TENDER DOCUMENT

TENDER No.: DLI/ENGG/PI-588(1)/C-01

FOR

CONSTRUCTION OF METROLOGY (STANDARD) BLOCK AT
NPL COMPLEX
DR. K.S. KRISHNAN ROAD, NEW DELHI

FOR

NATIONAL PHYSICAL LABORATORY (COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)

VOLUME – IIB

ADDITIONAL SPECIFICATIONS

EXECUTING AGENCY

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ADDITIONAL SPECIFICATIONS FOR CIVIL WORKS

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1.0 PREAMBLE

1.01 In addition to the general obligation of the Contractor during defect liability period, the Contractor shall guarantee successful performance of waterproofing treatments for a period of ten years from the certified date of completion of the work. The Engineer shall prescribe the form and the manner of executing such guarantees. The Contractor hereby confirms that there is nothing in the items/specifications (or a shortcoming therein) as will prevent such successful performance. The work shall be executed through approved specialists experienced in the respective trades.

1.02 Any builder’s work required as part of electrical and other installation shall be executed by the Contractor as directed under this contract at his own cost.

1.03 The tenderer shall submit the scheme for excavation before start of work for Engineer’s approval. The payment of excavation shall be released as per approved scheme or actual work done, whichever is less.

1.04 The tenderer shall be required to submit and take approval from the Engineer of shop drawings of the items of work specified in the specifications or as directed from time to time. No extra payment shall be made for the same. Shop drawings shall be in metric units and shall be prepared in a format approved by the engineer.

EXPANSION JOINTS

2.0 Technical Specification

**Armour Board**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Units</th>
<th>Test Result</th>
<th>Tested as per</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Water Absorption</td>
<td>Kg / Sq. Mtr</td>
<td>0.45 Max</td>
<td>ASTM- D3575</td>
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<td>2.</td>
<td>Density</td>
<td>Kg / Cu.Mtr.</td>
<td>28 Min.</td>
<td>do</td>
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<tr>
<td>3.</td>
<td>Compression Strength</td>
<td>Kg / Cm.Sq</td>
<td>0.21 Min.</td>
<td>do</td>
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</tbody>
</table>
### (25% Deflection)

<table>
<thead>
<tr>
<th>No.</th>
<th>Specification</th>
<th>Unit</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Compression Set</td>
<td>%</td>
<td>25% Max</td>
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<tr>
<td>5</td>
<td>Tensile Strength</td>
<td>Kg/ Sq. Cm</td>
<td>1.8 Min. do</td>
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<tr>
<td>6</td>
<td>Elongation</td>
<td>%</td>
<td>60 Min.</td>
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</tbody>
</table>

#### 2.01 Laying Procedure

While creating expansion joint the armour board as manufactured by M/s Supreme Industries or equivalent will become one side of shuttering. To hold two free sides of shuttering a MS bolt of 12 MM Dia with both sides threaded will be used at every 1 Mt interval with matching nuts with concrete sleeve 50 MM x 50 MM. This bolt will taken out & hole of sleeve is to be grouted afterwards with cement mortar.

When forming expansion joint with armour board in in-situ concrete, joint sealing slots is to be formed in the following manner.

The armour board is to become one side of shuttering. Cut off a strip of armour board equal to D. Further; cut the strip along the joint length into two.

The depth of top strip should be = (1.25 W or W + 5mm whichever is less) +(W/2 or 15mm whichever is less) and the bottom strip = (D - top strip) where D = slot depth in MM \ W = slot width in MM

Pin the top strip back on to the bottom strip using nails at two-inch intervals. Ensure that the slot is clean and dry. Install a strip of filler material on top of armour board flush with finished surface using either a separation Tape/synthetic rubber based adhesive.

Just prior to Sealing pull off the top strip to create an uncontaminated sealing slots ready for preparation & sealing.

#### 2.02 Measurements

The measurement shall be taken in Square meters correct to two places of decimal for the length and breadth of the joint.

#### 2.03 Rates

The rates for the item shall include the cost of all the material, tools, and labour, involved in all the operations described above including cartage and lifts.
JOINT SEALING COMPOUND - SEALANT

2.04 The polysulphide sealant should be PIDISEAL 42 P conforming to grade BS:4254:1983 or IS-12118, Part-I&II - 1987 Pouring Grade Sealant or equivalent as approved by the Engineer-in-Charge. It should be a two-part/component sealant based on a LP liquid polysulphide polymer containing a base compound and accelerator in right proportion which, when mixed, cured by chemical reaction to form a tough flexible and resilient rubber seal.

2.05 The sealant should be a two component paste curing to firm rubber with colour of Part-A and each lot of supply shall be supported with manufacturers test certificate. Off white and of Part-B: Black Mixed Grey. This should contain 100% solid. Application temperature of sealant should be in between 5 to 45 degree Celsius. This should have hardness shore 'A' 14-19, Pot life minimum 2 hours at 25 Degree Celsius, cure rate 8 weeks at 5 Degree Celsius, 4 weeks at 15 Degree Celsius, 2 weeks at 25 Degree Celsius and 8 days at 35 Degree Celsius. Shrinkage should be less than 1%. This should have chemical resistance to spillage like dilute acids, alkalis, white spirit, lubricating oils, petrol, aviation fuels, diesel, kerosene and vegetable oils etc. When fully cured sealant must withstand wide temperature range from -40 degree to +80 degree Celsius.

2.06 These materials, when stored in original sealed containers in cool, dry place in the temperature range of 5 to 35 degree Celsius should have a shelf life of at least 12 months.

2.07 The rate of application of sealant may be calculated on the basis of the following formula:

\[
\text{Number of 1 kilograms} = 0.0015 \times L \times W \times D \\
\text{tins required Where:} \quad L = \text{Length of joint in meters} \\
W = \text{Width of joint in mm.} \\
D = \text{Depth of joint in mm.}
\]

2.08 PRIMER

It shall be PIDIPRIME A or equivalent single component primer suitable for use with polysulphide joint sealant, as approved by the Engineer-in-Charge.

2.09 JOINT SIZE

Overall width of the joint may vary in between 40mm. The maximum depth of the joint shall be as specified in item of work; out of which, the top 20mm shall be filled with the approved polysulphide joint sealing compound as mentioned above.
3.0 CONSTRUCTION PROCEDURE

3.01 Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-in-Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavements. The joint shall be 40 mm wide. The depth of the non-extruding filler pad shall be 20mm less than the depth of the concrete slab.

3.02 Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with the approved primer at the rate of 2.6 liters per 10 square meters. The expansion pad shall be properly cut to shape. Polyethylene bond breaker tape shall be applied on the top face of the pad to receive polysulphide sealant. It shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The faces of the pad against which the new concrete slab is to be laid shall also be painted with the approved primer before laying the concrete. While concreting a neat groove 40mm x 20mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish. An easily removable material shall be placed on top of the filler pad while concreting the next slab. This strip shall be removed just before sealing the joint.

3.03 For sealing the joints, the following operations shall be carried out:-

3.04 All the joint surfaces should be clean, dry and free from any loose material, dirt, rust, dust, scale, protective lacquer and grease etc.

3.05 The joints are cleared of any foreign matter to the full depth upto the top of expansion joint filler pad with a suitable tool.

3.06 The expansion joint filler material must be checked to ensure that it is tightly packed and that no gaps or voids exist at the base of the joint slot. The appropriate bond breaking tape (polyethylene) as approved by the Engineer-in-Charge should be located into the joint at the correct depth or as directed by the Engineer-in-Charge.

3.07 The joints are to be cleaned thoroughly with compressed air.

3.08 Priming is done with spray gun or by such approved methods at a rate of 2.6 liters per 10 sq. of the surface to be primed.

3.09 The primer is allowed to dry completely for at least 30 minutes, but not longer than 3 hours, before the sealant is applied.

3.10 The entire contents of the pack of curing agent shall be transferred into the base tin and mixed thoroughly for about 5 minutes until a homogenous, uniformly coloured material is obtained.

3.11 The sealant shall be poured immediately after mixing within the sealant pot-life i.e. 2 hours. The air temperature shall be above +5 deg. Celsius, directly
into horizontal joints. Sealant surface should be immediately tooled to a smooth finish before it begins to set.

3.12 To prevent accidental spillage of sealant on the top surface and to give a neat finish, masking tape should be applied on front edges of joint in such a manner that the material will not be spilled on the exposed surface of the concrete. Any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned. All necessary precautions as per the manufacturer's recommendations shall be taken.

3.13 Immediately after filling the joints, the sealant should be tooled either with a stainless steel or wooden spatula of the size of the joint to give a smooth surface. While tooing, the spatula should be wetted with a wetting agent like white spirit or kerosene. Masking tape shall be removed immediately after the sealant has been tooled. By tooing, the sealant is compressed with the result that air bubbles if any, are broken up and the sealant becomes free of voids and there is a proper adhesion of the sealant to the sides of the joints.

3.14 **MEASUREMENT**

The measurement of the specified size of the joint shall be recorded in running meters correct to two places of decimal.

