be furnished on prescribed data sheet.

9. **PERFORMANCE GUARANTEE**

The contractor shall guarantee that the proposed systems shall fulfill all the requirements as described herein and/or are considered necessary to provide a fully automatic, operator free operation of the connected systems.

The contractor shall guarantee that the various components as well as the whole system shall perform as specified.

10. **DEVIATIONS FROM SPECIFICATIONS**

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

2.0 SYSTEM CONFIGURATION

1. GENERAL

- 1.1. The proposed system shall perform all the functions, which are listed herein.
- 1.2. It shall carry all such other tasks, as may be found necessary to fulfill the operational requirements and the intent and purposes as defined whether specified or not.

2. CONTROL OF SUB SYSTEM

- 2.1. The proposed system shall be configured to provide a completely automatic and “HANDS FREE” operation of all the system being controlled.
- 2.2. The system shall be capable of monitoring Historical performance and fault data for proceeding 12 months period.
- 2.3. The system shall use the Historical data to generate, weekly, monthly, quarterly and annual maintenance schedules and guides. These guides shall be based on the maintenance requirement provided by the Contractors/ Manufactures of various connected systems.
- 2.4. A brief outline of the functions to be performed are listed here in. Detailed control logics are described later on.

2.5 HVAC Functions

- 2.5.1 Sequential start/stop of the whole HVAC System.
- 2.5.2 Duty cycling to operate all the equipments including, standby equipment for equal duration.
- 2.5.3 Automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit.
- 2.5.4 Activating/deactivating water valves to start/stop water flow through chiller circuits.
- 2.5.5 Programmed start/stop of individual AHU as per operating requirements.
- 2.5.6 Maintaining design inside conditions within specified limits as per designated programme by operating necessary controls and 2 way water valves.
- 2.5.7 Automatic change over from the heating to cooling cycle & vice-versa.
- 2.5.8 Automatic change over from the day cycle to night cycle.
- 2.5.9 Integrating the operation of variable speed drives of Secondary pumps to match the requirement.

2.6 **Lighting functions**

2.6.1 On/OFF operation of External & Internal lights on a timed basis.

2.6.2 ON/OFF lights in all the halls, lobbies, conference rooms etc.

2.7 **Water Services Functions**

2.7.1 To fill up the underground and overhead storage tanks based on signals of the level switches.

2.7.2 Duty cycling of water pumps to ensure equal run time for all pumps.

2.7.3 Starting of the standby pump in case of failure of the operating or scheduled pump and displaying fault alarm status of the tripped pump.

3. **Monitoring Of Sub Systems (Only Lt Side Voltage Will Be Monitored)**

3.1 The BMS shall monitor all the sub system being operated by it, as listed above.

3.2 In addition it shall monitor the following electric equipments and shall provide alarm whenever the actual values are outside the acceptable range.

3.2.1 Total Power consumption using KWH Transducers.

3.2.2 ON/ OFF /Fault status of D.G. Sets.

3.2.3 Performance of D.G. set including Voltage, current, output, PF etc. using an Electronic energy meter.

3.2.4 Voltage of D.G. Set Batteries.

4. **Control Logic (Main Chiller Plant)**

The proposed system shall be capable of performing the following functions.

4.1 Automatic and Sequential start/ stop of the various HVAC equipments, based on agreed time schedule. It shall use the Ambient Temperature as a guide to decide the lead time necessary to make the space comfortable, when occupants come to work.

4.2 There shall be provision to extend the working time in the evening, if required in a part or whole of the building.

4.3 It shall be possible to initiate the startup of the operating Cycle on Holidays by simple startup of any of the Air handling units.

4.4 All the air handling units will also be started at the designated time in the morning and shut down in the evening.

4.5 The outlets of Water Cooled condensers and chillers will have motorized shutoff valves, so that when a chiller is not operating, the valves shall be closed, to isolate the chiller.

- 4.6 Each Water Cooled condenser & Chiller (where used) shall have differential pressure switch to monitor the water flow.
- 4.7 The Pumps shall have a differential Pressure Switch (DP) to indicate the Water flow.
- 4.8 In each circuit the standby pump will be duty cycled to ensure equal run time for all pumps. In case of failure of the designated pump to operate, then the next pump in circuit will be energized and alarm status shall be displayed for the failed equipment.
- 4.9 A signal from the FDS shall be utilized to close the Fire Dampers and the AHU of the effected floor only in case of fire.
- 4.10 The same signal shall also be used to shut off the AHUs (but not the Fire Dampers) of one floor above and one floor below the effected floor in case of fire.
- 4.11 When the Fire Alarm is cleared, all the AHUs on the floor above and below of the effected floor, shall be restarted automatically.
- 4.12 However, on the affected floor instructions shall be flashed on the PC to reset the Fire Damper and thereafter the AHUs shall be restarted automatically, from the PC.

5. **AIR HANDLING UNIT (AHU) LOGIC**

- 5.1 Each AHU shall have a Return air Temperature Sensor.
- 5.2 The sensor shall modulate the flow of water to the coil through a 3 way modulating control valve.
- 5.3 A Differential Pressure Switch shall indicate the operating status of the fan and also the dirty filter status of air filter.
- 5.4 A digital output will switch ON/OFF the AHU as per the Logic of main plant.

6. **COOLING/HEATING CHANGEOVER (LOGIC)**

- 6.1 The changeover from cooling to heating cycle shall occur when the ambient temperature drops below 15 °C.
- 6.2 In heating mode all the A.C. equipment, except chilled water pumps shall be switched off and Isolated through motorized valves.
- 6.3 The Hot Water boilers will be activated to circulate Hot Water, using the Chilled Water Pumps.

7. **CONTROL LOGIC VENTILATION SYSTEM (KITCHEN)**

- 7.1 The system shall start the ventilation system for Air Washer (fresh air) & Scrubber (exhaust) when kitchen starts in the morning.

8. CONTROL LOGIC (LIGHTING)

- 8.1 The Internal lights shall be switched ON in the morning and switched off in the evening.
- 8.2 The ON and OFF timings of internal lights shall be programmed according to office hours.
- 8.3 The external lights shall be switched ON in the evening and switched off in the morning.
- 8.4 The ON and OFF timings of external lights shall be programmed according to the changing night time hours during summer and winter, after dividing them in 4 quarterly segments.

9. CONTROL LOGIC WATER SERVICES

- 9.1 The various water service pumps shall be switched ON and OFF according to the signals of the float switches in the underground and over head tanks.
- 9.2 The working and standby pumps shall be rotated on a daily basis to provide equal runtime to all pumps.
- 9.3 In case of failure of the working pumps, the other pump shall be activated and alarm raised to rectify fault.
- 9.4 The overflow line from the overhead tanks shall be provided with flow switches, to indicate failure of float switch in stopping water flow and raise alarm.

10. ENERGY MANAGEMENT (ELECTRIC SUPPLY)

- 10.1 A KW/HR Transducer shall be provided in the Incoming main circuit breaker, to measure the electric consumption.
- 10.2 Arrangement shall be made to separately measure the power supply from UPSEB and D.G. sets both for the Service equipments and offices.

11. MONITORING (ELECTRIC SERVICES)

- 11.1 The various Electric equipments in the Data Point summary are only to be monitored, for proper functioning and reporting of fault.
- 11.2 These are H.T. supply, D.G. set supply and Health of the D.G. set etc.

12. MONITORING (FIRE SERVICES)

- 12.1 The Fire Pumps, and sprinkler functioning are to be monitored as per Data Point Summary.

3.0 BUILDING MANAGEMENT SYSTEM

3.1 DESCRIPTION

This section defines the Basic Materials and Methods used in the installation of Lon Works/BACnet Control products to provide the functions necessary for control of the mechanical systems on this project.

- A. Provide a Facility Management and Control System incorporating Lon Works /BACnet, Direct Digital Control, equipment monitoring, and control consisting of microprocessor based plant control processors interfacing directly with sensors, actuators, and environmental delivery systems (i.e. HVAC units); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, sensing devices; a primary communications network to allow data exchange between microprocessor based devices. The system shall use EIA Standard 709.1, the Lon Talk protocol or BACnet as the communication protocol from node to node and from nodes and operator workstations.
- B. The system will consist of a flat, open architecture that utilizes the Lon Talk /BACnet 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, Lon Talk/BACnet 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/ BACnet protocol into IP datagram's shall conform to existing Lon Mark/BACnet 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.
- C. The system network shall be an Echelon Local Operating Network (LON) or BACnet. All nodes shall communicate with each other over one or more channels utilizing one of the LonMark approved transceivers (Type 1 – FTT-10A, Type 2 – Twisted Pair) or /BACnet over TCP/IP & MSTP network .. There will be no consideration given to any system that does not use LonWorks/BACnet as the primary communications network. System controllers shall be capable of sharing standard network variable data with other LonWorks/BACnet based devices that utilize the same transceivers.
- D. System controllers shall utilize either the Echelon's 3120 or 3150 Neuron microprocessor or 32 bit High performance processor for network communications. "Hosted" controllers that utilize a 3rd party chip coprocessor for communications are not acceptable. Controllers shall be capable of accepting control programs downloaded over the LON/BACnet
- E. The system installed shall be able to seamlessly connect devices other than HVAC throughout the building regardless of subsystem type, i.e. HVAC and lighting shall coexist on the same network channel without the need for gateways. These components shall share common software for network communications, configuration, time scheduling, alarm handling, history logging, custom programming and monitoring.

- F. Gateways shall not be used unless authorized in writing by the consultants. Use of a gateway requires submittal of the documentation as required by the owner or owner's representative. It is the intent of this specification that gateways be limited to integrating legacy systems where applicable. Acceptance of gateways is at the sole written discretion of the owner and consultants.
- G. System Monitoring and Supervisory Control shall be provided through the installation of a GUI (Graphical User Interface) software application that supports a direct driver to the LonWorks/BACnet database and is fully compliant and compatible with the LonMaker/BACnet Network Editor that is used on campus. The GUI workstation shall provide complete access to any point in the system at any time. The GUI shall be able to directly support LNS based discreet controller "plug-in" configuration modules as supplied by the device manufacturers. Remote Operator interfaces and configuration tools shall be supported in a client-server fashion.
- H. The control system shall be able to accommodate multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. All operator functions shall be recorded by an audit trail resident on the GUI platform.
- I. 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/BACnet, 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.
- J. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown or as implied in the contract documents.
- K. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.
- L. Lon Works/BACnet components not supplied by the primary manufacturer shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.
- M. All system controllers shall utilize a peer-to-peer communications scheme to communicate with each other and with the PC-type monitoring computer(s).
- N. Controllers shall contain non-volatile memory for storage of control programs, configuration, time schedules, and historical log data. All such data shall be retained in the event of a power failure. System controllers shall have an onboard, battery-backed

real-time clock to ensure correct time-of-day operation following a power failure. Terminal Device Control Units controllers (VAV's, Heat Pumps, etc) shall be peers on the network and be able to synchronize data from plant controllers upon network power up.

- O. History data logging and alarm detection shall be attained from all LonWorks/BACnet controllers in the network, including third party LonWorks /BACnet devices from alternate manufacturers. This data shall be monitored in the user interface software.
- P. Controllers shall use a software mechanism for network addressing and Identification. It shall not be necessary to set physical network address switches on each controller.
- Q. System shall utilize LonMark/BACnet defined standard network and command protocol Types (implicit messaging) for all data including, but not limited to, physical input and output values, input and output overrides, as well as general purpose input and output values used by the controller's control program. The utilization of explicit messaging or protocol converters shall not be acceptable unless approved in writing by the owner representative prior to bid.
- R. Individual products shall conform whenever possible to the LonMark /BACnet Interoperability Standards. If products are not certified by the LonMark/BACnet organization, product submittals must include the application source code, external interface file, resource files and complete documentation regarding all LonMark/BACnet Objects, network variables and configuration properties supported by the device.
- S. Products shall be provided with complete documentation. This shall include diagrams of all LONMARK/BACnet objects supported by the product as well as relevant technical specifications. Undocumented products must be tagged and accepted by the Architect or Engineer prior to installation. Do not install undocumented products without such acceptance.

3.2 RELATED WORK

- A. The installation of motor starters that are not factory-installed, thermal overload switches, and power wiring to motors, starters, thermal overload switches, and contactors, is specified in another Division. This Section includes the furnishing and installation of controls and wiring for automatic controls, electric damper and valve operators, terminal control units, interlocks, starting circuits, and wiring to power consuming control devices.

3.3 DEFINITIONS

Algorithm: A logical procedure for solving a recurrent mathematical problem.

- A. Analog: A continuously varying signal value (temperature current, velocity, etc.).
- B. Application Specific Device: A device that is furnished with a pre-established built in application that is configurable but not re-programmable.