3.15 **RATES**

Rate for the item shall include the cost of all materials, plant, machinery and labour involved in all operations described above, including all cartage and lifts, complete for a successful completion of the work.
4.0 ALUMINIUM DOORS & WINDOWS, STRUCTURAL GLAZING AND ALUMINIUM CLADDING

4.01 General

4.02 Aluminium doors, windows, curtain wall etc. shall be fabricated from approved extruded sections and the manufacture & installation shall be carried out by an approved specialised agency. Unless otherwise specified the fabrication shall be done with heavy gauge extruded box sections. The sections free of scratches shall be of the sizes & details as shown on drawings. The details shown on the drawings indicate generally the sizes of the component parts and the general standards. These may be varied to some extent to suit the standards adopted by the manufacturers of the aluminium work.

All materials and details especially the weather-strip, gaskets and sealants shall be of approved high quality material capable of resisting the local climatic and environmental requirements.

4.03 Shop Drawings and Samples

The contractor shall submit complete shop drawings and samples of each type of door, window, ventilators curtain wall and other aluminium works, to the Engineer for his approval. The shop drawings shall be prepared after taking actual measurements at the site. The shop drawings shall show full size sections of doors, windows, etc. thickness of metal, details of construction, details of glazing, anchoring details, hardware as well as connection of curtain wall windows, doors and other metal work to adjacent work. Samples of all joints and methods of fastening and joining etc. also shall be submitted to the Engineer for approval well in advance of commencing the work. Samples of the actual work shall be installed at the site and got approved before proceeding with the work.

4.04 Sections

The aluminium extrusions shall be from HINDALCO, INDAL, BHORUKA or equal approved make. The sections shall be extruded from aluminium alloy HE9WP of IS 733 of commercial quality and free from all defects impairing appearance, strength and durability. Hollow Box sections shall be extruded from HP9-WP Aluminium alloy as per IS:1285. The permissible dimensional tolerances of the extruded sections shall be such as not to impair the proper and smooth function/operation and appearance of doors and windows. For any excess weight of section used nothing extra shall be paid.
The sections shall also conform to the following parameters:

i) Minimum tensile strength - 19 kg./mm²

ii) Maximum allowable deviation in length from a straight line of 0.5mm/metre.

iii) Maximum allowable deviation from straight of 1 degree.

iv) Maximum permissible twist of 0.5mm metre.

v) Maximum variation in flatness of not more than 0.125 x width/25.

4.05 Anodizing/ Powder Coating

All aluminium materials used shall be specially anodized for protection against corrosion local environment in approved shade. The anodic coating shall conform to IS 1868-1968 and shall be of AC25 grade with minimum thickness of 25 Microns when measured as per IS:660/2-1970 and density shall be atleas 32 MG/sqm. The anodic coating shall be double sealed or alternatively sealed with steam and shall be of a minimum thickness of 50 micron. The anodic coating shall be tested in an approved laboratory by Eddy current method as per IS:6012 for thickness. Sulphuric acid shall be used as the electrolyte for the anodic process. Prior to anodizing all aluminium shall be rendered uniform in appearance free from disfiguring scratches, stains or other blemishes and etched in a caustic soda solution. Requisite tests shall also be carried out at the site as required by the Engineer and the contractor shall arrange all assistance and equipments required for the purpose.

Wherever specified, polyester grade machine applied powder coating of minimum thickness 35-40 microns shall be provided and such coating shall be of approved shade. Samples of powder coated panels shall be submitted by the Contractor well in advance to commencement of work from the approved agency. Pretreatment to frames shall be carried out to suit the requirements of final finishing as stated above.

4.06 Protection and Handling

All aluminium members shall be wrapped with approved self adhesive non-staining PVC tapes. and crated in a suitable manner to protect the material against any damage during transportation. The loading, unloading, storing shall be carried out in an approved manner with utmost care.

4.07 EPDM Gaskets

EPDM gaskets of approved make, size and profile shall be provided and installed at all locations as shown and as called for to render the installation absolutely air and weather tight.
4.08 **Sealant**

The gaps between the Aluminium member and the perimeter and also any gaps in the door and window sections themselves shall be raked out as directed and filled with silicon sealant of approved make and colour and weather resistant to ensure complete water-tightness.

The silicon sealant shall be of such colour, and composition that it would not stain the masonry/concrete work, shall receive paint without bond, will not sag or run and shall not set hard or dry out under any condition of weather. Silicon sealant shall be applied with a special gun as per manufacturers recommendation.

4.09 **Aluminium Doors and Windows**

4.10 **Doors**

The kick panel shall be of 1.25 mm aluminium alloy sheet conforming to IS Designation NS 3-1/2H of IS 737-1965. Specification for Wrought Aluminium and Aluminium Alloys Sheet and strip (for general engineering purposes) and shall be screwed to the frame and the glazing bar. The hinges shall be stainless steel frictional hinges of same type as in windows but of larger size. The hinges shall normally be of 50mm projecting type. Non projecting type hinges may also be used if approved. The handles for door shall be of specified design and of same specifications as the windows. A suitable lock for door openable either from outside or inside shall be provided. In double shutter doors, the first closing shutter shall have a concealed aluminium alloy bolt at top and bottom. IT Shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter doors may be provided with a three way bolting device. Where this is provided in the case of double door, concealed aluminium bolts may not be provided.

4.11 **Side-hung Windows and Ventilators**

For fixing stainless steel hinges, slots shall be cut in the fixed frame and the hinges inserted inside and may be rivetted to the frame. The hinges shall normally be of the projecting type not less than 65 mm and not more than 75 mm wide. The pins for hinges in case of non-oxidised work shall be of stainless steel of non-magnetic type or of suitable aluminium alloy. However, in the case of anodised work only suitable aluminium alloy for pins shall be used. Friction hinges shall be provided for side-hung shutter windows - in
which case peg stay will not be required. In case of non-friction type hinges, peg stay which shall be either of cast aluminium conforming to IS Designation A.5.M of IS:617-1959 or folded from IS Designation NS4 aluminium alloy sheet conforming to IS:737-1955. It shall be 300 mm long complete with peg and locking bracket and shall have holes for keeping the shutter open in three different positions. The peg and locking bracket shall be rivetted or welded to the fixed frame.

The handle for side-hung shutters, shall be of cast aluminium conforming to IS Designation A.5.M of IS:617-1975 and mounted on a handle plate or welded or rivetted to the opening frame in such a way that it could be fixed before the shutter is glazed to match the window. The handle shall be anodised. The handle shall have a two-point nose which shall engage with an aluminium striking plate on the fixed frame in a slightly open as well as in a closed position.

4.12 Centre-hung Ventilator

This shall be hung on two pairs of cup pivots of stainless steel and rivetted to the inner and outer frames of the ventilator to permit the ventilator to swing, through an angle of approx. 85 deg. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather conditions.

Stainless steel cord pulley-wheel in a bracket shall be fitted at the sill of the ventilator with stainless steel screws rivetted or welded to the bottom inner frame bar of the ventilator in position corresponding to that of the pulley.

4.13 Fabrication

All jointing shall be of mechanical type. The aluminium sections joints shall be designed to withstand a minimum wind load of 175 kg. per sqm. The designed shall also ensure that the maximum deflection of any framing shall not exceed L/175 of the span of the member. All members shall be accurately machined and fitted to form hairline joints prior to assembly. The jointing accessories such as cleats, brackets, etc. shall be of such material as not to cause any bimetallic action. The design of the joint and accessories shall be such that the accessories are fully concealed. The fabrication shall be done in suitable sections to facilitate easy transportation, handling and installation. Adequate provision shall be made in the door and window members for anchoring to supports and fixing of hardware and other fixtures as approved by the Engineer. The fabricated frames shall be square and flat with corners in a true right angle.
4.14 **Installation**

Just prior to installation, the doors, windows, etc. shall be stacked on edge on level bearers and supported evenly.

Unless otherwise shown window/door frames shall be fixed to openings with 25mm tubular section and minimum 2mm thick aluminium sub frame. Width of sub-frame shall be exactly the same width as the main frames.

When the rough ground is properly secured and all major internal and external finishing works are completed, the assembled doors/windows shall be placed in correct final position in the opening and fixed to the aluminium frame.

Sizes, details, spacing, etc. given above are approximate and indicative only. They can be varied as per design requirement to be approved by the Engineer-in-Charge and at the option of Engineer to suit particular sizes and situations and the contractor shall carry out the instructions of the Engineer in this regard at no extra cost to the owner. The contractor may suggest alternative methods of fixing and anchoring for consideration of the Engineer while the decision of the Engineer in this regard shall be final and binding.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Units may have to be assembled in their final location if the situation so warrants.

Where aluminium comes into contact with masonry, concrete, plaster or some dissimilar metal, it shall be coated with an approved insulation lacquer or plastic tape to ensure that electro-chemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for assembling composite units, bedding and pointing with mastic inside and outside, at the transoms and mullions, placing the doors, windows, etc. in their respective openings. After the doors/windows have been fixed in their correct assigned position, the open hollow sections abutting masonry/concrete shall be filled with cement grout (1 cement: 3 coarse sand) densely packed and finished neat. Packing grout shall be of the expanding type made by approved additive.

4.15 **Protection and Final Cleaning**

The doors and windows shall be suitably protected from damage until handing over. Care shall be taken not to use the doors and windows for support,
centering, etc., and no scaffolding or other materials and devices shall rest on these. All the openable members shall be kept firmly closed. The PVC wrapping shall be retained till the glazing work is commenced. After the glazing and all work connected with installation of doors/windows is complete all aluminium work shall be cleaned with a suitable thinner and left in clean unblemished and in an openable condition.

4.16 Aluminium Curtain Wall

4.17 Conventional Curtain Wall System - Single & Double Glazing

The curtain wall material is to be supplied and installed by an approved specialist curtain wall sub-contractor. In addition to the specifications for Aluminium doors & windows the following special specifications shall apply.

The contractor shall furnish preliminary design drawings showing the system details and items of work on scale 1:1 and other basic design as per Architectural requirements. The contractor shall also submit the calculation for the design of the framing system to withstand lateral wind pressure and the weight of glass.

(a) The curtain wall shall be designed for a wind pressure to withstand the wind load as per IS 875. The deflection of any framing member shall not exceed L/175 of the span nor panel deflection exceed L/60 of span. The curtain wall shall provide such thermal expansion and contraction of components as will be caused by the maximum ambient temperature variations without causing buckling, stress on glass failure of joints, sealants.

(b) A layer of clear transparent lacquer based on methacrylates or cellulose butyrate shall be applied on anodized/powder coated member before they are brought to the site. The lacquer shall be removed on completion of erection.

(c) The curtain wall shall consist of minimum one storey (extruded aluminium mullions) anchored at each floor slabs and horizontal framing member as per design. Necessary arrangements as required shall be made to drain out any water penetration, by all in built drainage system. Water penetration shall be defined as the appearance of uncontrolled water on the inside face of any part of curtain wall.
(d) The curtain wall system shall have a positive holding mechanism which retains the grid unit during unequal pressure condition. Vertical expansion and contraction shall be accommodated at each floor by means of expansion slip joints. All members shall be accurately machine milled and fitted to join with hair line joints. The joining accessories such as cleats, brackets, etc. shall be of such material as not to cause any bimetallic action. Steel parts for anchoring as bracing must either be non-corrosive or galvanised/powder coated as per instructions. During mounting, all necessary welding points have to be cold zinc galvanised.

e) The curtain wall shall be with compartmentalised system and unit frames shall provide pressure equalisation to double glazing and drain holes to drain water.

f) The completed installation shall be free from vibrations, wind whistles and noise due to thermal, structural movement ad wind pressure.

g) The curtain wall shall have to withstand a water penetration subject to continual steady water pressure, AS/BS 4315, of water spray at the rate of 250 litre per hour per sqm. of fixed glass area and static pressure of 20% design wind load.

h) Corner cleats must have a cross-section which corresponds to the interior profile contours. At the mitres a perfect sealing and gluing is required. In T-joints the seeping of water into the construction must be prevented by corresponding packing and permanently elastic sealing.

i) All gaskets are to be inserted in order to fulfil the specific window requirements (type, building height, etc.) permanently. The gaskets are to be exchangeable.

4.18 Glass

The following specified glass panes shall be fixed in the curtain wall. The glasses shall be free from flaws, specks or bubbles and shall have square corner and straight edges.
4.19  **Single Glazing**

It shall be imported 6mm thick float quality tempered and of clear transparent
tinted or approved solar reflective glass of approved makes (as of **Glaverbel**, **Belgium or Glaverbas, Singapore or Saint Gobain, France**) of the following characteristics:

- Coated face: 2
- Daylight reflection: 27%
- Daylight transmission: 45%
- Solar energy reflection: 21%
- Solar energy absorption: 27%
- Solar energy transmission: 53%
- Solar factor: 0.6
- Shading co-efficient: 0.69
- U value (ISO) W/sqm. deg.C.: 5.8

4.20  **Structural Glazing Curtain Wall**

The materials are to be supplied and the curtain wall installed by an approved specialist, experienced curtain wall sub-contractor. Before commencing the work, a sample shall be prepared at the site generally following the specifications indicated below and got approved by the Engineer.

Structural glazing curtain wall system shall be either fully unitized or semi-unitized as specified depending on site conditions and other prevailing factors and as approved by the Engineer.

The grid-unitized system shall consist of vertical mullions and factory prefabricated and glazed vision and spandrel frames, made of aluminium extrusions. The mullions, forming the supporting grid of the curtain wall shall be fixed to the building structure at the edge of each floor slab with aluminium or galvanized steel brackets, designed to allow for three-dimensional adjustment. Mullion connections at each floor shall be with aluminium or galvanized steel splices, allowing for vertical building and thermal movement.

The aluminium vision and spandrel frames shall be designed to receive fixed structural glazing and structurally glazed openable vents with protection of the glass edges.
The perimeter of each frame shall be designed with a deep cavity provided with continuous external and internal gaskets to achieve a double barrier for weather tightness and drainage of any infiltration water passing the first barrier.

The prefabricated double glazed panels shall be fixed onto the previously installed mullions by means of purpose designed hook-on brackets.

4.21 Submittals

4.22 The Contractor shall submit the following:-

i) Preliminary Design Drawings for junctions of external glazing and concrete structure or other finishes fully describing the materials, profiles, relevant sections, thickness, methods of glazing and sealing, typical spandrel panels, detail of fixing methods and anchorage system to walls or structure, details for provision for thermal movement, details for fire stops/seals, expansion joints, condensation gutters, louvers, mullions, jointings, etc. and all other pertinent information.

ii) Structural Calculations for the aluminium and external glazing systems based on requirement given in tender and that specified herein. All calculations shall be certified by a Professional Engineer to substantiate that the installation offered is capable to withstand the loads stipulated in this specification. Structural design shall be got approved from the owner’s consultant.

iii) Complete information on Glass, Aluminium Panel, Structural Silicone Sealant and all other materials to be used in the works as required by the Engineer including test reports/certificates.

iv) Proposed Erection Procedure and the method of erection at site. This statement shall include, but is not limited to the following information:-

- Delivery to site, to take into consideration limitations of transportation routes, site access, hoisting, storage of materials, etc.
- **Requirements for temporary staging, external access etc.**
- **Proposed installation method, fixing etc.**
- **Protection and cleaning of the installation.**
- **Other documents, information on technical aspects etc. as required by the Engineer.**

v) **Shop Drawings**

The contractor shall submit shop drawings prepared in AutoCAD and showing clearly the relationship of the external façade works to the structure, mechanical and electrical system, floor slabs and other related works. They shall show the arrangement of components, the sequence and details of fabrication, assembly and installation of components. They shall be submitted to the Engineer/Architect for approval and shall include the following:

Mock up, jointing techniques, relative positions of all adjacent walls, beams, columns and slabs, all correctly dimensioned.

Dimension and position of glass edge/faces relative to metal and also provide dimensions and edge details for aluminium panelling as applicable.

Full size details, including isometric drawings of sealing, flashing and jointing methods.

Die drawings for all gaskets, extrusion etc.

Materials, type, size, location and spacing of all stainless steel screws, bolts, welds, anchoring devices, accessories etc.

Fully detailed programme for the presentation of shop drawings to the Architect for approval and in no case shall the contractor proceed with any portion of the works without approved shop drawings.

**Instructions and explanatory details for the sequence of fabrication, assembly, erection, and the installation of all materials including the glass and reglazing procedures.**

All shop drawings shall be submitted in a sequence consistent with sequence of erection, installation or assembly of the various
elements of the work. The contractor shall be deemed to have determined and verified all materials, site measurements and construction criteria related thereto and to have checked the shop drawings for complete dimensional accuracy.

Any approval by the Engineer/Architect of shop drawings shall not relieve the contractor of his responsibility for any deviation from the requirements of the contract unless he has specifically informed the Engineer/Architect in writing of such deviation at the time of submission and Engineer/Architect has given written approval to the specific deviation.

The Contractor shall be required to submit 3 sets of prints of all shop drawings, as well as one soft copy.

The Contractor shall modify materials, fabrication, methods of erection and workmanship as may be necessary, if any of the tests conducted in the Mock up have failed. The actual materials, fabrication, erection and workmanship in the field shall match the approved test assemblies modified.

vi) Guarantee

The contractor shall be fully responsible for and shall guarantee proper design and performance of his installed system for a period of 10 years from handing over of the works.

The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, air pollution, thermal stresses, building movements and the like.