- C. Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.
- D. Control Wiring: This includes conduit, wire, and wiring devices to install complete HVAC control systems, including motor control circuits, interlocks, sensors, PE and EP switches, and like devices. This also includes all wiring from node to node, and nodes to all sensors and points defined in the I/O summary shown on drawings or specified herein, and required to execute the sequence of operation. Does not include line voltage power wiring.
- E. Diagnostic Program: Machine-executable instructions used to detect and isolate system and component malfunctions.
- F. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer.
- G. Gateway: A device that contains an input/output (I/O) software driver to translate input data from one format to output data in a second format.
- H. Human-Machine Interface (HMI): Human-machine interfacing allows the operator to manage, command, monitor, and program the system.
- I. HVAC Control Systems: The complete LonWorks®/BACnet control system, comprising the user interface and routers, gateways, repeaters, nodes, the operator workstation, software, portable operator terminals, network communications wiring and raceways, and required field hardware, etc.
- J. Integration: Establishing communication between two devices through the use of a gateway.
- K. Interoperable: Establishing communication between two devices through the use of a common protocol and without the use of any gateways.
- L. LonTalk™: Open communication protocol developed by the Echelon Corporation
- M. LonWorks®: The overall communications technology for control systems developed by Echelon Corporation. The technology employs routers, gateways, bridges, and multimedia transceivers to permit topology and media- independent control solutions.
- N. LONMARK® Interoperability Association: Standards committee consisting of numerous independent product developers and systems integrators dedicated to determining and maintaining the interoperability guidelines for the LONWORKS® industry.
- O. LonMarked™ - device has been certified for compliance with LonMark standards by the LonMark association.
- P. LonWorks® Application Specific Nodes (LASN) - a networked device or node that contains a complete, configurable application that is specific to a particular task.

- Q. LonWorks® Programmable Nodes (LPN) - a programmable control product that incorporates solid-state components based upon the Neuron® chip to perform control loops or functions. The application in the controller is custom software produced by the integrator specifically for the project.
- R. LonWorks® Single Point Nodes (LSPN): devices such as temperature and humidity sensors, that have an on-board Neuron microprocessor and network interface allowing them to communicate on the LonWorks® network.
- S. Network: A system of distributed control units that are linked together on a communication bus. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location.
- T. Node: A LonWorks® device with a neuron chip and LonTalk transceiver.
- U. Operating System (OS): Software that controls the execution of computer programs and which provides scheduling, debugging, input/output controls, accounting, compilation, storage assignment, data management, and related services.
- V. Operator Workstation (OW): The OW consists of a high-level processing personal computer that provides graphic user interface to network.
- W. Peripheral: Input/Output (I/O) equipment used to communicate to and from the computer and make hard copies of system outputs and magnetic files. Peripherals include CRTs, printers, hard drives, disk drives, and modems, etc.
- X. Portable Operations Terminal (POT): Permits remote operator interface to facilitate network management, node commissioning, diagnostics, and general operator interface .
- Y. Programmable Device: A device that does have a pre-established built in application. An application creation software tool is required for an application to be created and downloaded to the device.
- Z. Router: A device that routes messages destined for a node on another segment sub-net or domain of the control network. The device controls message traffic based on node address and priority. Routers shall also serve as communication links between powerline, twisted pair, fiber, coax, and RF media.
- AA. XIF: “External Interface File” contains the contents of the manufacturer’s product documentation.

3.4 SUMMARY OF WORK

- A. Provide LonWorks/BACnet based products that communicate on multiple channels to meet the functional specifications as indicated on the Drawings and the dedicated product functional specifications and profiles specified in other sections.

- B. Provide LonTalk/BACnet routers as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.
- C. The BAS Contractor shall utilize Performance Calculations to simulate all network traffic in advance to minimize field troubleshooting prior to installation of network control devices. Additional routers and/or repeaters shall be installed by the contractor to maintain acceptable network traffic.
- D. The BAS Contractor shall utilize a LonWorks/BACnet protocol analyzer tool to monitor network traffic on all installed control channels for a minimum of 24 hours per channel after final installation. The BAS contractor shall reconfigure nodes and/or install additional routers as necessary to maintain traffic to less than 50% of channel bandwidth capacity.
- E. Provide Intelligent Devices (ID's), Programmable Control Units (PCU's), and Terminal Device Control Units (TDCU's) as herein specified, as needed to perform functions indicated in the input output summaries and sequences of operation, and/or indicated on the HVAC drawings.
- F. Provide wire, raceway systems, 24 DC and/or 24 AC power supplies and final connections to nodes provided by this contract and the following Control Units to meet or exceed all pertinent and applicable codes.
- G. The BAS Contractor shall provide all controls, sequences of operation, and systems monitoring as required by these specifications and by the drawings. Provide all required devices, sensors, hardware, software, wiring, controllers, etc.

3.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION.

- A. Control Valves
- B. Sensor Wells
- C. Control Dampers

3.6 QUALITY ASSURANCE

- A. General: The HVAC Control System shall be furnished, engineered, installed, tested and calibrated by factory certified technicians qualified for this work.
- B. Reference Standards
 - 1. Control system components shall be new and in conformance with either of 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)
 - iv. BACnet (Building Automation Control Network)
- C. Products

- a. Utilize standard components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.
- b. All products (PCU's, TDCU's and ID's) shall contain Lon Works/BACnet networking elements to allow ease of integration of devices from multiple vendors.
- c. 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.

3.7 SUBMITTALS

A. General: Submit the following according to conditions of Contract and Division 15 sections. In addition, provide the following:

- 1 Product data on all components used to meet the requirements of the specifications such as enclosures, network transceivers, XIF documentation, configuration parameter options, mounting details, power supplies, etc.
2. Software documentation regarding the proposed PC operating system third party utilities and application programs, and the proposed application program for the Control Units.
3. Mechanical system served by the HVAC Control System. Indicate and Tag each input/output served by each Control Unit or Intelligent Device.
4. Submit 3 sets of submittals for review within 3 weeks of contract award.

B. Shop Drawings

1. The controls contractor shall submit AutoCAD generated schematic drawings for the entire control system for review and approval before work shall begin. Included in the submittal drawings shall be a one-page diagram depicting the complete system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start- stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.
2. The submittals shall include manufacturer's catalog data describing each item of control equipment or component provided and installed for the project.

3.8 OPERATION AND MAINTENANCE MANUALS

- 1 Include the following documentation:

2. Maintenance Instructions: Document all maintenance and repair/ replacement procedures. Provide ordering number for each system component, and source of supply. Provide a list of recommended spare parts needed to minimize downtime.
3. Documentation of network variables, network node configurations, priority interrupts, node binding, addressing structure, etc.

3.9 INSTRUCTION OF OWNER OPERATING PERSONNEL

- A. All training shall be by the HVAC Controls Contractor and shall utilize specified manuals, as-built documentation, and the on-line help utility.
- B. Operator training shall include 2 initial eight-hour sessions or, if the owner desires this time may be allotted differently. The initial operator training program shall be to establish a basic understanding of Windows based software, functions, commands, mouse, etc. The training shall encompass as a minimum:
 1. Troubleshooting of input devices, i.e., bad sensors.
 2. Sequence of operation review.
 3. Sign on - sign off.
 4. Selection of all displays and reports.
 5. Commanding of points, keyboard and mouse mode.
 6. Modifying English text.
 7. Use of all dialogue boxes and menus.
 8. System initialization.
 9. GUI Software.
 10. Lon Maker /BACnet Network Management Software.

3.10 ACCEPTANCE PROCEDURE

- A. Upon completion of the installation, Contractor shall start-up the system and perform all necessary calibration and testing to ensure proper operation of the project control systems.
- B. Schedule a hardware demonstration and system acceptance test in the presence of the Contracting Officer and/or the Engineer. The acceptance testing is defined as demonstrating the sequence of operation as indicated in the drawings. The hardware demonstration is specified in this Section. The Contractor shall perform all tests prior to scheduling the acceptance test and hardware demonstration to insure the overall system is ready for inspection and observations.
- C. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and be deemed substantially complete as defined in Division 1.

3.11 OWNERSHIP OF PROPRIETARY MATERIAL

- A. The owner shall retain all rights to software for this project.
- B. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of Trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to:
 - 1. Project graphic images
 - 2. Record drawings
 - 3. Project network database
 - 4. Project-specific application programming code
 - 5. All documentation.

3.12.1 WARRANTY

- A. The HVAC Control System shall be free from defects in workmanship and material under normal use and service. If within twelve (12) months from the date of substantial completion, the installed equipment is found to be defective in operation, workmanship or materials, the building systems contractor shall replace, repair or adjust the defect at no cost.
- B. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.
- C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

3.13 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Do not install electronic hardware in the project until non-condensing environmental conditions have been established. Products installed in violation of this request will be replaced at no additional cost to the project.
- B. Coordinate storage requirements for factory mounted terminal control units on air terminal devices, air handling units or other packaged control equipment. Do not store control units on site in non-conditioned areas.
- C. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

PART 2 – PRODUCTS

3.2.1 NETWORKS

- A. The system architecture shall as a minimum support the following levels.
1. Support's 9.6, 38.4, 76.8kbps/ 78kbyte FTT 10 channels for operating nodes.
 2. 10/100 MB high speed bus to tie together multiple 78kbyte FTT 10 channels.
 3. IP (via network interface card, or a LTA card & Lon to IP adaptor).
 4. Modem to FTT10 for remote sites.
 5. Access to a system workstation over the IP via Ethernet/standard web browser.
- B. Local area network minimum physical and media access requirements:
1. Ethernet; IEEE standard 802.3.
 2. Cable; 10 Base-T, UTP-8 wire, category 5.
 3. Minimum throughput; 10 Mbps with the ability to increase to 100 Mbps.

3.2.2 PROGRAMMABLE NODES (Applicable only for Lonworks controller)

A. GENERAL REQUIREMENTS.

1. LPNs shall be equipped with a 3120 Neuron® with co-processor or 3150 Neuron® microprocessor controller, (flash or EEPROM) memory for general data processing, power supply, network transceivers.
2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.
3. A LPN shall operate totally stand-alone and independent of a central computer for all specified control applications. Software shall include a complete operating system (OS), communications handler, point processing, standard control algorithms, and specific control sequences.
4. LPN's shall be a modular design with a separate wiring base. The base shall be din-rail mounted and provide terminal strips to allow field wiring to take place without the controller hardware being present. The controller hardware shall "plug-in" to the wiring base. The controller hardware shall be able to be removed without removing wires or terminal strips.
5. LPN's shall include a battery or capacitor backed hardware calendar/clock device.
6. The LPN Lon Works® network interface shall be a Type 1 transceiver. A communication connection shall be provided for attaching POT to node for downloading and troubleshooting applications.
7. The LPN shall provide for a RS232 PC connection.
8. The LPN shall provide for a RS232 modem connection.

9. The LPN shall provide for a connection to a local digital display unit.
10. LPNs shall include:
 - i) Network service pin.
 - ii) Power On indicator light.
 - iii) Network communication indicator light.

B. INPUT/OUTPUT REQUIREMENTS

1. Binary Input (BI) Types Supported by the DDC/LPN: The BI function shall accept on-off, open-close, or other change of state (two state data) indications.
2. Analog inputs shall include 0-10 Vdc, 0-20 mA, 4-20 mA, and 1,800 ohm (25 ° C) or 10,000 ohm (25 ° C) thermistor. Resolution of the Analog to Digital converter shall be a minimum of 10 bits.
3. DDC/LPNs shall include universal inputs that support either of the above describe inputs.
4. The DDC/LPN shall accommodate both binary and true analog outputs, 0-10Vdc. The resolution of the digital to analog converter shall be a minimum of 8 bits.
5. Binary outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits.
6. The DDC/LPN shall accommodate expansion input/output units.
7. Enclosure shall be NEMA 1.
8. The DDC/LPN shall include all hardware and software required for communications with other nodes, PCs, and the OW over the Lon Works LANs.
9. Programming shall provide for the control of network data traffic through the use of send on delta and time adjustable control of network broadcasts or polls.

3.2.3 LON WORKS® APPLICATION SPECIFIC NODES (LASN) (Applicable for Lonworks only)

A. General characteristics of LASN

1. The processor shall be a 3120 or 3150 Neuron.
2. LonMark certified and must comply with the following LONMARK® interoperability profile guidelines:

a) Variable Air Volume (VAV) boxes	- Profile 8502
b) Fan Coil Units	- Profile 8501
c) Unit Ventilators	- Profile 8505
d) Heat Pumps	- Profile 8503

3. Non-programmable, configurable application.
4. Shall provide software configuration tool, as specified under system software.
5. Data broadcasting to the network or data polling shall be controlled by the application to preclude data storms on the network.
6. Controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog and digital outputs shall be industry standard signals such as 0-10Vdc and floating point control allowing for interface to industry standard field devices.
7. After a power failure the LASN must run the control application using the current set points and configuration. Reverting to default or factory set points is not acceptable.

B. ROOM SENSORS

1. Room temperature sensors are to be provided with a cover to prevent accidental damage.
2. Terminal unit temperature sensors shall all be of the thermistor (NTC) type with a minimum of 100 ohm/ degrees F resistance change versus temperature change within a range of 60 to 90F to ensure good resolution and accuracy. Thermistor shall produce 3000 ohm at 77 degrees F for calibration.
3. Sensor shall be supplied with a vertical base for mounting on a standard single gang junction box supplied by the SI contractor.
4. Temperature sensor cover plate shall be vandal proof, flush mounted with hex head hardware.

Alternatively standard room temperatures with 0-10V/ 4- 20 mA output shall also be acceptable.

3.2.4 DIGITAL DISPLAY UNIT (DDU) – Liquid Crystal Display or Workstation

A. GENERAL REQUIREMENTS.

1. The DDU shall permit the project operating staff to:
 - (i) Display point values
 - (ii) Display parameters
 - (iii) Change time schedule elements
 - (iv) List and acknowledge alarms
 - (v) Monitor points in the system
 - (vi) Command points (manual overrides) of points
 - (vii) Override input points (put inputs in test)

- (viii) Read and check LonWorks /BACnet variables on the network
 - (ix) Password protected
 - (x) Node configuration for Fan Coil and Rooftop Unit TCUs
2. DDU with the following components:
 - (i) Liquid Crystal Display
 - (ii) Minimum 4x20 character
 - (iii) Pushbuttons for scrolling display and enter
 - (iv) Permanent mount or portable connection.

3.2.5 LON/BACnet ROUTERS, REPEATERS AND TRANSCEIVERS

A. GENERAL

1. Equip each router with a network transceiver on each network port.
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. Routers shall utilize LonTalk®/BACnet protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.
4. Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® /BACnet software tool.
5. The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.
6. Provide a minimum of two Neuron 3120 or 3150 processors or 32 bit Hi performance processor for use as the network router communication controller.

B. ETHERNET IP ROUTER

- 1 Equip each router with an Ethernet IP communication on one side and a Lon Talk® /BACnet transceiver Type.
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.
4. On the LonTalk®/BACnet side, the routers shall utilize LonTalk®/BACnet protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.

5. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks®/BACnet software tool.
6. The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

C. TRANSCEIVERS

1. Type 1 network transceiver, free topology, twisted pair: Provide a transformer isolated, twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:
 - i. Meets LonMark™/BACnet Interoperability Association Standards.
 - ii. Differential Manchester encoded signaling for polarity insensitive network
 - iii. Wiring.
 - iv. Transformer isolated for common mode rejection.
 - v. 78 kbs network bit rate up to distances of 2000 meters.
 - vi. Free topology supports star, home run, multidrop and loop wiring.
 - vii. Topologies.
 - viii. Complies with FCC and VDE requirements.
 - ix. UL recognized component.
2. Type 2 Network Transceiver, Twisted Pair: Provide a transformer isolated twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:
 - i. Meets LonWorks®/BACnet interoperability standards.
 - ii. Differential Manchester encoded signaling for polarity insensitive network wiring.
 - iii. Transformer isolation for common mode rejection.
 - iv. 1.25Mbs network bit rate up to distances of 1000 meters.
 - v. FCC and VDE Level B requirements compliance.
 - vi. UL recognized component.

SOFTWARE

A. COMMAND & OPERATING SOFTWARE

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. Web Browser Access: The DDC/GUI 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.

B. GRAPHICAL OBJECT-ORIENTED PROGRAMMING SOFTWARE

1. The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in LonWorks®/BACnet 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, set point, display and input/output functions to create logic diagrams that represent sequences of operation for LPNs/DDC.
2. Program elements shall be able to be combined into a custom template that can then be used as a standard function.
3. 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.
4. 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.
5. The programming software shall reside on each POT and OW server for programming and/or configuring each model of LPN/DDC 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.
6. 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.
7. All DDC set points, 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.

- C. **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.

- D. Provide integral trend-logging presentation in the programming screen.
- E. Print capability, with page break reference tags to allow down to 8 ½"x 11" size paper
- F. Off-line simulations (step function, continuous run function, simulation of external inputs)
- G. Dynamic presentation of logic in on-line state (all intermediate values)
- H. Text to logic screens
- I. Memory monitoring
- J. Power cycle restart function
- K. Run-time capability
- L. Calculator objects, (basic stuff), including if-then-else, log, ln, exp, and trig functions.
- M. Recognize standard network variable type data (nvi) and create network variables to put on the network (nvo)
- N. Programming Objects
- O. 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.
 - 1. 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.
 - 2. 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).
 - 3. 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.
- P. Object Libraries

1. 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.
2. 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.
3. 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.
4. 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:
5. Recognize all Standard Configuration Parameters (SCPTs)
6. Provide capability for setting all Standard Configuration Parameters (SCPTs)
7. Translation capability for user defined configuration parameters
8. Monitoring capability for nvo's from the nodes
9. Ability to set the values for nvi's to the nodes

Q. Network Management

1. 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®/BACnet device network variables, known as "binding;" and record binding data into node addressing tables, and create a database of all addressing and binding information for all nodes on the network.
2. Network management shall include the following services: browse all network variables on nodes; Attach, Detach, Manage, Add, Remove, and Replace nodes; plus transmission error off-line, on-line reporting.
3. The network management database shall be resident in the operator workstation server, ensuring that anyone with proper user name/password authorization has access to the network management database at all times.
4. The software shall have Client/server capability to allow multiple users ability to manipulate the database simultaneously.

R. Human-Machine Interface - Operator Workstation Software

1. The HMI shall be client/server architecture to allow multiple client access to an Ethernet connected server. The workstation shall operate also as a stand-alone workstation/server.
2. The software shall enable an operator to interact with various devices including recorders, input/output (I/O) systems, transmitters, and other field devices.
3. It shall provide the following functions:
 - i. Calendar.
 - ii. Scheduling.
 - iii. Trending.
 - iv. Alarm monitoring and routing.
 - v. Time synchronization.
 - vi. Time zone handling
 - vii. Integration of LonWorks®/BACnet controller data
 - viii. Object linking and embedding for process control (OPC) for connectivity to third part OPC compliant software/devices.
 - ix. Color graphic display
 - x. On-line plots
 - xi. Use Microsoft NT security
 - xii. System documentation generation
 - xiii. Dynamic data exchange (DDE)
 - xiv. Dispatch of a single time schedule to all programmable nodes
4. **System Configuration.** At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access:
 - i. Create, delete, upload, or modify control strategies.
 - ii. Add/delete objects to the system.
 - iii. Tune control loops through the adjustment of control loop parameters.
 - iv. Enable or disable systems
 - v. Generate text file reports to a networked printer.
 - vi. Select points to be alarm able and define the alarm state.
 - vii. Configure alarms to be sent to Microsoft windows mail client
 - viii. Select points to be trended over a period of time and initiate the recording of values automatically.
 - ix. Provide different levels of security to every object in the HMI database
 - x. Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords
5. **Event Alarm Notification and Actions**
 - i. The HMI software shall provide alarm recognition, storage, routing, management, and analysis.

- ii. The HMI software shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
- iii. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - a) To alarm.
 - b) Return to normal.
 - c) To fault.
- iv. Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
- v. Provide timed (schedule) routing of alarms by class, object, group, or node.
- vi. Provide alarm generation from “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- vii. Control equipment and network failures shall be treated as alarms and annunciate.
- viii. Alarms shall be annunciating in any of the following manners as defined by the user:
 - a. Screen message text.
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - i. Day of week.
 - ii. Time of day.
 - iii. Recipient.
 - a. Pagers via paging services that initiate a page on receipt of email message.
 - i. Auto answer (at OWS) and auto dial (from node)
 - ii. Graphic with flashing alarm object(s).
 - iii. Printed message, routed directly to a dedicated alarm printer.
 - iv. Audio messages.
 - v. The following shall be recorded by the OWS HMI software for each alarm (at a minimum):
 - a. Time and date.
 - b. Location (building, floor, zone, office number, etc.).
 - . Equipment (air handler #, access way, 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.

- iii. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- iv. A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.
- v. Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.
- vi. Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.
- vii. 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 supersede 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.
- viii. The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

6. Data Collection and Storage Requirements

- i. The OWS HMI shall have the ability to collect data for any property of any object and store this data for future use.
- ii. The data collection shall be performed by objects, resident in the node, and if desired OWS, shall have, at a minimum, the following configurable properties:
 - a. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - b. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - c. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - d. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 - e. All log data shall be stored in a database in the OWS HIM and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
 - f. Systems that cannot provide log data in HTML formats at a minimum shall not be acceptable.
 - g. The OW shall have the ability to archive its log data either locally (to itself), or remotely to a OWS server. Provide the ability to configure the following archiving properties, at a minimum:

- i. Archive on time of day.
 - ii. Archive on user-defined number of data stores in the log (buffer size).
 - iii. Archive when log has reached its user-defined capacity of data stores.
 - iv. Provide ability to clear logs once archived.
- 7. Audit Log**

Provide and maintain an Audit Log that tracks all activities performed on the OWS HMI. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to OWS HMI or to a server. For each log entry, provide the following data:

- a. Time and date.
- b. User ID.
- c. Change or activity: i.e., change set point, add or delete objects, commands, etc.

8. 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.

9. Graphical Real-Time Displays.

- The HMI, shall at a minimum, support the following graphical features and functions:
- i. Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.
 - ii. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 - iii. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - iv. Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered.
 - v. Adjustments to analog objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value.
 - vi. The OWS shall be able to support multiple graphic objects at the same time. If tiled, then each graphical object shall be fully scalable or aspect locked.
 - vii. Trend Displays (variable versus time) - A trend display shall show the values of points plotted versus time similar to a strip chart recorder. Eight tags shall be trended per trend. The HMI software shall provide real-time and historical trending (for data which had been logged). This may be achieved by either color graphic page display or an Microsoft excel based display.
 - viii. Real-Time Trends - shall contain real-time data without consuming hard disk space.

- ix. Historical Trends Logs - A historical trend log display presents data stored on the computer's hard disk.
- x. X-Y Plots (variable versus variable) - An x-y plot shall dynamically represent the real-time or historical relationship one variable plotted against another variable.
- xi. Automatic Generation - All trends and plots shall be self-generated and not require any programming by the user.
- xii. The HMI software shall provide dialog boxes and menu picks for configuring trends and plots.
- i. Any analog or binary data may be trended or plotted.
- ii. The software shall store pre-configured presentation of trends to facilitate operator call-up of trend log displays. It shall be possible to call up a trend log with pre-assigned data.

10. Graphics Builder - The HMI software shall provide a graphics builder.

- i. Display Documentation - The graphics builder shall provide show, simulate, review, and document animation functions to allow the user to identify, diagnose, change, and document animation points on each display.
- ii. A library of vendor-supplied objects will be included. These objects, widgets, and symbols must be continuously scalable. These items shall be editable by the user.
- iii. A library of animated graphic objects shall be included.
- iv. Animation - The Graphics Builder will animate process graphics with real-time data from field devices.
- v. Multi-State Color Animation shall be provided to change a graphic object's color from a palette of colors.
- vi. Alarm Color - Color animation for normal, alarm, and alarm acknowledged states for both analog and binary point tags shall be provided. The user shall define the foreground and background colors for each state.
- vii. Alarm Blink – Objects and text data shall blink based on alarm state and acknowledged state.
- viii. Text and Numeric Animation - The software shall display the numeric value of an analog point, text of a text point, and the descriptors of a binary point. Display Linking - The software shall provide a display linking function. Clicking the object associated with the link changes the display to a new user-defined display.
- i. Pick able / Non-Pick able - The software shall enable active points to be selected with the mouse and accessed. It shall be possible to make a point non-pick able: 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.
- ii. Ability to open external executable files from button click

- iii. Ability to open HTML web pages from button click
- iv. Ability to view Microsoft Excel files from button click
- 11. On-Line Help. Provide a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.
- 12. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.
 - 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.
 - g. System Diagnostics. The system shall automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciate to the operator.
 - h. DDE Server - The HMI software shall be able to communicate and exchange data with any Third Party DDE compliant application.

MICROSOFT REPORT GENERATION – The HMI software shall be able to seamlessly interact with Microsoft Office Products, including Excel, with no additional programming.