In addition specific 10 years guarantee (to be furnished in non-judicial stamp paper of value Rs. 100/-) in approved proforma shall be given for performance of glass, double glazed units, anodising, PVDF coating to cladding sheets and sealants. All the guarantees shall be submitted before Final payment and shall not in any way limit any other rights to correction which the Employer may have under the Contract.
4.23 Structural Requirements

Individual and aggregate components of the external glazing shall be designed, fabricated, assembled, transported, installed and protected so that no evidence of the following will be apparent, visually or measurably, when subject to the pressure loads (including erection loads) and temperatures specified. There should be:

- **No damage**
- **No orange peeling, oil canning or other surface distortions.**
- **No colour variations in the organic coating on anodised finish**
- **No excessive deflections.**
- **No excessive off-set from true alignment.**

4.24 Deflections

For the design pressures and loads, limit of deflections and stresses are as follows:

i) Normal to plane of the wall, linear deflection of framing members shall not exceed 1/240 of span length or 20mm whichever is less.

ii) In the plane of the wall, deflection of horizontal rails shall not reduce the glass or panel bite below 75 per cent of the design dimension and shall not reduce the glass or panel edge clearance below 25 per cent of the design dimension or 3mm whichever is greater. Restrict deflection further if required for proper assembly and fit of components.

iii) At connection points of framing to anchor including cantilever braces, lockers, etc., anchor deflection in any direction shall not exceed 1mm. Where anchorage or connection points are not clearly defined, maximum anchor point deflection which are used to determine span of element shall not exceed 2mm.

iv) Stresses must take into account interaction and shall not exceed the allowable values established in the Specifications. In no case shall allowable values exceed the yield stress.

v) At 1.5 times design pressure, net permanent deflections of framing members must not exceed 1/1000 of span length and components must not experience failure or permanent distortion. At connection points of framing members to anchors, deflection in any direction shall not exceed 1.0mm and permanent set shall not exceed 0.5mm.
Where connection points are not clearly defined, maximum anchor point deflection and permanent set which are used to determine span of element shall not exceed 1.5mm and 0.75mm respectively.

4.25 Design Wind Pressure

vi) Design typical exterior envelope to withstand positive and negative wind load acting normal to plane of walls to meet basic wind pressure of 1.25 KN/Sqm. Cpe (external pressure co-efficient) is to be taken in following manner.

a) For general areas : 0.8
b) Local effect : 1.2

a. Internal co-efficient(5% opening) Cpi : ± 0.2

_the co-efficients are to be obtained from Section 6 of IS 875 (Part 3) 1987 in case of any other situation._

vii) Design corners within 3000mm and parapet areas of exterior envelope to withstand upgraded wind requirements stipulated in ANSI 58.1 ASCE7-95 and building code.

4.26 Building Tolerances

Building tolerances shall be in accordance with the Structural Engineer’s or the specifications in accordance with the Indian standard/British code of practices.

4.27 Building Movement

Provision shall be made by the Contractor/Specialist in design, fabrication and installation of curtain walls to accommodate differential vertical live load and creep movement as follows :

i) Lateral movement in any direction of Tower of maximum H/60 where H is height above ground level, with a maximum differential movement of adjacent floors or storey height/500.

ii) **Horizontal movement perpendicular to building facade of isolated edge beams (i.e. those not attached to floor slab) of beams span/ 500 relative to beam supports.**

iii) Midspan vertical deflection of the edge of Tower concrete slab relative to the column support positions of L/500 or 20mm whichever is less, where L equals beam span between column. End deflection of
cantilevered beams relative to the column support position of L/250 or 20mm whichever is less where L is the span of cantilever.

iv) Column shortening of maximum +/- H/2000 where H equals column height.

v) The Contractor is advised that the vertical deflections of adjacent floors are independent due to variations in floor loading and that provision should be made for the worst possible combinations of relative movements.

4.28 **Thermal Movement**

Provision shall be made in the curtain wall design and installation for noiseless expansion and contraction resulting from an exterior surface ambient temperature range of 0°C to 85°C and a building interior temperature range of 5°C to 45°C without buckling, opening of joints, glass breakage, undue stress on fasteners, or other detrimental effects. Allowances for both horizontal and vertical movements shall be made.

4.29 **Weight**

The total weight of the structural glazing including glass, aluminium panels any reinforced structural steel members and fixing to structure shall not be more than 140 kg/m².

4.30 **Structural Calculations**

The Contractor shall engage a professional engineer to prepare structural calculations of the external glazing systems taking into consideration structural loading permitted by the structural design of the building. Structural design shall include, but shall not be limited to, computations for the justification of all external glazing sections and connections including fasteners, welds and anchorage assemblies. Structural calculations shall be cross referenced to the applicable shop drawings details. The Engineer responsible for the design calculations shall review the shop drawings and issue a certificate of compliance stating that the final approved shop drawings are in conformance with the calculation or vice versa. All designs must be accompanied by details of the cladding, method of fixing and design calculations.

All panels used for these external façade elements and their system of fixing shall be designed to take into account wind load, deflection, relative
movements of the panels, water tightness and the building form as well as long durability and integrity of the panels and the fixing system without any water leakage.

The contractor shall provide a complete structural analysis showing the resultant effect of force on all applicable structural components including anchors, welds, fasteners etc.

The contractor shall submit for the Architect's approval all calculations in reference to structural properties of external glazing, and all connections, die dimensions of all extrusions, and complete data as to alloys proposed for use. Approval of the structural calculations shall not relieve the Contractor from any of the responsibilities and requirements as herein specified.

All structural calculations shall be in compliance with all applicable or relevant Indian/British or other International codes and standards.

4.31 Fabrication Requirements

4.32 Product Handling

All materials and finishes shall be new and free from any defects which may impair the strength, functioning, durability or appearance of the external glazing and related construction.

Material shall be packaged and stored in a manner that will prevent surface damage or contamination, distortion, breakage or structural weakening.

Any materials damaged during manufacture, shipping, assembly, storage or erection shall be replaced at no extra cost to the contract.

4.33 General

No materials, equipment or procedures shall be used that may adversely affect the functioning, appearance and durability of the completed glazing and related construction. The work shall be accomplished in compliance with the specified criteria without buckling, opening up of joints, cracking of glass, leakage or other harmful effects. The materials used must be capable of withstanding the effects of installation and allow sufficient tolerance to prevent damage to the finished surface.
Materials, finishes, shapes, sizes, thickness, and joint locations shall conform strictly to those required by the drawings and specifications.

All work shall be of the highest quality, in accordance with the best trade practices and performed by skilled workmen. All work shall be accomplished to the satisfaction of the Engineer.

All components exposed in the finished work shall be free from warping oil-canning effects etc.

4.34 **Fabrication**

To the greatest extent practicable, fabrication and assembly shall be executed under factory conditions.

4.35 **Manufacturer's Standards**

Materials, components and system incorporated in the work shall be in compliance with the standards and procedures of the appropriate manufacturers and the standards and codes referred to in the specification.

4.36 **Storage and Handling**

Wherever possible, all materials shall be stored in dry, well-ventilated conditions prior to fabrication.

No metal or glass shall be left exposed to the external elements prior to fabrication.

Adequate storage facilities must be provided for all materials prior, during and following fabrication. The Contractor is to submit full details of these facilities for the approval of the Engineer.

All sealants, paints and other such materials are to be stored strictly in accordance with the manufacturers instructions.

4.37 **Jointing**

All exposed metal joints with metal to metal hairline contacts shall be accurately fit and firmly secured.
All fastenings into or through aluminium shall be stainless steel, and
installed at approved spacings. Fasteners shall not penetrate gutters and
drainage system.
All fastening jointing and splicing of members shall be concealed. Exposed
fasteners shall occur where expressly permitted by the Engineer. Where
exposed in finished surfaces, screw heads shall be oval head countersunk
type finished to match adjacent surfaces.
All joint sealant except as noted on the drawings shall be concealed.

4.38 **Anti-galvanic Action**

All dissimilar metal surfaces shall be isolated to prevent galvanic action.
Materials used for this purpose shall be non-absorptive.

All steel parts shall receive a protective treatment commensurate with their
respective functions. The treatment shall be one or more of those described
in the specification and as approved by the Engineer.

Aluminium surfaces in contact with mortar, concrete, fireproofing, plaster,
masonry and absorptive materials shall be coated with an anti-galvanic
moisture-barrier material.

4.39 **Metal-to-Metal Contact**

Metal surfaces shall be separated in such a manner that metal does not
move on metal. Materials used for this purpose shall be as specified.

4.40 **Sealant and Gasket Applications**

Sealant and gaskets shall be provided where shown on the drawings or
required for a permanently watertight installation.

The design of all sealed joints shall be in accordance with the
recommendation of the sealant and/or gasket manufacturer.

All adjoining surfaces not to receive sealant and gaskets shall be protected
against staining by masking and/or other methods.

Joints and joint surfaces shall be clean, dry and free of any material that
may have an adverse effect on the bonding and/or seal of the sealant and
gasket materials.
Sealant and gaskets shall be applied under the conditions recommended by the manufacturers. All surfaces to receive sealant and gaskets shall be primed unless recommended otherwise in writing by the Manufacturers. No sealant that has started to set in its container or a sealant that has exceeded the shelf life published by the manufacturer shall be used.

All joints shall be filled continuously and completely with sealant forming a neat uniform concave bead. The material flush with adjoining flush surfaces shall be finished unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

Materials certification for gasket shall be EPDM or neoprene and shall be as required to the standards applicable.

Glazing gaskets shall be extruded with continuous integral locking projections to engage into the metal glass holding member and shall be designed to be in contact at all time with adjacent elements during dynamic loading, building and thermal movements and provide a watertight seal as required to meet the performance criteria.

Roll-in glazing and back up gaskets shall be sized in lengths or units to provide for a minimum crown in of 1 percent to 2 percent or as otherwise recommended by the manufacturer to insure against any pull back at the corners.

Roll-in glazing and back up gaskets for any one light or glazed opening shall be continuous one-piece units with factory fabricated injection moulded corners free of all flashing and burrs.