4.0 SCHEDULE OF DATA POINT SUMMARY

S.No.	Description	Qty. (Nos.)	Condition of Services				Field Device
1.	<u>Water Chilling Units</u>	--	A_i	D_i	A_o	D_o	
1.1	Chiller On/Off	3	x	x	x	3	Chiller Panel
1.2	Chiller Water Temp. Reset	--	x	x	3	x	Chiller Panel
1.3	Chiller Run Status	--	x	3	x	x	Chiller Panel
1.4	Chiller Trip Fault	--	x	3	x	x	Chiller Panel
1.5	Chiller Auto/Manual status	--	x	3	x	x	Chiller Panel
1.6	Chiller Water Temperature In (Qty.) + Out (Qty.)	--	3	x	x	x	Immersion type temp. sensor
1.7	Chiller Flow Switches	--	x	3	x	x	Flow switch
1.8	Chiller Out butterfly Valves/ Status	--	x	3	x	3	Motorized valve
1.9	Ambient Temperature	--	1	x	x	x	Temp. Sensor
1.10	Ambient RH	--	1	x	x	x	Humidity sensor
1.11	Chiller Return Header Flow		1	x	x	x	Electro-magnetic type Flow meter
Sub Total :			6	15	3	6	
2.	<u>Chilled Water Pumps</u>						
2.1	Chiller Pump On/Off	7	x	x	x	7	Pump Panel
2.2	Chiller Auto/Manual status	--	x	7	x	x	Pump Panel
2.3	Chiller Pump Status	--	x	7	x	x	D/P switch
2.4	Water Line Pressure	--	1	x	x	x	Pressure sensor
Sub Total :			1	14	X	7	

3.	<u>Air Handling Units</u>						
3.1	Return Air Temperature	28	28	x	x	x	Duct Temp. sensor
3.1	AHU Filter Status	--	x	28	x	x	Filter DP Switch
3.2	Airflow Status	--	x	28	x	x	Air flow switch
3.3	AHU auto/manual status	--	x	28	x	x	AHU panel
3.4	3-WAY Motorized Valve (Control/Status)	--	28	x	28	x	Motorized valve
3.5	AHU On/Off	--	x	x	x	28	AHU Panel
Sub Total :			56	84	28	28	

S.No.	Description	Qty. (Nos.)	Condition of Services				Field Device
4.	<u>Ventilation Systems</u>		A_i	D_i	A_o	D_o	
4.1	Fan ON/OFF	10	x	x	x	10	Fan Panel
4.2	Fan Status		x	10	x	x	Current Relay
4.3	Auto/Manual status	--	x	10	x	x	Fan Panel
Sub Total :			X	10	x	10	
5.	<u>Electrical Equipments</u>						
5.1	H.T. KW/HR	--	x	1	x	x	Power transducer
5.2	H.T. Trip	--	x	1	x	x	Potential contact free from panel
5.3	H.T. Breaker Status		x	1	x	x	Potential contact free from panel
5.4	Transformer Trip Fault	1	x	1	x	x	Potential contact free
5.5	L.T. Panel monitoring (Thru power meter)	5	x	x	x	x	Energy Meter with MOD BUS Output
5.6	L.T. Breaker Status	--	x	5	x	x	Potential contact free from panel
Sub Total :			X	9	x	x	
6.	<u>D.G. sets Automation</u>						
6.1	<u>D.G. Sets</u>						
6.1.1	D. G. Trip	2	x	2	x	x	DG Panel
6.1.2	D. G. Monitoring	--	x	x	x	x	MOD BUS Output from DG PLC
6.1.3	D. G. set Battery Voltage	--	1	x	x	x	Voltage Transducer
6.1.4	DG Diesel Tank Monitoring		1	x	x	x	Level Transmeter
Sub Total :			2	2	x	x	

S.No.	Description	Qty. (Nos.)	Condition of Services				Field Device
7.	<u>Water Supply System</u>						
7.2	Water Services Pump Flow Status	--	x	3	x	x	D/P switch
7.3	Auto/Manual status	--	x	3	x	x	Pump Panel
7.4	Variable Speed Control (domestic water pump)	2	2	x	x	x	VFD
7.4	U.G. & overhead Tank Water Level Indicator (HI/LO)	3	x	3	x	x	Level switch
7.5	Bore well pump Auto / Manual status	--	x	1	x	x	
7.6	Bore well pump status		x	1	x	x	
	Total		2	11	x	X	
8.	<u>External Lighting</u>		A_i	D_i	A_o	D_o	
8.1	External light ON/OFF	3	x	x	x	3	
8.2	External light status	--	x	3	x	x	
8.3	Light sensor	--	3	x	x	x	LUX Sensor
	Sub Total		3	3	x	3	
8.	<u>Internal Lighting</u>		A_i	D_i	A_o	D_o	
8.1	Internal light ON/OFF	10	x	x	x	10	
8.2	Internal light status	--	x	10	x	x	
8.3	Light sensor	--	5	x	x	x	PIR occupancy Sensor
	Sub Total		5	10	x	10	
8.	<u>Lifts</u>		A_i	D_i	A_o	D_o	
8.1	Lift status	--	x	2	x	x	Lift panel
8.2	Lift trip status	--	2	x	x	x	Lift panel
	Sub Total		2	2	x	x	
9.	<u>Fire Fighting</u>						
	Diesel Pump Status	1	x	1	x	x	D/P Switch
9.1	Fire pump status	2	x	x	x	x	Pump Panel
9.2	Hydrant Line Pressure	--	x	x	x	x	Pressure sensor
	Sub Total		1	1	X	X	
	Grand Total		50	96	28	39	

<u>5.0 TECHNICAL DATA</u>			
<u>BUILDING MANAGEMENT SYSTEMS</u>			
S.No.	Description	Unit	Condition of Services
1.	<u>Microprocessor Based Control System</u>		
1.1	Make of system		
1.2	<u>Main Operating Station</u>		
1.2.1	PC		
1.2.2	CPU/Type		
1.2.3	Speed		
1.2.4	Hard Disc Capability		
1.2.5	Ram Size		
1.3	Centralized or distributed		
1.4	No. of sub controller		
1.5	List of items controlled by each sub controllers		
1.6	No. of I/O points of Various controllers		
1.7	Type of communication bus		
1.8	Types & makes of various Sensors		
1.9	Confirm that suitable Valves for AHU, main Headers, branching etc. are included in this Package.		
1.10	Data point summary of Proposed system		
1.11	Make of 2/3 way motorised valves		
1.12	Model and sizes		
1.13	Make and model of butterfly valves		
1.14	Sizes of butterfly valve		

6.0 TEST PERFORMA

The following data will be provided to test the functioning of BMS Controls and for use in calculating the plant capacity.

S. No.	Item		Unit	Test Result
1.	<u>Conditions</u>			
	Ambient conditions			
1.1.1	-Temp. D. B.		°C	
	-Temp. W.B.		°C	
1.1.2	- R.H.		%	
1.2	Inside Conditions			
1.2.1	-Temp. D. B.		°C	
	-Temp. W.B.		°C	
1.2.2	- R.H.		%	
2.	<u>Chiller</u>			
2.1	Chilled water temp in		° C	
2.2	Chilled water temp out		° C	
3.	<u>Air Handling Units :</u>			
3.1	Coil face area		Sq.m	
3.2	Air temperature	-Entering	°C	
		-Leaving	°C	
3.3	Water temperature	-Entering	°C	
		-Leaving	°C	
3.4	Simulated filter dirty state		Ok/No	
4.	<u>Fan coil units</u>			
4.1	Air quantity across coil		Cubm/Hr	
5.	<u>Pumps</u>			

5.1	Water temperature	In/Out	

S. No.	Item	Unit	Test Result
6.	<u>Room Conditions at Design Conditions</u>		
6.1	-Temp. D. B.	°C	
	-Temp. W.B.	°C	
	(A no. Of readings shall be Taken and averaged)		
7.	<u>Controls</u>		
	Report on test and Functioning of all Controls.		
	<u>Notes :</u>		
A.	<u>Test Instruments</u>		
1.	All instruments for testing shall be provided by the Airconditioning contractor.		
2.	Thermometer used for measurement of temperature of Water/refrigerant shall have graduations of 0.1°C and shall be got calibrated from N.P.L. or any recognized test house before hand.		
3.	Thermometers used in the psychrometers shall have Graduations of 0.2oC and shall be calibrated as at (2) above.		
4.	Pressure gauges shall also be got calibrated before hand from a recognized test houses.		
5.	Balancing valves shall be used for measuring flow rate through the chillers.		
6.	Where ever the flow rate vs. Pressure drop curves or the heat exchangers of the same mode, as installed, certified by project co-coordinator on the basis of tests conducted at manufacturer's works are produced, flow meters for measuring water flow rate through these may not be provided. Actual water flow shall in such a case, be computed with reference to these curves and the actual pressure drop measured at site.		
7.	Air flow rates shall measured in the supply duct using Pitot tube.		
B.	<u>Capacity computations</u>		
3.	<u>Air Handling Units</u>		
	The capacity shall be computed from the water temperature and water flow measurements. A tolerance of + or - 5% from the N/T value shall be acceptable in the capacity to computed. Air quantity shall be measured in the supply duct and checked with the quantity specified in the A/T. A tolerance of + or - 10% in the air		

	quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperatures and recorded
	For the purpose of system capacity, the refrigeration tonnage obtained from the main refrigeration plant will be accepted. If due to any reason, internal load mentioned in the tender specifications is not available, psychometric computations for actual load conditions will be done and the plant, if found satisfactory, will be accepted.

7.0 TEST AT SITE

1. GENERAL

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the Engineer-In-Charge, in accordance with the provisions of the applicable ASHRAE standards or approved equal and furnish necessary test certificates from manufacturers.

2. CONTROLS

2.1 Valves:

Hyd. /pneumatic test certificates.

2.2 Instruments and controls

Visual examination.

3. FOR ASSOCIATED WORKS AT SITE.

- 3.1 All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certificates.
 - 3.2 Inspection of controller panels and its devices.
 - 3.3 Checking of electrical control circuits and checking functioning of HVAC System and other circuits where applicable.
 - 3.4 Checking of calibration of controls and instrumentation
 - 3.5 Checking of assemblies for instruments panels, annunciator panels, etc.
 - 3.6 Inspection of complete installation at site.
 - 3.7 Function testing of all systems as per specifications.
4. The above inspection procedure is given for general Guidance and information of vendors and inspection of Engineer-In-Charge is strictly not limited to these and Inspection Engineer of Engineer-In-Charge will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer, co-ordination of inspection agency of Engineer-In-Charge with his factory/sub-vendor's factory/erection site will be the sole responsibility of successful vendor after placement of order for complete Air Conditioning plant covered under these technical specifications.

5. **ELECTRICAL EQUIPMENT:**

- 5.1 All electrical equipment shall be cleaned and adjusted on site before application of power.
- 5.2 The following tests shall be carried out:
 - 5.2.1 Wire and cable continuity tests.
- 5.3 Insulation resistance tests, on all circuits and equipment, using a 500 volt meggar. The meggar reading shall be not less than one megaohm.
- 5.4 Earth resistance between conduit system and earth must Not exceed half (1/2) ohm.
- 5.5 Operating tests on all protective relays to prove their correct operation before energizing the main equipment.
- 5.6 Operating tests on all circuit etc.

6. **PERFORMANCE TESTS:**

- 6.1 The installation as a whole shall be balanced and Tested upon completion, and all relevant information, including the following shall be submitted to the Engineer-In-Charge.
 - 6.1.1 Differential pressure readings across each filter, fan and coil, and through each pump.
 - 6.1.2 Continuous recording over a specified period, of Ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 6.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream “on-coil” of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 6.3 Any other readings shall be taken which may subsequently be specified by the Engineer-In-Charge.

7. **Miscellaneous:**

- 7.1 The above tests are mentioned herein for general Guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.
- 7.2 The date of commencement of all tests listed above shall be subject to the approval of the Engineer-In-Charge, and in accordance with the requirements of this specification.
- 7.3 The contractor shall supply the skilled staff and all Necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a

complete system if the Engineer-In-Charge requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.

- 7.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, all for the satisfaction of the Engineer-In-Charge.
- 7.5 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
- 7.6 The contractor must inform the Engineer-In-Charge when such tests are to be made, giving sufficient notice, in order that the Engineer-In-Charge or his nominated representative may be present.
- 7.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Engineer-In-Charge.
- 7.8 The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the Engineer-In-Charge, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

7.0 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	Cut out
Operating pressure		← 10.0 Kg/ sq.cm	→
Jockey pump		9.0 Kg/ sq.cm	7.0 Kg/sq.cm
Fire Electrical Pump	1	6.5 Kg/ sq.cm	automatically
Fire Electrical Pump	2	5.5 Kg/ sq.cm	automatically
Diesel Engine driven pump	3	4.50 Kg/ sq.cm	manual

Note: - The diesel pump shall start automatically, on fall of pressure in the pipe line, in the absence of electric supply, but the stopping shall be manual.

1. Jockey pump shall start and stop through pressure switch automatically.
2. Jockey pump shall stop when main pump starts.
3. Main pump shall start automatically on fall of pressure but stopping shall be manual.

4. VIBRATION ELIMINATORS

- a. Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

5. INSTALLATION

- a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- b. Pumps and motors shall be truly aligned by suitable instruments.
- c. All pump connections shall be standard flanged type with appropriate number of bolts. In case of nonstandard flanges companion flanges shall be provided with the pumps.
- d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Architect or their authorized representative of inspection of equipment during manufacturing and also to witness various tests at the manufacturers 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 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 rent 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. Incomer section: - The incoming section shall comprise
 - i. Moulded case circuit breaker with Electronic release, ammeter, voltmeter, selector switch set of phase indication lamps .
 - ii. Aluminum bus bars
 - iii. TP & N outgoing Moulded case circuit breaker with Electronic release for electric fire pump
 - iv. TP & N outgoing Moulded case circuit breaker with Electronic release for Jockey pump.

- v. TP & N outgoing Moulded case circuit breaker with Electronic release for battery charger unit control.
- vi. TP & N outgoing Moulded case circuit breaker with Electronic release (spares)
Note: - Terminal blocks, inter-connections, labels etc. as necessary.

5. ELECTRIC FIRE PUMP SECTION: - This section shall incorporate the following facilities.

- i. TP & N Moulded case circuit breaker
- ii. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- iii. Starter unit, current transformer and ammeter
- iv. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.
- v. Pump lock out devices due to faults or abnormalities as specified.
- vi. Visual/ audio alarms, indications and communications facility as specified.
- vii. Necessary inter connection control and power cable work, cable glands, lungs and internal wiring and connections.

6. ENGINE SECTION: - The engine section shall incorporate the following facilities.

- i. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- ii. Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.
- iii. Engine shut down and block out devices due to faults or abnormalities as specified.
- iv. Visual/ audio alarm indication and enunciator facility as specified.
- v. Inter- connection control and power cable work, cable glands, lungs, all internal wiring and connection etc.

7. AUXILIARY PUMP SECTION: - Each of the auxiliary pump section for priming pump shall incorporate the following:

- i. TP&N Moulded case circuit breaker
- ii. Control system components such as relays, timers, contractors etc. as are necessary for functional requirements.
- iii. Starter unit, current transformer and ammeter

- iv. Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.
- v. Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.
- vi. Low water level alarm for terrace tank, where provided.

8. CONTROL SECTION: - This section shall incorporate the following:

- i. Control components integrating the various sections, so as to satisfy the functional requirements.
- ii. Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.
- iii. Visual/ audio alarms not covered in individual sections.
- iv. Lamps healthy test facility.
- v. Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.
- vi. Test facility to stimulate operation of hydrants.

9. OTHER CONTROL COMPONENTS

a. Pressure Switches:

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at present pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

b. Low water level indication and switch:

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level 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 to ensure that the control systems remain 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 carried out strictly in accordance with the approved drawing.

The scope of installation work shall include the following, where or not expressly mentioned in the schedule of work.

- i. Cement concrete (1:2:4 mix) foundation for all pump sets
- ii. Vibration isolation arrangement for all pump sets
- iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes
- iv. Necessary supports and clamps for wet riser pump room
- v. Necessary supports and clamps for wet riser plumbing the building
- vi. Supporting bracket/ frame work for the fuel oil tank of the engine
- vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.
- viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are not strong enough to support the pipes, thereby likely to cause different settlement.

- ix. Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.
- x. Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.
- xi. Valve chambers of approved design with external (yard) hydrant.
- xii. Ground level hydrants of approved design, where 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. Color 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

a. 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

- b. 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.
- c. 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.

d. Valves

Butterfly or Sluice valves of size 80mm and above shall be double-flanged cast iron conforming to IS: 780.

Check valve shall be of cast iron double flanged conforming to IS: 5312.

Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.

Air Valves

25mm dia screwed inlet cast iron single acting air valves on all high points in the system or as shown on drawings.

Drain Valves

50 mm dia black steel pipe conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

3.0 INSTALLATION CONTROL VALVE:- Installation control valves shall comprise of the following.

- a. One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut
- b. One automatic alarm valve, fitted with handle and cover.

- c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.
- d. One combined waste and testing valve including 5 mtr of tubing and fittings
- e. Alarm stop valve
- f. Strainer
- g. Drain plug
- h. Padlock & strap
- i. Wall box for installation of valve

4.0 PRESSURE GAUGES:- Burden type pressure gauges conforming to IS/ BS specifications shall provided at the following locations.

- a. Just above alarm valve
- b. Just below alarm valve, on the installation stop valve
- c. One pressure gauge on delivery side of each pump
- d. Required number of pressure gauges on pressure tank

5.0 INSTALLATION OF PIPING

A. Below ground piping: -Under ground piping should be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. Wherever pipes pass through roads/ pavements shall be protected against corrosion with two coats of bituminous painting and wrapped with pykote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.

B. ABOVE GROUND PIPING: -

a. All above ground piping shall be installed on suitable to pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.

- | | | |
|------|---------------------|----------|
| i. | 20 mm to 32 mm dia | 2 mtr |
| ii. | 40 mm to 65 mm dia | 2 mtr |
| iii. | 65 mm to 100 mm dia | 1.75 mtr |
| iv. | above 150 mm dia | 1.50 mtr |

b. Piping shall be so installed that the system can be thoroughly drained. All the pipes shall be arranged to drain to the installation drain valve. In case of basement and other areas where the pipe work, is below the installation drain valve / auxiliary valves of the following sizes shall be provided.

- i. 20 mm dia valve for pipes up to 50mm dia

- ii. 25 mm dia valve for 65 mm dia pipes
- iii. 32 mm dia valves for pipes larger than 65 mm dia
- c. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 50 mm of larger diameters.
- d. The piping shall be pressure tested by the hydrostatic method upto a pressure of 1.5 times the working pressure the piping shall be slowly charged with water so that all the air is expelled from the piping by providing a 25mm inlet with a stop cock. The piping shall be allowed to stand full of water for a period of 2 hours and then the piping shall be put under pressure by means of manually operated test pump or by a power driven test pump. The pressure gauges used for testing shall be accurate and shall preferably be calibrated before the testing is carried out. All the leakages and defects in joints revealed during the testing shall be rectified to the entire satisfaction of the consultant. The system may be tested in sections parts as the work of erection of piping proceeds. The piping shall withstand 1.5 times the working pressure for at least 2 hours.

6.0 PUMP SETS

Same as wet riser & Hydrant System specification.

7.0 ANNUNCIATION SPRINKLER PANEL

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

- a. Panel should be made in a module of 20 zones e.g. Each module will have audible and visual indications and will monitor the circuit conditions. With 24v DC battery.
 - A.C. Power Supply
 - Fault and Fire indication lamp
 - Alarm acknowledgment push buttons
- b. The circuits provided in the control panel for each zone shall indicate the following conditions:
 - i. Open Circuit in zone wiring
 - ii. Short Circuit in zone wiring
 - iii. Normal conditions
 - iv. Power failure
 - v. Low battery
- c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.
- d. Suitable protection may be provided against charging of the battery over and above the specified values.

8.0 BATTERY UNIT

- i. The system shall be powered by lead acid storage stationery complete with automatic dual rate charger boost and trick operating form 220 V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.
- ii. The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1 V 20 per cell, and operate at a trickle charge rate of 100 to 200 AH, when the battery terminal voltage exceeded about 2.25 per cell.
- iii. The power unit should have the following.
 - a. Voltmeter 0-03 V
 - b. Ammeter of suitable range
 - c. Indicator lights for mains
 - d. Indicator lights for DC output
- iv. The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (IF and isolated supply is provided a line earthing indicator should also be provided).
- v. The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.
- vi. The connection to the 220 V, 50 Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for 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

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| 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. |

**Construction of National Institute of Allied Health Sciences (NIAHS)
at NAZAFGARH, 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 / Polybond
5.	Aluminium Die-Cast handles & two point locking kit	Giesse / Securistyle / Alu – alpha
6.	Aluminium Extrusion	Indal / Mahavir / Hindalco / Jindal
7.	Aluminium Fabricators	M/s. International Glass House, M/s. AGV Alfa Lab Ltd., M/s. Consolidated Engg. Company / M/s. Ajit (India) Pvt. Ltd./ Calco / Alkarma
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 Engr-in-Charge.
10.	Automatic variable temperature control / fixed temperature control faucets	Jaquar / AOS-Robo-U-Tec/ Parry/ Angash / Euronics
11.	Ball Cock	Sant / L&T/Audco
12.	Ball valves with floats	Zoloto / Leader / Sant / Jayco /GPA/Audco/ AIP
13.	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.
14.	Brass stop & Bib Cock	Zoloto / Sant / Jaquar
15.	Butterfly valves	Zolato/Audco / AIP /Sant
16.	C. I Fitting	RKS/ AVR/ UNIK/ Electrosteel/ Kesoram/ ISSCO/ Neco/ RIF
17.	C.I Sluice Valve & Non Return Valve	Kirloskar / IVC/ Leader /Zoloto/L&T/Audco/ Sant/ AIP
18.	C.I Valves (Full way, Check and Globe Valves	Leader / Kirloskar / SKF / Zolto / Sant / Upadhyay / Castle / Kartar

19.	C.I. Manhole Covers	Neco/R.I.F./B.C./Hepco/SKF/Kajeco
20.	C.P. Fittings Mixer / Pillar taps/ C.P brass angle valve/ Valves Washers, C.P. brass accessories	Parko /Jaquar /Marc/ Plumber / Dripless / Soma / Kingston / Gem/ Crystal / Sanitaryware (ARK) Parry/ Ideal / Orient/ Kohler
21.	C.P. Waste, Spreaders, Urinal	Jaquar/Parko/Kingston/GEM/Plumber
22.	Calcium Silicate False Ceiling	India Gypsum/ Armstrong / Decosonic/Daiken/ Aerolite
23.	Calcium Silicate Boards	Hilux / Aerolite
24.	Calcium Silicate Tiles	Aerolite / Hilux
25.	Carpet Flooring & Skirting (Floatax)	Forbo/ Polyflor/ Tarket
26.	Cement	ACC / L&T / Ultra tech / Birla Corp. Ltd. (Cement Divn.) / JK Cement / Jaypee-Rewa / Shree / Lafarge /Prism /India Cement / Bangur
27.	Cement: White	Birla White / JK
28.	Central Control	Rain Bird, USA/Toro/Nelson,
29.	Centrifugally cast C.I Rainwater fitting / Bronze gratings etc.	Sages Metals/ GMGR/ Electro Steel / Kesoram / IISCO / Neco / BIC / Neer
30.	Centrifugal Pump	Crompton /Kirloskar/ KSB/ Voilation Projects/ Unnati/ BS Enviro.
31.	Centrifugally C.I Rainwater Intel fitting , Bronze gratings	Sages Metals, GMGR, Electro Steel , Kesoram, IISCO , Neco , BIC , Neer
32.	Centrifugally casted C.I. Pipes	Neco / Hepco / Anand/ Kapilash
33.	Ceramic tiles	Johnson / Somany / Kajaria / Spartek / Nitco / Orient / Bell Ceramics
34.	Ceramic tiles Adhesive	Cico / Bell / Pidilite / BalEndura / BASF/ Sika
35.	Chlorinator	Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon/ Jesco / Prominent
36.	Chlorine Dosing System	Toshcon / Chloromax
37.	Clear Glass / Clear Float Glass / Toughened Glass	Modi / Saint Gobain (SG) Asahi India Safety Glass Ltd / GSC / Tata / Atul
38.	Cockroach Trap	Chilly/ Player/ Camry
39.	Compressed Chequered tiles	Johnson / Somany /Johnson/ Kajaria / Spartek / Nitco/ Orient / Bell Ceramics
40.	Concrete Additive	Sika /STP/CICO/Pidilite / Fosroc / Fairmate / MC Bauchemie / Chokesy.
41.	Copper Fittings (Capillary)	Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.
42.	Copper Pipes	Rajco Metal works, Mumbai / IBP Conex Ltd.
43.	CPVC Pipes & Fittings	Flowguard/ Astral/ Ashrivad/ KISAN/ Jain Supreme
44.	Curtain Rod/Drapery Rod	Vista work / Mac Decor
45.	Dash Fasteners	Hilti / Faischer /Bosch
46.	Disc Filter	Azud, Spain/ Amaid / Arkal,
47.	Door closer / Floor spring	Doorking / Everite / Hardwyn/ Master