Materials, recommendations and details describing the proposed use, design, and application procedures for Gasket (EPDM) and neoprene. Glass and glazing materials shall be documented and fully described on the shop drawings.

Air seal gasket shall be continuous closed cullular (sponge) EDPM/ neoprene gasket.

4.41 Glazing

All glazing shall be as per specifications given hereinafter and shall be obtained from approved sources.

All glass shall be new. Mock up glass shall not be used on the building. Glass shall be of the specified type, quality and tint with cleanly cut edges and
sharp corners. All glass panels shall be inspected before installation and a record of all glass panels inspected shall be kept. All glass which are marked or defective beyond the manufacturer’s stated tolerance are to be replaced by the contractor at no cost to the Employer. Defective glass or glass having damaged coatings or seals shall not be installed. Specific type and make of glass once selected and used in the project shall remain unaltered for the project.

No materials or assembled units are to be left exposed to adverse weather conditions prior to erection at site.

Handling of glass shall be kept to a minimum and all glass shall be carefully protected from soiling and from condensation and other moisture.

The Contractor is required to check all glass on unpacking and ensure that there is no scratching or blemish to the surface. A record of all glass inspections is to be kept and a copy issued to the Engineer on a regular basis as required.

Glass and glazing materials and requirements are subject to a final review by the Architect. Substitutions in the interest of the performance, function, compatibility of materials and safety may be proposed for Architectural review. All proposals must be properly and adequately documented.

Neoprene, glass and glazing materials, including but not necessarily limited to, extruded glazing gaskets, glass setting blocks, jamb shims, bushings, tapes, separators, joint fillers and sealant backup gaskets shall be high quality ozone resistant, cured elastomeric-virgin neoprene compounds.

Glazing shall be done, except as otherwise specified, complying with Float Glass Marketing Association (FGMA) Glazing Manual. A minimum nominal glass bite of 12 mm shall be provided.

The glazing pocket shall be thoroughly cleaned before setting glass including weep drain holes and slots. Solvents shall be compatible with aluminium, glass/glazing and sealant materials.

Setting blocks shall be placed at quarter points. Side blocks shall be placed in the upper half of each jamb of each glass panel. Side blocks must be positively retained in position. Setting blocks shall be 75 durometer silicone rubber at least 10 mm thick. Edge blocks to be 75 durometer neoprene rubber.
Stops shall be removed and replaced and sealant applied as required for a complete glass installation. Details of installation shall permit replacement of glass from inside of the building.

The glazing shall be carried out progressively according to the programme.

Openings which are obstructed during construction shall be deferred.

All glass which breaks or sustains damage shall be replaced.

Before installation all temporary protective coatings shall be removed.

### 4.42 Single Glazing

Single glazing shall be imported 6mm thick float quality heat strengthened and of clear transparent tinted or approved solar reflective hard or soft coat glass of approved makes of the following characteristics:

#### Single Glazing

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Tinted heat strengthened and reflective hard coat glass in range of Blues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating</td>
<td>Face #2</td>
</tr>
<tr>
<td>Visible Light</td>
<td></td>
</tr>
<tr>
<td>Day Light Transmission (LT)</td>
<td>16% approx.</td>
</tr>
<tr>
<td>Light Reflectance (LR)</td>
<td>In 14% approx.</td>
</tr>
<tr>
<td></td>
<td>Out 11% approx.</td>
</tr>
<tr>
<td>Solar Energy</td>
<td></td>
</tr>
<tr>
<td>Direct Energy Transmission (DET)</td>
<td>10% approx.</td>
</tr>
<tr>
<td>Direct Energy Reflectance (DER)</td>
<td>9% approx.</td>
</tr>
<tr>
<td>Energy Absorption (EA)</td>
<td>81% approx.</td>
</tr>
<tr>
<td>Solar Factor (SF)</td>
<td>27% approx.</td>
</tr>
<tr>
<td>Shading Co-efficient</td>
<td>0.31 approx.</td>
</tr>
<tr>
<td>U Value N/m².K (for soft coat)</td>
<td>4.6 to 4.9 approx.</td>
</tr>
<tr>
<td>U Value N/m².K (for hard coat)</td>
<td>4.9 to 5.8 approx.</td>
</tr>
</tbody>
</table>

### 4.43 Double Glazing

The insulated glass unit shall be made up of 2 pieces of glass put together with aluminium spacers in between to maintain space uniformity. The air in the middle shall be kept dry constantly with special desiccants (drying agents) and elastic sealants. The enclosed layer of air between the 2 pieces of glass shall make the
insulation capability about twice that of monolithic glass. The sealants used in the double glazing units shall be of organic materials. The insulated glass shall comprise 6mm hard or soft coated heat strengthened reflective tinted glass as detailed below in the external pane while the internal pane shall comprise 6mm approved Indian make clear annealed float glass. The said glasses shall be duly manufactured into an insulated glass unit as detailed on an imported manufacturing line and shall be factory-fabricated with dual seal and assembled with the aid of an 12 mm aluminium spacer bar duly filled with desiccants to achieve low dew point temperatures over a very long period of time and minimize pane deflections and danger of glass breakage. The desiccants shall be of small bead size and shall be filled in the spacer bar with the aid of automatic filling machines leading into pneumatic filling of the spacer profiles. The insulating unit duly incorporated with the desiccant drying agent in the aluminium spacer shall be assembled with moulded bent corners and thereafter a poly-isobutylene primary seal shall be applied on the 2 edges of the spacer bar in addition to the secondary seal of “Structural” silicone of Dow Corning - DC 995/ DC 933.

Double Glazing 6/12/6mm insulated glass unit shall comprise

Coated Surface                      Face #2
Visible Light
Day Light Transmission (LT)         15%
Light Reflectance (LR)             14%
Solar Energy
Direct Energy Transmission (DET)    9%
Direct Energy Reflectance (DER)    9%
Energy Absorption (EA)             82%
Solar Factor (SF)                   1.8%
Shading Co-efficient                0.21
K Value (Summer) W/m².K            2.5
All spandrel glass shall have an additional internal polyester opacifier coating to match the colour of the vision panels.

4.44 **Flashing**

Where required, to prevent leakage, flashing shall be formed from either stainless steel, aluminium or sheet neoprene of 1.5 mm thickness with joints lapped and sealed 150 mm minimum.

Flashing shall be provided where external glazing terminates and wherever else required to provide a completely watertight installation.

4.45 **Screed Stop/Water Stop**

The Contractor shall be responsible for the supply and installation of water/screed stop along the facing edge of each floor slab. The Contractor is to ensure that the design and installation of the water/screed stop shall be compatible with all elements of the external glazing and shall not interfere with the erection or the fixing of finishing items such as skirtings or internal spandrel panels.

4.46 **Column Closers**

The Contractor shall supply and install suitable closer sections to seal up the gap between columns and/or walls which abuts the line of the external glazing.

The principal function of the closer piece shall be to provide a neat connection with the external glazing as well as a means of cutting off stray artificial light from the outer face of the column/wall.

The column closer shall be installed in such a way as to provide a flexible connection to allow for tolerances, building/external glazing movements and dimensional differences between the external glazing and the column and/or wall face.

The column closer shall also be designed in such a way as to allow the following:

i) Easy removal for maintenance

ii) Installation after finishes are applied to the column/wall.

iii) Easy removal of internal glazing units for cleaning/maintenance/replacement.

iv) Compatibility with the requirements of the Fire Safety requirements.
4.47 **Thermal Insulation**

Thermal insulation shall be provided in all spandrel area. Insulation shall be provided using fasteners of the type and spacing recommended by the insulation manufacturer.

The Contractor is to replace any damaged or wetted insulation material when so instructed by the Engineer.

4.48 **Fire Stop**

At each floor edge the required fire protection is to be maintained between elements of structure by using fire stop insulation to give a minimum of 2 hours fire protection between floors including in front of columns or blank walls.

The fire stop material is to be installed to completely seal up the void between the face of the structure and the glazing and shall fully comply with local Codes and Regulations.

The fire stop material must be flexible to allow movement between the structure and the external glazing.

The fire stop material shall be located and held in position in such a way so as to ensure integrity of the fire protection as well as preventing accidental damage or loss of materials.

The contractor is required to provide full details of all fire stop material including fire test certificates and confirmation of local Fire Service Bureau approved material status. Shop drawings shall also be submitted for approval showing the full details of fire stops.

4.49 **Method for Reglazing**

The Contractor shall provide a method statement to the Engineer describing the full procedure for replacing external or internal glazing and frame elements. This description shall include but is not restricted to the following:-

i) Description of reglazing procedure.

ii) Description of frame replacement and/or in-situ remedial works

iii) Details of facilities and manpower requirements.
iv) Estimate of time necessary for such procedure based on the provision of skilled labour to carry out such operations.