48.	Door Locks	Godrej / Harrison / Link
49.	Door Seal – Woolpile Weather Strip	Anand Reddiplex/ Enviroseal
50.	Doors & Windows Fixtures / Fitting.	Everite / Argent / Classic/ Crown / Earl Bihari
51.	Drainage Pumps	Grundfos/ KSB/Salmson/Kirloskar
52.	Ductile Iron Fittings (IS:9523)	Electrosteel/Kesoram/Tisco/Jindal
53.	Ductile Iron Pipes (IS:8329)	Electrosteel/Kesoram/Tisco/Jindal
54.	E.P.D.M Gaskets	Anand Reddiplex / Enviro Seals
55.	Epoxy Floor	Fosroc/ BASF/ Cico/ Sika Pidilite/ MC Bouchehe
56.	Epoxy SLF Flooring	Sika/ Stonhard / STP / BASF / Pidilite
57.	Extruded Polystyrene Board	Styrofoam by DOW Chemicals/ Insulboard by Supreme Industries
58.	Filtration Plant / Softening Plant	Bikon water / Ion exchange /Thermax/ Pentair/ Eureka Forbes/Doshi Ion/Fontus
59.	Fire rated Doors & Frames	Navair / Shaktimet / GMP/ Promat / Godrej
60.	Fire Rated Glass	Saint Gobin, Torch, Glaberwal
61.	Fire Retardant Paint	Viper FRS 881, Nullifire, Burger
62.	Fire Seal	Sealz, Alstroflam, Abacus
63.	Fire: Door Closures, Mortice Dead locks	Becker Fire Solution, Inersoll Rand LCN Series, Dorma TH Series.
64.	Fire: D-Type Pull Handles	Becker Fire Solution, Dorma, Hardwin
65.	Fire: Hinges,	Becker Fire Solution, Inersoll Rand, Dorma .
66.	Fire: Panic Exit Device	Dorma / D-line
67.	Fire: Panic Exit Devices	Becker Fire Solution, Inersoll Rand LCN Series, Dorma PHA Series.
68.	Fire: Tower Bolts	Suzu, Nulite, Dorset
69.	Flush Door Shutters	Duro / Greenlam / Century/
70.	Flush Valves	Gem/ Jaquar / Parko/Kingston / Plumber / Marc
71.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini /Kanwal/ Vijay Cycle & Steel
72.	G.I. Fittings	R/Unik/Zoloto/K.S./Sun/Swastik
73.	G.I. Pipes	Jindal / Tata / Prakash Surya / SAIL / Swastik
74.	Geyser	Spherehot / Racold / Venus / Voltas / Usha Lexus / Almonard / Bajaj
75.	Glass : Mirror	Modiguard / Atul / Saint gobain/ Asahi India Safety / Modi Float
76.	Glass Wool	Rockwool / UP Twiga / Liold Insulation
77.	Glass/ Glass for Aluminum Doors/ Windows	Glaverbel /Asahi India Safety Glass Ltd. / Atul /Saint Gobain/ Modi Float glass (India)
78.	Grab bars and Disabled Hardware	Dorma / Ozone/ D-line
79.	Gunmetal Valves / C.P brass angle valve	Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco
80.	Gypsum Board	Gypsum false ceiling Gypsum India Ltd. / Beral Gypsum / India Gypsum / Laffarge / USG/ Saint Gobain (Gyproc)

81.	Gypsum False Ceiling	Gypsum false ceiling Gypsum India Ltd. / BoralGypsum / India Gypsum / Laffarge / USG/ St. Gobain (Gyproc)
82.	Hand Drier	Kopal / Utech Systems / Blue Circle (India) Pvt. Ltd. / Euronics Automat
83.	HDPE Pipes / Moulded Fittings	Emco /Polyefins/Pioneer Plyfab
84.	HDPE Solution tank	Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.
85.	Heat Resistant Terrace Tiles	Thermatek
86.	Horizontal Centrifugal / Monoblock Pumps	Kirloskar / DP Holland / Wilo/Ground fiss/CR Pumps/Salmson / Ebara
87.	Hydro-pneumatic System	HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar
88.	Inbuilt Drip Line	Azud/ Rainbrid-USA/ Netafim
89.	Insulation of Hot water pipes	Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex/ Armacell
90.	Laminates	Duro/Century/Greenlam/Formica/Decolam/ Sungloss/ Sunmica/ Durian
91.	Liquid Level Controllers / Indicators	Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer
92.	Liquid Soap Dispenser	Chilly/Euronics/Camry/Utec/Kopal
93.	M.S. Pipe	Jindal / Prakash – Surya / BST/ Kalinga /TATA / TT Swastik
94.	Mainline Isolation Valve	Sant /Leader /Zoloto,
95.	Metal False Ceiling	Decosonic / Armstrong / Durlum / Trac / Unimet
96.	Mineral fibre ceiling	Armstrong / Nittobo/ Daiken
97.	Modular SS Railing System	Metallica India / Stark Steel Fabricators / Het creators / D – Line International Denmark / Mobel Hardware
98.	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird, USA
99.	Night Latch	Godrej /Harrison / Link
100.	Non Return Valve	Sant/ Leader/ Zoloto / AIP
101.	OT: Bumper Guard Stretcher Guard Crash Rail System	MDD/TSI/LSR/Radius
102.	OT: Wall Guard Grab Rail /Hand Rail System	MDD/TSI/LSR/Radius
103.	OT: Anti-bacterial paint	Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX
104.	OT: Conductive Tile Flooring: ESD-Control Tile Flooring	Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux
105.	OT: Doors	TRILUX/Penlon/LSR/TSI/Metaflex
106.	OT: Stainless Steel Scrub Sink Two Bay	MDD/ LSR/ radius/ TSI
107.	P.R.S. Dials	Rain Bird, USA/ Toro, USA/ Nelson,
108.	P.T.M.T. Fitting	Prince India / Symet

109.	R.C.C Pipes	Indian Hume Pipe / Pragati Concrete Udyog / ISI Marked Pipes/Daya/KK / JSP
110.	Paint- Cement Paint	All types of paints i.e. cement based paints, Oil bound distemper, acrylic paints, plastic emulsion paints etc shall be First quality of ICI, Berger, Asian, Shalimar, Goodlas Nerolac and Johnson & Nicholsan make, For Cement based paint add Snowcem plus and Tatacem make.
111.	Paint - Dry Distemper	
112.	Paint - Oil Bound Distemper / Acrylic Washable Distemper	
113.	Paints - Cement Based	
114.	Paints - External Emulsion Paint	
115.	Paints - Other Paints / Primer	
116.	Paints - Plastic Emulsion Paint	
117.	Paints - Resin Based Paints	
118.	Paints - Synthetic Enamel Paints	
119.	Paint Epoxy paint	Nerolac / Shalimar / Cico / Fairmate / Sika / BASF / Berger / Asian / Pidilite
120.	Paints - Texture paint	Berger / J & N / Spectrum / Unilite heritage / Asian / Shalimar / ICI
121.	Paver blocks (All Types)	KK Manholes / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles
122.	PE-AL-PE Pipe and Accessories	Kitec/ Jindal/ Kissan/Vista
123.	Pipe coat material (pipe protection)	RPG Raychem/Pypkote/Makphalt
124.	Plastic seat cover of W.C	Commander/Hindware / Johnson / Poddar / Parryware / Bestolite/ Capri
125.	Plywood/Block board/Ply board	Duro/ Greenply/ Century/ Kitply/ Greenlam/ Novapan/ Marrino/ Greenply / Euro/ National / Anchor
126.	Polycarbonate Sheets	Macrolux / GE Plastic / Vergola / Skyarch/ Polytechno
127.	Poly-sulphide Sealant	Pidilite / Fosroc / Choksey / ChematalRai/ Cico / Sika, MC Bouchemie, BASF
128.	Pop up Connecting Assembly	Rain Bird/Dura/Lasco,
129.	Popup Spray Head	Rain Bird/Toro, USA/Nelson,
130.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
131.	PP-R Pipes (PN – 16)	Amitex Polymers Pvt. Ltd. / Prince/ Supreme/ Vector
132.	Pre-coated Galvanised Steel Sheet	Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals
133.	Pre-Laminated Particle Board	Anchor / Novapan /Century /Green Ply/ Archidply /Bhutan Board
134.	Pressed Steel Doors Frame	West Wind Concepts Pvt. Ltd., Gurgaon/ Shiva Steel Pvt. Ltd., Noida /AGEW Steel Manufacturing, Ahmedabad/ Sukri / Godrej / Gurdian / Navair
135.	Pressure Relief Valve	Omega/ Sant/Leader/ Zolato / Upadhyay /

		Audco
136.	Pumps	DP Holland / Wilo/ Grund foss
137.	PVC continuous fillet for periphery packing of glazings / Structural/Glazing	Roop / Anand / Forex Plastic/ Nagalia/Trading Company
138.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor / Responsive / Premier Vinyl flooring / Regent / Armstrong
139.	PVC flushing cistern	Commander /Johnson Pedder / Parryware / Duralite/ Geberit
140.	PVC Pipes & fitting SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Prince / Supreme / Finolex /SKF / ORI PLAST / Kasta / Vector
141.	PVC Water Stops	Prince , Supreme , Finolex , Oriplast, BASF , Maruti
142.	Polyethylene Storage Tank	Sintex / Polycon/ Fusion / Plasto
143.	R.O. System	Ion Exchange/ Sterling India Ltd. / Pentair water /
144.	Reinforcement Steel	SAIL/RINL/TISCO/IISCO
145.	RQRC Hydrant	Harvel/Alprene/Rain Bird, USA
146.	RQRC Key	Harvel/ Aqua/ Drip& Drip
147.	Sensor Operated Auto Flushing System Urinals	Jaquar / AOS-Robo/U-tec/Angash/Euronics
148.	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes /SK Precast Concrete/ Advent concreteovision
149.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon / Pidilite / Choksey /Wacker / Forsoc / Cico/Dow Corning / Sika/
150.	Sluice valve / NRV	Kirloskar/IVC/Kilburn /Zoloto/Castle/ Leader / L&T/Audco
151.	Solar Hot water system	Tata BP Solar / EPL India Limited / Solahart (India), BHEL, BEL
152.	Solenoid valve	Rain Bird, USA/Toro/Nelson,
153.	SS Gratings, Soap Dish Towel Rail etc.	Camry/Glacier/Gem
154.	Stainless Steel	Salem Steel or as approved E-in-Charge
155.	Stainless Steel bolts, Washers and Nuts	Kundan / Puja / Atul
156.	Stainless Steel Clamps	Hilti /Intellotech Konzept
157.	Stainless steel CP Grating	Chilly / Camry
158.	Stainless Steel D-handles	D-line / Giesse /Dorma
159.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
160.	Stainless Steel Pressure Plate Screws	Kundan/ Puja/ Atul
161.	Stainless Steel Screw for Fabrication and fixing of Windows	Kundan / Puja / Atul
162.	Stainless Steel Sink	Hindware / Jayna / Neelkanth / Nirali /

		Kingston /AMC/ Orient / Commander
163.	Stone ware pipes & Gully Traps	Perfect / SKF/ R.K/ Hind / Anand
164.	Submersible Drainage pump	Jyoti / Crompton/ Kirloskar/ KSB /Grundfos/ Mather & Platt / JS/Wilo/ITT
165.	Sunken Portion Treatment	Choksey / Sika / Cico, MC Bouchemie / MC Bouchemie / BASF
166.	Super plasticizer	CICO, MC Bauchemie (India) Pvt Ltd, Roffes Construction Chemicals, Pidilite Industries
167.	Tiles: Ceramic tiles	Bell/ Somany / H.R.Johnson / Kajaria / Spartek / Orient / Nitco
168.	Tiles: Glass Mosaic Tiles	Mridul/ Italias/ Bisazza/ Pace India
169.	Tiles: Glazed tiles	Bell/ Somany / Johnson / Kajaria / Spartek / Orient / Nitco
170.	Tiles: Vitrified Tiles	Bell/ Somany / H.R.Johnson / Kajaria / Spartek / Orient / Nitco /RAK
171.	UPVC Pipes & fittings	Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral
172.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
173.	Valve Box	Rain Bird, USA/Carson Brook, USA/Dura,
174.	Veneered Particle Board	Duro / Greenply / Century / Kitply / Greenlam / Novapan / Merino / Euro/ National/ Anchor / Action Tesa / Durian
175.	VFD Pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt / Ebara.
176.	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal
177.	Vitreous China/ Sanitary ware	Parryware / Neycer / Cera / Hindware/ Kohler/ Grohe
178.	Water Cooler	Blue Star/Voltas/Usha/Godrej
179.	Water Meter	Capstan / Kranti/ Anand/ Kant
180.	Water Proofing Agencies	Shalimar Tar products / IWL (India) Ltd./ Llyod Insulations India Ltd./ Chemisol Adhesive Pvt. Ltd. Mumbai / Indian Water proofing / Overseas Water proofing / (Chemistik) Texas Ltd. / Fosroc / Sika/ Cico/ MC Boucheme
181.	Water Proofing Materials	Shalimar Tar products / IWL (India) Ltd./ M/S Llyod Insulations India Ltd./ MIS Chemisol Adhesive Pvt. Ltd. Mumbai (Chemistik) Texas Ltd. / Fosroc / Sika / Cico / MC Boucheme
182.	Water supply pumps	KSB/ Grunfos/ Kirloskar/ Crompton/ Mather & Platt/ Ebara.
183.	White Glazed Fire Clay Sink	Sanfire/ Cera / Neycer / Hindware
184.	Wooden Laminated Flooring	Faus / Scheit / Kaind / Nitco /Euro / Pargo

2. Electrical Work

S.No	Description	Make/manufacturer
1.	11 KV VCB Panel	L&T, ABB , Crompton,Areva , Schneider
2.	11KV, 433 V OLTC oil type transformer	Crompton Grieves, ABB, Siemens, Areva, Kirloskar Electric, Andrew Yule, Voltsamp, BHEL, Sudhir IVL
3.	A/C cutlet 32 Amps with MCB	Hensel/ North West/ Crabtree /Adhunik
4.	A/C Outlets	North West/ MDS-Legrand/ Crabtree / Adhunik
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), ABB (emax).
6.	APFC Panels	L&T, Siemens (Siepan), SPC Electrotech, GE
7.	APFC-Relay	L&T, GE, Siemens, Neptune, Schneider
8.	ATS	L&T, Asco, Mitsubishi, Schneider Electric
9.	Auxiliary relays compatible with PLC etc.	Siemens, L&T, 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, Caldye, Expo-Fyn, BCH, HBL
13.	Brass compression gland (Heavy duty)	Commex, Gripwell
14.	Bus bar	Jindal/ Hindalco
15.	Bus trunking , rising mains, end feed unit, top-off box(plug-in type)	L&T, ABB, Siemens, Schneider , C&S, Tricolite, zeta
16.	Cable lugs & gland	Dowel, Jhonson, Gripwell, Comex, Hex, Comet
17.	Capacitors with harmonic filters	Universal, Epcos, L&T, GE, Meher, C&S, Asian, Fraco
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, Commscope.
21.	Colour Monitor	Samsung , Philips, LG
22.	Contacts	ABB, L&T, Schneider, Siemens, C&S.
23.	Control Cables	Polycab, Nicco, Ecko, UIL, KEI
24.	Control fuse base with HRC fuse / HRC Fuse	L&T, GE, Siemens, ABB, Alstom, C&S, Bussman,
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)	Elektrone, Havell's, RR Cables, Harsh

28.	Crimping lugs/thimbles	Dowells, Hex, comet
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 & L.V. panel board capacitor control panel (Bolted / Folded fabrication)	L&T, ABB, Schneider, AEI, Kappa, Pragati, Gilbert
32.	Cubicle type fuse unit	Siemens, L&T, ABB, Schneider, C&S
33.	Data Outlets	BELDEN /LEIONI /SYSTEMAX /SIMONE
34.	DB's	Havells, Indonasian, Legrand, Hager, Schneider, ABB
35.	DG Set- Alternator	Stamford, Lorey Somer, kirloskar, toyo denki, avk
36.	DG sets package	Jakson Engineers, TIL, Sudhir Genset, Caterpillar, Sterling generators ltd., Perkins, Kirloskar
37.	Diesel engine	Cummins, Mitsubishi, Perkins, Caterpillar, Kirloskar, Ashok Leyland
38.	Digital lighting control system	Aura dimming, relux controls, lightolier control, effectron, Philips, Schneider.
39.	Digital Numerical Relays	L&T, ABB, Siemens, Schneider, Areva
40.	DWC HDPE Pipe	DURA-LINE, REX, CARLON, EMTELLE
41.	Energy / Digital meters	Enercon, Alacirity, 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, Advance Panel, Adlec, Tricolite, Sudhir, Zeta.
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 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	Crompton, ABB, Alstom, Siemens, C&S, Schneider, Areva, Advance Panel & Switchgear, Ambit, 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	MDS, Havells, ABB, Hager, Legrand, Northwest
56.	Insulators	Jaya Shree, Modern, IEC, WSI.
57.	Intelligent detectors & hooters & accessories	Notifire, Honeywell, Johnson Control, Schneider
58.	Intelligent fire alarm panel	Notifire, Honeywell, Johnson Control, Schneider
59.	Inverter	Microtek , Luminous , Su-Kam
60.	Isolators	Siemens, L&T, ABB
61.	Jointing kit	Reychem, Xicon, Birla 3M
62.	Light fittings/ Lamps	Philips, Wipro, Bajaj, Havells, Keslec, Pierlite
63.	Lightning arrestor	Indelec, Gersom, Helitta, MDS, Hager, Duval Messin, L&P Electro, LPI
64.	LT cables (XLPE,PVC)	Cable Corporation Of India, Universal, Havells Nicco, Polycab, Finolex, Rallison, Gloster, Elektron,KEI
65.	LT panels	ABB, L&T, GE, Siemens, Schneider, SPC, Advance Panel, Adlec, Tricolite, Sudhir, Jakson, Zeta.
66.	Lugs	Dowell's/ HAX
67.	MCBS , RCCB & DB	Legrand, Schneider, Siemens, GE, ABB, Hager, L&T, Havells MDS, Adhunik,
68.	MCCB with variable Microprocessor based (O/C, S/C, E/F) / Thermo magnetic releases	L&T D-sine , Siemens(sentron) , Merlin Gerin (NS compact) , ABB-ISO Max
69.	Measuring instruments (Digital type)	L&T, Ducati, Conzerv, HPL, Siemens
70.	Modular switches, socket outlets and wiring accessories with moulded cover plate	Clipsal/ MK/ Legrand /PHILIPS/ SIEMENS
71.	Modular switches, sockets, boxes , accessories	Anchor (ave), MK (wraparound) , Siemens, legrand (mosiac), L&T, clipsal (neo`c' metro), Havells (piccadily), Philips
72.	MS Conduit	Supreme, BEC, AKG, Steel Craft, Mk, NIC, Kalinga
73.	MS Conduit accessories	Rama, Novel, BEC, AKG, steel craft, MK, NIC
74.	Multi-function Meter	L&T, ABB , Siemens, Schneider, Ducati, CMS
75.	Overload relay single phase preventer	Tesys, ABB, L&T, Siemens, Areva
76.	Panel accessories	L&T,Rishab, Siemens, BCH
77.	Poles- Light	Bajaj, Transrail ,Power control corp, National tubing co, sancube, Hilite
78.	Power capacitor with batter than 14% harmonic filter at 525 V (long	L&T(Meher) , EPCOS (Siemens)/ DUCAT/ Neptune

	life mixed Dielectric)	
79.	Programmable timer (self-powered electronic digital)	L&T, Siemens, Hagar, MDS, Legrand
80.	Projection system	Aties, Harmonpro, JBL
81.	Protective relays (Microprocessor based compatible with PC & PLC)	Siemens, L&T, ABB, Areva
82.	Push button, indicating lamps (led type)	Siemens, L&T, ABB, Schneider, C&S
83.	PVC conduit	Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG
84.	PVC conduit Accessories	Precision, Avonplast, Clipsal, Harsh, Polypack, BEC, AKG.
85.	PVC Insulated copper wire / copper Cables 1.1 KV grade (FRLS)	L&T, Finolex, Ralison, Havells, Polycab, Finolex, Batra Henlay, GEM CAB, Elektron
86.	PVC mat	Premier Polyfilm Ltd, Polyelectrosafe, Challenger, Electro Mat,
87.	Race ways/ Cable Trays/ Floor trunking / wall channels	MK, Legrand, Bhopal Switchgear Pvt Ltd, Profab, Indiana, Needo, Steelite, MEM, Rico Steel, Pilco, Slotco
88.	Relay and Control Panel	Siemens Approved Panel Builder.LPS
89.	Relays- Auxiliary / Numerical /Bi metal relay	L&T, GE, ABB, Alstom, Easun Reyrolle, Siemens, Areva.
90.	Sandwiched bus-duct	Siemens, ABB, Schneider, C&S Electric, L&T
91.	Selector switch	Salzer, Kaycee, Siemens, HPL, L&T, BCH
92.	Selector Switch	Kaycee/ Salzer
93.	Starters	Siemens, L&T, ABB, Schneider, C&S, Areva
94.	Surge diverter	Tercel, ABB, Siemens, Emerson, Hager, Phoenix, Legrand
95.	Tap-off, Splitter box	Zinwell, Novatron, Catvision
96.	Telephone cables/ wires	Polycab, Finolex, Havells, RR Kabel, L&T, Bonton, Skytone, Ralison, Cable corporation of India, Gloster
97.	Telephone tag block	Krone, Tvs, R&M, Phoenix, Wago
98.	Telephone wires	Bonton/ Delton/ Polycab
99.	Terminal strip	Connectwell, Phoenix, WAGO
100.	Termination Kits	Raychem, Birla, 3M
101.	Transformer- Oil type /distribution	Crompton, BHEL, Voltamp, Kirlosker
102.	Trivector - Meter (Digital type) only for SEB supply.	L&T, Secure, Enercon, Siemens,
103.	UPS	Emerson, A.P.C, Socomec, AOS, PCI, GE, Gutoor, Mistubishi, Siemens
104.	Voltmeter and ammeter	AE, Meco, Universal, Rishab, Yokins
3. <u>Fuel and HSD Tank</u>		

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
4.	<u>SOLAR POWER</u>	
S. No.	Details of equipment/ material	Make/ Manufacturer
a.	Solar system	Tata BP Solar / EPL India Limited / Solahart (India), BHEL, BEL

5. 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
2.	Fire Alarm Detectors, Hooters, Manual Call Point UL Listed	MORLAY/SIEMENS FIRE FINDER /ANSUL/ Notifier/ IFC (Johnson Control)
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

6. LIFTS:

S. No.	Details of equipment / material	Make/ Manufacturer
1	Lifts	OTIS/ Kone / Mitsubishi/ Schindler/ Johnson Lifts Pvt. Ltd. Chennai

7. 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

8. HOT WATER GENERATOR SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Hot water generators	Enmax/ sunmax/ goodsun / tata bp solar/ Thermax/ voilation projects
2.	Recirculating pumps	Grundfoss/ ebara /Wilo
3.	Ball valve	Rb/ itap/ leader,
4.	Check valve	Caliber/ leader / peco
5.	“Y” – strainer	Caliber/ leader/ flowtech /strainwell
6.	Air release valve	Rb/ tbs/ cimbrion
7.	GI/MS pipes	Tata / jindal / BST/ SAIL
8.	Insulation	Vidoflex/ almaxflex
9.	Temperature indicator	H-guru/ omicron / scientific

10.	Pressure indicator	H-guru/ fiebig/ scientific
9. <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
10. <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
11. <u>BUILDING MANAGEMENT SYSTEM</u>		
S. No.	Details of equipment/ material	Make/ Manufacturer
1.	2-way Motorized Valve	Johnson/ Sontay Siemens /Honeywell
2.	Air ,Water Pressure Sensors	Johnson / Sontay/ Greystone/ Siemens/ Honeywell
3.	Air DP switches	Johnson /Sontay/ Greystone / Siemens /Honeywell
4.	CO2 Sensor	Honeywell / Siemens / Sontay
5.	Colour Printer	Cannon / Epson/ Hewlett Packard
6.	Colour Monitor	Dell(Ultra Sharp) / HP(Pavillion) / ASUS /Samsung(Sync Master) / LG (Flatron)
7.	Communication Cables / Signal Cable/ Control Cables	Finolex / Elektron / Delton / Fusion Polymers / Polycab / Excel / Varsha/ Teleflex/ Finecore
8.	Current Relay	Veris / Seto / Mamac/Omron / ABB
9.	Damper Actuator	Johnson/ Siemens
10.	DDC Controllers	Johnson/ Cylon/ Siemens/ Honeywell
11.	DP Switch – Air/ Water	Honeywell / Sontay / Siemens
12.	Duct, Room Temperature/ RH Sensors /Humidity Sensor	Johnson / Sontay / Greystone/ Siemens/ Honeywell/ Alerton
13.	Duct Static Pressure Sensor / Temperature Sensor	Honeywell / Alerton / Siemens
14.	Flame Proof Level Switch / Level Transmitter	Veksler / Filpro / Sontay / Techtrol

15.	Flow Meter	Schenitech / Honeywell / Kampstrup
16.	Immersion Temperature Sensor	Honeywell / Alerton / Siemens/ Johnson / Sontay / Greystone
17.	Interfaces , Gateways , Network Controllers	Johnson/ Cylon/ Siemens/ Honeywell
18.	LAN cables for BMS Network	Belden / D-Link / Avaya
19.	Level Switches	Kele /Veksler /Fluitech /Minilec /Honeywell
20.	Operation Workstation Hardware Software	IBM / HP/ Dell/ Johnson/ Cylon/ Siemens/ Honeywell
21.	Outside Air Temperature Sensor / Outside Temperature & RH sensor	Honeywell / Alerton / Siemens / Johnson / Sontay / Greystone
22.	Personal Computer	HP / DELL / LENOVO / TOSHIBA
23.	PH Sensor / TDS Sensor	Honeywell / Hach / Greisinger
24.	Pressure Transmitter – Water	Honeywell / Alerton / Siemens
25.	Room Humidity Sensor	Honeywell / Alerton / Siemens
26.	Room Temperature Sensor	Honeywell / Alerton / Siemens
27.	Room Thermostat for FCU	Johnson / Siemens/ Anchor/ Honeywell
28.	Standalone 16 bit DDCs	Honeywell-WEBS / Alerton / Spyder / Siemens (PX SERIES)
29.	Variable Frequency Drive	Johnson / Siemens /Emerson /Honeywell / ABB
30.	Voltage / Current / Power Factor Transducer	SETO / ABB / L&T / Enercon / SETCO
31.	Water DP Switches	Sontay / Kele
32.	Water Flow Switch	Honeywell / Alerton / Siemens
33.	Water Level Switch	Veksler / Filpro / Sontay
34.	Web Based BMS Software with unlimited user license	Siemens(Design Insight) / Honeywell-WEBS / Alerton
35.	Web Based Router / Network Area Controller	Honeywell-WEBS / Alerton / Siemens