4.40 Tolerances

4.51 All parts of the external glazing system when completed shall be plumb, square, level and correctly aligned within the following limitations :-

i) Deviation from true horizontal, vertical and design location in plan must not exceed 1 mm per meter, to a maximum of 4 mm for any component nor shall any expansion joint between or among members vary in excess 1 mm per meter of joint length, to a maximum of 4 mm.

ii) Maximum offset from true alignment between two (2) consecutive members place end to end must not exceed 1 mm edge to edge.

iii) Maximum offset between glass framing members at corners of glazing pocket must not exceed 1 mm.

iv) The Contractor shall provide accurate bench marks at all floors for use in the erection.

v) The Contractor shall submit regular survey records to the Engineer which shall include mark checks, vertical and horizontal alignment, anchorage levels, etc.

4.52 Anchorage

Component parts shall be securely anchored in place by bolting, welding or other permanent mechanical attachment system which will comply with performance requirements and permit movements which are intended or necessary. Slip pads between moving parts shall be installed.

A separator at contact surface of dissimilar materials shall be provided wherever there is a possibility of corrosive or electrolytic action.

Weld slag shall be removed and prime paint applied over welds. Also paint exposed portions of inserts. Touch up shop applied paint that is damaged by welding or other causes.
4.53 **Protection**

The Contractor is to ensure that the highest possible standards of materials protection are maintained both in the fabrication and installation of the external glazing system.

The Contractor is to ensure that all materials and completed panels are delivered to site without damage and that all components are fully protected. In this respect a method statement will be required describing the protection measures to be adopted when transporting material to site and hoisting it into the floors for final installation.

Panels awaiting installation are to be stacked on pallets to a height to be stored separately on site for possible fabrication in-situ. As stated elsewhere it is intended that as much as possible the fabrication shall be carried out off site in the shop. Wherever this is not feasible for whatever reason the Contractor is required to submit details of in-situ work for approval by the Engineer.

All materials stored on site are to be protected in such a manner as to prevent damage from falling objects, dust, water and dirt. The material must be safe from mishandling or damage by any contractor/agency/sub agencies either in the pursuit of their own works or by their personnel.

During installation, the Contractor shall provide protection to the external glazing to prevent the ingress of water from either rain or any other reasons. This protection shall be strong enough to withstand adverse wind conditions, and shall provide complete protection at the top level of the installation necessary to prevent the ingress of water into or behind the cladding.

The external glazing shall be screened from weld splatter, spray-on fireproofing, concrete, alkaline masonry washes, paint and other deleterious substances. Any such soiling shall be promptly and completely removed. The design of protective screening shall be such as to provide adequate ventilation of the space between the glass and the protective screen and not induce thermal stresses in the glass. In no case shall the protective screening be placed in contact with the glass.

The Contractor shall provide at each completed floor an internal protection of 1,000 gauge heavy Polyethene sheet suspended from the top of the external glazing at slab soffit and extending to the floor. These drop sheets must maintained until all wet trades are completed on each floor.
The fixing method for sheets is to be indicated in shop drawings and a sample approved by the Engineer.

4.54 **Testing**

4.55 **Test programme**

The Contractor shall submit for the consideration and approval of the Engineer, detailed descriptions of a testing programme which shall include the followings:-

i) Wind loading and air infiltration
ii) Water penetration (including dynamic test)
iii) Deflection under dead/live loading
iv) Thermal movement

Tests shall be carried out at a test facility proposed by the Contractor and approved by the Engineer. All tests shall be carried out in accordance with the standards or other equivalent and approved standards.

The Contractor shall submit for the approval of the Engineer detailed descriptions of the proposed test assemblies or mock-ups, testing schedules and reports.

All specified tests shall be carried out in the Mock up as well.

Structural performance tests (positive and negative) shall be carried out in strict conformance with the procedures set forth in accepted standards.

Controlled water penetration shall be defined as any water which appears on the interior side of the wall construction and which is temporarily contained in the wall drainage system, eventually to pass out through weep holes. Water that overflows on the Interior side will be considered as uncontrolled water penetration.

Sequence of physical testing shall be as follows:

i) Preliminary loading
ii) Tests for air infiltration
iii) Tests for water penetration for static pressure.
iv) Test for water penetration for dynamic pressure.
v) Structural performance tests (positive and negative pressures). Deflections shall be measured with micrometer dial indicators at critical locations selected by the approved testing agency.

viii) The physical testing procedure shall be immediately halted should any part of the test assemblies, including glass and glazing, fail to conform to the requirements specified in the specification. The type and nature of failure will be recorded and then the testing continued through the sequence or through the complete testing cycle, noting any additional failures or, at the direction of the Engineer. The test assemblies will be dismantled immediately and completely, the cause of the defect analyzed and the revised assembly rebuilt, all at no extra cost. After the revised test assembly has been rebuilt, the testing shall trace the entire set of tests in the sequence at no extra cost to the Employer. At the discretion of the Architect this procedure may be required to be repeated as often as necessary until all defects have been corrected. Under no circumstances shall any testing be continued when a failure occurs unless the Engineer is notified and agrees to continue with the testing. Corrective measures made necessary by the tests applied to the test assemblies shall be incorporated in the field erected curtain wall aluminium and glass components.

4.56 Field Tests

During the progress of the Contract Works and upon completion of the installation the Engineer may request for such tests to be carried out as he may deem necessary in order to ascertain whether the installation conforms to the Contract Documents. Fee payable to testing authorities, if applicable, shall be borne by the Contractor. The Contractor shall also arrange to carry out such tests as may be required by the Government or other Authorities. The cost of all such tests shall be paid by the Contractor at no extra cost to contractor.

The Contractor shall provide all test instruments and other temporary provisions to enable the tests to be carried out on the works so specified. Typical portions of the constructed curtain wall system and aluminium cladding shall be physically tested in accordance with the requirements of ASTM E783 and ASTM E 1105. Area to be tested shall be as directed by the Architect.

The Contractor shall give reasonable notice of the tests in writing, to the Engineer, who shall have the option of being present at all such tests.

Complete records of the tests (whether successful or unsuccessful) shall be maintained by the Contractor. Preliminary copies shall be issued to the
Architect to whom, at the conclusion of all such tests, the Contractor shall supply two bound sets of all results.

In the event that such testing should result in uncontrolled leakage, the Contractor shall eliminate the causes of such leakage at no additional cost to the Employer. Remedial measures proposed by the contractor to maintain standards of quality and durability are subject to approval. The contractor to provide powered scaffold, hose, and sufficient personnel to operate scaffold and hose.

4.57 Inspection

All shop and field materials and workmanship shall be subject to inspection by the Engineer at all times. These inspections shall not relieve the Contractor from the obligation to provide materials confirming to all requirements of the Contract Document and matching approved samples. The Contractor shall promptly correct any deficiencies reported and carry out his own control measure for all materials whether inspected or not.

4.58 Cleaning

The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes of the external glazing.

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.

The internal surfaces of glass and aluminium frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting.

The Contractor shall provide written verification that cleaning agents are compatible with aluminium, stainless steel glass coatings, granite, glazing materials and sealants. In no case shall alkaline or abrasive agent be used to clean the surface. Care shall be taken during cleaning to avoid scratching of the surface by grit particles. Prior to snagging inspections the Contractor shall remove the internal protection sheets and carry out a thorough cleaning of all glass, aluminium and spandrel panels.
The protective sheeting shall then be removed permanently provided that no other wet works or services work are required in the immediately vicinity of the external glazing.

The Contractor shall also make good any physical damage to the wall including scratches, dents, abrasions, pitting etc. to the satisfaction of the Engineer.

Manufacturer’s delivery or job marking on glass and adhesive for manufacturers cables shall be either a neutral or slightly acidic material and in no case shall such material be alkaline. Any staining of glass by alkaline material will be cause for rejection of the glass.

After the installation of each panel 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.

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.

The Contractor shall carry out regular inspections of the glass to monitor the effectiveness of the protection and to take all necessary remedial action.

Prior to the handing over of each floor to the Engineer, the Contractor shall carry out a final cleaning of the external glazing.

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 of external glazing.

Cleaning is defined as being free of any substance that cannot be removed by a normal washing with a mild detergent and water.

4.59 Handover, Maintenance Manual and As-Built Drawings

4.60 Inspections

Prior to handover of the completed installations, the Contractor shall provide suitable access to the Engineer to carry out snagging
inspections both internally and externally. Any such defects arising from these inspections shall be set right by the Contractor.

4.61 Maintenance Manual

On completion of the works, the Contractor shall submit to the Engineer three (3) copies of Maintenance Manual which will include recommendations and procedures for periodic inspection, maintenance and cleaning of all components of the external glazing etc. and instructions with appropriate drawings on methods to be employed to replace any component of the installation.

The Maintenance Manual shall include :-

i) Recommended inspection schedule and periodic inspection procedure.

ix) Complete explanation of operation principles and sequences.

x) Complete parts list, with numbers and glass sizes.

xi) Method statement of reglazing and replacement of component parts.

xii) Instruction for the proper cleaning and routine maintenance of the façade, including frequency.

4.62 Record Drawings

During construction, the Contractor shall maintain accurate records of the actual construction. This information shall be supplied to the Engineer and shall form the basis of as-built record of the finally constructed external glazing system on façade.

4.63 Frameless Glass Shutter to Aluminium Door Frame

The frameless glass doors shall consist of horizontally tempered glass of required thickness and shall be supplied in a ready to assemble condition complete with patch fittings, floor closers, handles, locking arrangements, etc. The door shall be supported by two patch fittings, one at bottom and other at top. While, the bottom patch fittings shall move on floor spring, the top patch fitting shall move on pivot which shall form an integral part of side patch fitting. The side panel and top lights shall be anchored to side wall by using a thin aluminium channel and silicon sealant.
5.0 EPOXY FLOORING

5.01 EPOXY FLOORING SPECIFICATIONS

5.02 Correct preparation of surface is essential. Fibfloor SL should be laid only if the moisture content of the floor is below 5%. When applied over concrete, the surface must be sound, free from dust, oil, grease and other contaminants. Remove oil and grease by scarifying or dry grinding or by burning followed by wet mopping with liquid detergent. Allow the floor to dry before priming. Where there are expansion joints in the floor, these must be treated separately. At end of floor near entrance, around trenches & gutters, cut open the concrete floor & anchor Fibfloor SL.

5.03 PRIMING

5.04 Surface should be bone dry prior to this application. All surfaces should be primed using Fibfloor Primer @ 250 gms per sq.m. Mix Primer Component A & B in 2:1 ratio A: B resp.thoroughly and apply by brush or roller. Allow the primer to become dry.

5.05 MIXING

5.06 Mixing is carried out in a specially designed drum mixer or in a bucket with the help of drill mixer fitted with paddle. Mix Fibfloor SL component A & C thoroughly with the help of mixer/drill mixer until a homogeneous mix is obtained and then add component B slowly, ensuring complete dispersion. After adding Component B, continue mixing for 5 - 10 minutes. Fibfloor SL must be laid immediately after mixing is over. The mix should be spread evenly over the recommended area using a notch trowel. Use spike roller with long handle on pourable casted floor to remove entrapped air. If antiskid surface is required, scatter antiskid aggregate on to the applied surface within one hour of Fibfloor SL application.

5.07 SPECIFICATION FOR ANTISTATIC PVC FLOORING (ROBUST EL-7)

5.08 INSTALLATION

The flooring should be installed on a smooth, clean and dry sub floor which should be free from any undulations, using good quality water based adhesive as per manufacturer’s recommendation. The installation should be done by an agency accredited by the manufacturer which should be able to provide a manufacturers installation manual.
5.09 **Sub Floor Preparation:**

Concrete/cement under floors should be well cured/dried until the water content of the sub-floor falls below 5% and all paint, oil, grease, asphalt and other adhesives should be completely removed. Crevices and irregular surfaces should be leveled.

5.10 **Thermal Welding:**

It is recommended to weld the joints by heat fusion process to get a seamless floor. The joints in the flooring should be sealed by using a PVC welding bar of matching colour to be supplied by the manufacturer, using a hot air gun for fusion of welding bar with flooring.

5.11 **Warranty:**

The supply and installation agency should be able to provide written warranties for a period of at least three years for the performance of the material and for a period of at least one year for the installation. These warranties should be certified by the manufacturer.

5.12 **SPECIFICATION FOR PVC FLOORING (MIPOLAM-150)**

5.13 **PRODUCT**

Providing and fixing of 2mm thick PVC flexible homogeneous floor covering in sheet of size 2.0m x 20 m, Its surface should be densely compacted for improving wear and ease of maintenance. It should have anti-bacterial and fungicidal properties and should complies with the EN 649 (34-43) and K5 (Group P) wear rating. It has to be suitable for heavy traffic area.

5.14 **INSTALLATION**

The flooring should be installed on a smooth, clean and dry sub floor which should be free from any undulations, using a good quality water based adhesive as per manufacturer's recommendation. The installation should be done by an agency accredited by the manufacturer which should be able to provide a manufacturers installation manual.

5.15 **Sub Floor Preparation:**

Concrete/cement under floors should be well cured/dried until the water content of the sub-floor falls below 5% and all paint, oil, grease, asphalt and other adhesives should be completely removed. Crevices and irregular surfaces should be leveled.
5.16 Thermalweding:

It is recommended to weld the joints by heat fusion process to get a seamless floor. The joints in the flooring should be sealed by using a PVC welding bar of matching colour to be supplied by the manufacturer, using a hot air gun for fusion of welding bar with flooring.

5.17 Warranty:

The supply and installation agency should be able to provide written warranties for a period of at least three years for the performance of the material and for a period of at least one year for the installation. These warranties should be certified by the manufacturer.
6.0 **SPECIFICATION FOR VITRIFIED TILES FLOORING**

The tiles shall be of approved make and generally confirm to standard as indicated in Appendix-‘A’. They shall be flat, and true to shape and free from blisters, crazing, welts, crawling or other imperfection detracting from their appearance. The tiles shall be tested as per standard mentioned in Appendix ‘A’.

The tiles shall be square or rectangular of nominal size such as 594 x 594, 597 x 597 to 600x600 mm or any nearest available size as directed and approved by the engineer-in-charge. The thickness of tiles shall be 9.6mm to 10 mm for size 600 x 600mm as specified. The length of all four sides shall be measured correct to 0.1 mm and average length, breadth shall not vary more than $\pm 0.6\%$ from specified dimensions. The variation of individual dimension from average value of length/breadth shall not exceed $\pm 0.6\%$. Tolerance in thickness shall be $\pm 0.5\%$.

6.01 **The tiles shall be vitrified, homogenous through out its body structure and surface shall be mirror finish as specified.** The underside of the tiles shall not have any finish in order that the tiles may adhere properly to the base. The edges of the tiles shall be preferably free from shine or polish. However any finish, if unavoidable shall be permissible on only upto to 50 percent of the surface area of the edges.

6.02 Preparation of surface and laying :-

6.03 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar 1:4 (1 cement: 4 fine sand) or as specified. The average thickness of bedding shall be 20mm.

6.04 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

6.05 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square meter over such an area as would accommodate about 5-6 tiles. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

6.06 The surface of the flooring during laying shall be frequently checked with a straight edge about 2m long, so as to obtain a true surface with the required slope.
6.07 Where full size tiles can not be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

6.08 After tiles have been laid surplus cement slurry shall be cleaned off.

6.09 Pointing and Finishing

The joint shall be cleaned off the grey cement slurry with wire/coir brush or trowel and all dust and loose mortar removed. Joints shall then be grouted with epoxy grout of LATICRETE, BAL ENDURA or equivalent of desired contrast colour. The floor shall then be kept wet for 7 days. After curing the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

6.10 Measurement

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square meter correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the covers. No deduction shall be made nor extra paid for voids not exceeding 0.20 square meter. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sq. meter.

6.11 Rate

The Rate for flooring shall include the cost of all materials, tiles, Cement mortar, Epoxy grout etc. complete and labour involved in all the operations described above and filling the joints with solid epoxy grout of approved make. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Appendix "A"

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Property</th>
<th>Standard Laid Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Deviation in Length</td>
<td>± 0.6%</td>
</tr>
<tr>
<td>2.</td>
<td>Deviation in Thickness</td>
<td>± 0.5%</td>
</tr>
<tr>
<td>3.</td>
<td>Straightness of side</td>
<td>± 0.5%</td>
</tr>
<tr>
<td>4.</td>
<td>Rectangularity</td>
<td>± 0.6%</td>
</tr>
<tr>
<td>5.</td>
<td>Surface Flatness</td>
<td>&lt; 0.3%</td>
</tr>
<tr>
<td>6.</td>
<td>Water Absorption</td>
<td>0.5%</td>
</tr>
<tr>
<td>7.</td>
<td>MOHS Hardness</td>
<td>6</td>
</tr>
<tr>
<td>8.</td>
<td>Flexural Strength</td>
<td>27 N/MN2</td>
</tr>
<tr>
<td>9.</td>
<td>Abrasian Resistance</td>
<td>204 MM3</td>
</tr>
<tr>
<td>10.</td>
<td>Skid Resistance</td>
<td>0.6</td>
</tr>
<tr>
<td>11.</td>
<td>Breaking Strength</td>
<td>1113 N</td>
</tr>
<tr>
<td>12.</td>
<td>Density (G/CC)</td>
<td>2</td>
</tr>
<tr>
<td>13.</td>
<td>Frost Resistance</td>
<td>Frost Proof</td>
</tr>
<tr>
<td>14.</td>
<td>Chemical Resistance</td>
<td>No Damage</td>
</tr>
</tbody>
</table>
15. Thermal Shock Resistance  | No Damage  
16. Colour Resistance       | No Damage  
17. Thermal Expansion       | 9 x 10^-6

7.0 SPECIFICATION FOR GRANITE FLOORING/SKIRTING

7.01 Granite Stone Slabs:

The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-charge.

7.02 Dressing:

Every slab shall be cut to the required size and shape and machine cut and table rubbed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with machine edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane. The thickness of the slab after it is rubbed shall be 18-20 mm.

7.03 Preparation of surface and Laying:

Base concrete of R.C.C. slab on which the slabs are to be laid shall be cleaned, wattled and mopped. The bedding for the slabs shall be with cement mortar 1:3 (1 cement : 3 coarse sand) as given in the description of the item. The average thickness of the bedding mortar under the slab shall be 12 mm and the thickness at any place under the slab shall be not less than 8 mm.

The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows.