12. HVAC

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	HVAC Contractor	ETA / Blue Star / Suvidha / Voltas / Mistcold / Dyna Aircon/sterling Wilson
2.	Water / Air Cooled Screw Chilling Machine (ARI Certified)	Carrier / McQuay / York/ Trane
3.	Acoustically Insulated Inline Fans	Humidin / Airflow /Alfa Therm / Caryaire/Wolter/Kruger/Nicotra
4.	AHU / Air-washer Fans (AMCA Certified for Sound & Performance)	Comferi / Kruger / Yilida / Greenheck / Nicotra
5.	Air Distribution, Ducting GI Sheets	Sail , Tata , Jindal
6.	Air Handling Unit	Flaktwoods / DRI / Edgetech / Zeco/ Balance Air / Waves / Fedders Lloyd/ Caryaire, Airflow
7.	Air/Water Cooled Chilling Machine - Screw Chillers	Carrier / York/ Trane, Hitachi/ Voltas/ Climaveneta / Dunham Bush/ Mc Quay

8.	Air-Circuit Breaker	L&T / Siemens / ABB / Schneider
9.	Aluminium Sheet/ Sections	Hindalco / Balco / Nalco/ Jindal
10.	Auto Air Vent Valve	Anergy / Rapid Cool / Sant/ Rapid control
11.	Automatic Air Vent	ABB/ Seimens/ Anergy/ Rapid Control
12.	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	System Air / Kruger / Airflow / ABB / Humidin / Alfa Therm / Nicotra
13.	Balancing Valves (Water Duty), Butterfly Valves (W D), Check Valves(W D), Purge Valve, Drain Valve	Audco, Advance , Castle, Inter Valve
14.	Ball valves (with & Without strainers)	Rapid control, Leader ,Castle
15.	CAV / VAV Boxes	Titus / Carrier / Trox
16.	Centrifugal Fans, Fan Section	Nicotra, Krugger, Humidin, Brightflow
17.	Change Over Switch	Elecon / L&T/ Siemens
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
20.	Cooling Tower	Bell / Paharpur / Case/ Mihir/ Advance
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
25.	Dirt & Air Separator	Anergy / Spirotech / Spirotherm
26.	Dual Plate Check Valve	Advance / Honeywell / Larsen Toubro
27.	Duct / Pipe Support	Easyflex / Resistoflex / Diamond
28.	Duct UVGI System (Ultra Violet Germicidal Irradiation System)	Ruks / Trimed / Magneto
29.	Electric Motors	Siemens , ABB , Crompton
30.	Electrical Panel & Sub-panels	EAP / Adlec / Advance / Ace Autotmaton/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
34.	Extruded Aluminium Grills, Diffusers	Caryaire , Ravistar , Servex ,Airflow
35.	Extruded aluminum grills / Diffusers / Dampers	Caryaire / Mapro / Ravistar / Dynacraft / Balance Air
36.	Factory Fabricated Duct & Flanges	Rolastar / Zeco / G P Spiro / Aircon/ Ductofab / Technofab
37.	Fan Coil Unit (AMCA Certified Fan for Sound & Performance)	Carrier / Caryaire / Edgetech / Waves / Zeco / Fedders Lloyd /Daikin / VTS / Flaktwood

38.	Fibre Glass Rigid Board	U.P.Twiga / Owen corning / Kimco/ Lloyd insulation
39.	Fire Damper Actuator	Belimo / Siemens / Danfoss
40.	Fire Smoke Damper	Caryaire / Ravistar / Titus / Trox / Airflow/Ruskin/ Systemair/ Airflow
41.	Flexible Pipe Connection	Resistoflex, Kanwal
42.	Galvanised MS Sheet	SAIL / Tata / Jindal
43.	Globe valve / Gate valve / Ball valve	Leader / Sant / Zoloto / Rapid Cool / L&T / Kirloskar
44.	Heat / Energy Recovery Wheel	DRI / Novelair-Sevcon / Bryair / Ostberg / Flaktwoods
45.	Horizontal Split Casing / End Suction / Mono-block Pump Sets (For Condenser Water Pumps / Primary CHW Pumps / Hot Water)	Kirloskar / Beacon / ITT / Armstrong / Grundfoss/ Mather & Platt /WILO
46.	Hot Water Generator & Pan Humidifier	Sant / Enmax / Rapid Control / KEPL/ Khokhar/ Emerald
47.	HRC Fuse and Fittings	L&T / Siemens / GE/ C & S
48.	Indicating Lamps	Siemens / L&T/ Emco
49.	Industrial Type Thermometer	Emerald / Guru /Waaree/Fie big/ H- Guru
50.	Insulated Flexible Duct	Caryaire / Atco / GP Spiro
51.	Insulation Fibre Glass – Aluminium faced, and, XPS	UP Twiga , Owens Corning , Kimmco, Supreme, Lloyds
52.	Laminar Flow Diffusers	Ravistar ,Systemair, Airflow
53.	M.C.C.B. / MCB / MPCB	L&T / GE / Siemens / ABB / Schneider/ MDS
54.	Manual / Automatic Balancing Valves	Advance / Sevcon / Technoflow (Frese) / TA / Honeywell
55.	Modulating Motor	Honeywell , Johnson , Belimo , Rapid Control
56.	MS Painted / GI Cable Tray (Factory Fabricated)	Indiana / Slotco / Pilco / Kepl / Ricco
57.	Nitrile Rubber Insulation (For Pipe Insulation)	Armaflex / Superlon / K-flex
58.	Packaged Type Scrubber / Air Washer	Waves / Airflow / Humidin / Ambassder / Zeco / Balance Air
59.	Paints	Shalimar / Asian / Nerolac /Burger
60.	Piping (Chilled / Drain)	Jindal, TATA/ SAIL/ Mukut
61.	Power & Control Cables	Havells / Finolex/ Power Age/ Gloster / Universal / Polycab / National/CCI
62.	Pre, Fine & Hepa Filters	Thermodyne / Shree Multitech Engineers / Purolator / Spectrum / Dyna Filters ,Macro scientific
63.	Pre-Insulted Fabricated Ducts	Pal / P3 / kingspen
64.	Pressure Gauges	Feibig / Emerald / Waaree/H Guru
65.	Pressure Independent Balancing Cum 2-way Control Valve (Single Body)	Sevcon / Technoflow (Frese) / TA / Honeywell /Belimo /danfoss
66.	Propeller Fans	Caryaire , CG, Magneto,Khaitan,Alstom

67.	Proportional Thermostat	Honeywell , Johnson ,Anergy Controls
68.	Red Oxide, Zinc Chromate Primer	ICI , Berger
69.	Rotary Switches	L&T / Siemens / GE / BCH
70.	RP Tissue	UP Twiga , Styrene Packing
71.	Scale Preventer System	Scale Guard (Aqua Treat) / Crystallo / Scaloid
72.	Selector & Toggle Switch	Kaycee / L&T/Siemens
73.	Single Phase Preventer	L&T / Minilec / Siemens
74.	Split Casing, Monoblock Pump - HVAC	Kirloskar/ Beacon/ ITT/ Armstrong/ Grundfoss/ Mather & Platt/ WILO
75.	Starters, Contactors, Push Buttons, Overload Relay	L&T / GE / Siemens / BCH / Schneider / Hager
76.	Suction guide	Anergy/ ABB/ Sandnu
77.	Tar felt / CPRX compound	Shalimar tar product/Asian
78.	Thermometers	H.Guru/ Emerald/ Japsin/ Fiebig
79.	Three phase motors	ABB / CG / Siemens / Bahrat Bijli / Kirloskar
80.	Time Delay Device	Siemens / L&T/ BCH
81.	Two Way, Three Way Valves	Honeywell , Johnson , Sauter, Landis & Staefa, Anergy
82.	Vacuum Degasser	Spirotech / Spirotherm
83.	Variable Frequency Drive	Danfoss / ABB / Schneider /Siemens/ Allen Bradley
84.	Variable Speed Pumping System (For Secondary Chilled Water Pumps Motors)	ITT / Armstrong / Grundfoss/WILO
85.	Vibration Isolation Spring & Flexible Pipe Connector	Resistoflex / Diamond/ Kanwal
86.	Voltmeter / Ammeter	A.E. / IMP./ Conzerve /ABB /L&T
87.	Water Flow Switch	Anergy / Rapid Cool / Honeywell / Rapid control
88.	Water Piping (MS & GI)	Tata / SAIL / Jindal
89.	Welding Rods	Advani / L&T
90.	Y-strainer / Pot – strainer	Rapid control , Sandnu , Emerald , Maharaja, Sant

13. 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 Contractors	Seimens , L&T , ABB
3.	Air Release Valve	Rb , Tbs ,Cimbrio, Zoloto
4.	Alarm valve & Hydraulic (Alarm motor with coupling)	HD fire protect/ Mather&Platt
5.	Alternator	Stamford/ Lorey Somer/ kirloskar/ toyo denki/ avk

6.	Ammeter, Voltmeter, PF, kW, Hz, meter (Analogue), Energy Meter	AE/ Enercon/Conzerve
7.	Ball Valve	Rb , Zoloto , Leader , Danfoss , Sant , Rapid , Castel, Emerald Audco, Sant
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
12.	Cables	Universal , CCI , Gloster, Elektron, Polycab, Finolex
13.	Control / Potential / Current Transformer	Precise, Gillbert & Maxwell/ AE/ Kappa
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
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	Ceasefire / Newage / Safex/ Minimax/ Usha fire
19.	Fire Buckets	Safex , Minimax, Peter Autokit
20.	Fire Extinguisher	Safex , Minimax , Peterautokit , Omaxe, Padmini Fire. Ceasefire, Newage
21.	Fire Hose Pipes	Ceasefire / Newage / Safex/ jayshee/ ushafire
22.	Fire Hydrant Valves	Ceasefire / Newage / Safex/ Minimax/ Peterautokit
23.	Fire Man's Axe	Ceasefire / Newage / Safex
24.	Flexible trailing cable for lifts	Lapp Kabel or approved equivalent
25.	Flow switch	Potter / System sensors/ Rapid flow
26.	Foot Valve (Cast iron/ Gunmetal)	Kirloskar/ Neta/ Leader/ Zoloto
27.	Forged steel fitting	V.S.Forge/True Forge / DRP-M
28.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini / Kanwal
29.	GI clamps	Chilly/Hilti/GMGR
30.	GI , MS Pipes	Tata , Jindal , BST , Praksh Surya
31.	Gunmetal Branch Pipe	Newage , Ushafire , Winco , Kailash
32.	Gunmetal Valves (fullway Check and Globe Valves)	Audco / Zoloto / Sant
33.	Hose Reel	Minimax ,Usha Fire , Omaxe, Padmini Fire, Newage , Minimax, Ceasefire
34.	Hydrant Valves	Newage , Minimax , Peterautokit,Safex, Ceasefire
35.	Indicating Lamps & Push Buttons	L&T , Technico , Led Type

36.	Non-Return Valve – Swing	Intervalve ,Audco (Cast Iron), Zoloto, Sant
37.	Nozzle	Newage , Winco , Ushafire , Kailash
38.	Over Load Relays	GE , L&T , Siemens
39.	Pipe coat material (pipe protection)	Pypcoat / Makphalt / Safex
40.	Pipe External Protection	Pipe Kote (4mm thick) equivalent or other approved makes
41.	Pipe Hangers	Chilly/ GMGR
42.	Power/auxiliary Contactors	MG/ Siemens/ ABB/GE/L&T
43.	Pressure guage	Fiebig/ H.GURU
44.	Pressure Switch	Danfoss , Indfoss , Switzer
45.	Push Buttons, Indicating lamps LED	MG/ Larsen&Toubro/ Schneider
46.	RRL Hose	Jayshee , Newage , Ushafire , Padmini Fire, Ceasefire, Safeguard ,Superex , Jyoti
47.	Single Phase Preventer	L&T , Minilac, Grinnel, Tyco, Yiking, Eversafe
48.	Sluice Valves	Kirloskar , Audco , Unik , Leader, Zoloto, Sant
49.	Solenoid valve, Spray nozzle	Eversafe / HD / Tyco
50.	Sprinkler (ICV)	HD , Fireasfe , Reliable , Wormald, Padmini Fire
51.	Sprinkler Heads	Grinnel / Tyco / Yiking / Eversafe/ Reliable/ HD/ Fireasfe / Padmini Fire
52.	Steel flexible extension	Eversafe / Safex
53.	Suction “Y” Type Strainer	Kirloskar , Leader , Zoloto, Sant
54.	Vibration Eliminator	Resistoflex / D wren / Kanwal
55.	Weld Electrodes	Advani/ ESAB/ L&T

14. 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

15. 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
16. <u>DATA NETWORKING</u>		
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

17. 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
<p>Note:-</p> <ol style="list-style-type: none"> 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. 		