The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or
white cement with or without admixture of pigment to match the shade of the granite slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-charge.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/ Streaks or as directed by Engineer-in-charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-charge.

7.04 Measurement:

Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). The shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

7.05 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.
7.06 SPECIFICATION FOR WOODEN FLOORING AND SKIRTING

7.07 GENERAL

The wooden texture laminated flooring shall be of Scheit (Germany) Faus Floor (by Faus Group, Spain), Kaindl (Austria) or equivalent with bottom layer of poplar fibre underlay and PE film. The thickness of laminated plank should be 8mm-8.3mm thick with min. 189-289mm wide having joint guard joint protection system. The plank should have glueless click insulation system arrangement. All joints to be filled with click guard joint sealing system for extra joint strength and moisture protection.

7.08 TECHNICAL CLASSIFICATION REQUIREMENT

<table>
<thead>
<tr>
<th>Method</th>
<th>Units</th>
<th>Requirement</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion Class</td>
<td>EN 13329</td>
<td>AC 4:IP&gt;9000</td>
<td>IP&gt;9000</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>EN 13329</td>
<td>N/mm²</td>
<td>&gt;1C 1</td>
</tr>
<tr>
<td>Resistance to staining</td>
<td>EN 438.2.15</td>
<td>Rating(*)</td>
<td>Group 1 &amp; 2:5</td>
</tr>
<tr>
<td>Resistance to cigarette burns</td>
<td>EN 438.2.18</td>
<td>Rating(*)</td>
<td>Group 3:4</td>
</tr>
<tr>
<td>Effect of furniture leg</td>
<td>EN 424</td>
<td>-</td>
<td>No damage</td>
</tr>
<tr>
<td>Effect of castor chair</td>
<td>EN 425</td>
<td>00</td>
<td>No damage</td>
</tr>
<tr>
<td>Thickness swelling</td>
<td>EN 13329</td>
<td>%</td>
<td>≤18%</td>
</tr>
</tbody>
</table>

(*) Rating scale 1 to 5, where 5 is the best = “No visible change”

7.09 MEASUREMENT:

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square meter correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the covers.

7.10 RATE

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Noting extra shall be paid for the use of cut (sawn) in the work.
8.0 SPECIFICATION FOR WALL LINING

8.01 Note :-

- Angle bead has to be used at the external angels to get straight line & finish & protection from impacts. It should be charged extra.
- Edge bead has to be used to protect the exposed edges of Gypboard. The edges can be at the opening for doors, windows, glazing etc. or any other exposed edges. It should be charged extra.
- Control joints to be incorporated wherever the length of the wall panelling is more than 10 mtrs. It should be charged extra.

8.02 ITEM DESCRIPTION

<table>
<thead>
<tr>
<th>Component</th>
<th>Dimension</th>
<th>Fixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypboard</td>
<td>12.5 x 1219 x 2438 mm</td>
<td>It is screw fixed to the ceiling section</td>
</tr>
</tbody>
</table>
| Perimeter Channel      | Thickness – 0.55 mm
Length = 3660 mm
Flanges = One 20 mm & Other 30 mm
Web = 27 mm | Used at perimeter of the the ceiling and fixed on the wall or partition with nylon sleeves and screws at 610 mm c/c |
| Ceiling Section        | Thickness – 0.55 mm
Length = 3660 mm
Flanges = 26 mm each with 10.5 mm lip
Web = 27 mm |                                               |
| Drywall Screws         | Dimension = 25 mm               | They are used to fix Gypboard on the metal frame                       |
| Joint Paper Tape, Jointing Compound, Top Coat |                                               | They are used for filling and finishing the square and tapered edges of the boards. |

8.03 MEASUREMENT

The measurement will be done in square meter correct to two decimal places. The rate shall include providing and fixing of pallets, frame work if any, fittings and fixtures and shall includes all taxes like sales tax, work tax, if any etc. complete.
8.04 RATE

The rate shall be inclusive of all frame work, wastage, scaffolding, tools, plants, all cost of composite panel i.e. basic, excise and custom duty if any, fright, taxes or any other tax complete.

8.05 SPECIFICATION FOR EPOXY COATING

Correct preparation of surface is essential. Fibfloor- FC should be laid only if the moisture content of the substate is below 5 %. The surface must be sound and made free from dust, oil, grease and other contaminants before application of Fibfloor- FC. Surface shall be cleaned by sand papering. Allow the surface to dry before priming. Where there are joints in the base, these must be treated separately.

8.06 PRIMING

Surface should be bone dry prior to this application. All surface should be primed using Fibfloor Primer @ 250 gms per sq.m. Mix Primer Component A & B thoroughly and apply by brush or roller. Allow the primer to become dry.

8.07 COATING

Mix together Fibfloor- FC Component A and Component B thoroughly using a pallet knife or an electrical drill mixer till a homogenous and uniform colour is obtained. After mixing, apply Fibfloor-FC by brush or roller to the required thickness on the dried primed surface. Fibfloor-FC is a high build coating. It is advisable to apply in two coats at right angles to each other. This way the second coat will cover any porosity/air gap of the first coat. Allow first coat to become dry before the second coat is applied. (Generally, second coat is applied after overnight curing of first coat.)
9.0 SPECIFICATION FOR ALUMINIUM COMPOSITE PANEL

9.01 General

The aluminum composite panel shall be stove lacquered coversheet on the front side and Mill finish or stove lacquered coversheet on the reverse side produced in a continuous finishing process as per technical data sheets of Alcomex (Dongshin), Alucobond - West Germany or equivalent. It should be a prefabricated anodized material and surface of the standard panel shall either lacquered, anodized or laminated with a self adhesive foil.

The composite panel shall be light weight with excellent product properties for indoor and outdoor applications.

9.0.2 Fixing Arrangement:

i) **Frame Work**: Mild Steel hot dipped galvanized C brackets of size 75mm x 50mm x 1.6mm with slot of 8mm x 35mm are fixed to the existing RCC columns walls or any other backing surface, Aluminium hollow section of size 50mm x 25 mm of 1.6mm thick are fixed to these brackets both vertically and horizontally by using M6 x 75mm stainless steel bolts and nuts. The frame work can easily be aligned for plumb and straightness panel fixing.

ii) **Panel Fixing**: Composite panels are cut to size, routed, corners notched and bend as per the dimensions specified. After the panels are bend aluminium cleats of size 16mm x 16mm by 25mm length are fixed to the edge of the panels by using aluminium pop rivets. The panels are fixed to the frame work by using stainless steel screws. The gap of 12mm or 16mm between the panels (both vertical and horizontal) are filled with backer rod of size 12mm x 20mm or 16mm x 20mm, weather proof silicon sealant of Wacker, Dowcorning or equivalent make is used to filled the grooves.

Technical Data : The composite panel shall be of Alcomex (Dongshin), Alucobond - West Germany, Reynobond - France or equivalent with following technical data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel thickness</strong> (mm)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Cover sheet thickness</strong> (mm)</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Weight</strong> (kg/m²)</td>
<td>5.5 kg</td>
</tr>
<tr>
<td><strong>Core</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Polyethylene, type LDPE</strong> (g/cm³)</td>
<td>0.92</td>
</tr>
<tr>
<td><strong>Surface</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Lacquering</strong></td>
<td>Modified Polyester Lacquer System</td>
</tr>
</tbody>
</table>
Brilliance (initial value) 30-30 % accord. To Gardner
Hardness (pencil hardness) H
Temperature resistance From - 50 to + 80 C
UV stability Very good

Technical Specifications of composite panel AS PER ASTM STANDARDS.

<table>
<thead>
<tr>
<th>Panel thickness (mm)</th>
<th>4</th>
</tr>
</thead>
</table>

**Technical properties**

<table>
<thead>
<tr>
<th>Technical properties</th>
<th>0.123</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment of inertia I (cm4/m)</td>
<td></td>
</tr>
<tr>
<td>Section modulus W (cm3/m)</td>
<td>0.81</td>
</tr>
<tr>
<td>Rigidity E-j (kNcm2/m)</td>
<td>865</td>
</tr>
<tr>
<td>Alloy/condition of the cover sheets</td>
<td>EN AW-5005A (AlMg.1), H44</td>
</tr>
<tr>
<td>Modulus of elasticity (N/mm2)</td>
<td>70,000</td>
</tr>
<tr>
<td>Tensile strength of the cover sheets (N/mm2)</td>
<td>Rm : 145-185</td>
</tr>
<tr>
<td>0.2% proof stress (N/mm2)</td>
<td>Rp0/2: 110-175</td>
</tr>
<tr>
<td>Elongation</td>
<td>A50 &gt;=3%</td>
</tr>
<tr>
<td>Linear thermal expansion</td>
<td>2.4 mm/m at 100 C temperature difference</td>
</tr>
</tbody>
</table>

**Acoustical properties**

<table>
<thead>
<tr>
<th>Acoustical properties</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption factor</td>
<td>as 0.05</td>
</tr>
<tr>
<td>Airborne sound Insulation index Rw (dB)</td>
<td>24</td>
</tr>
<tr>
<td>Loss factor d</td>
<td>0.0057</td>
</tr>
</tbody>
</table>

**Thermal properties**

<table>
<thead>
<tr>
<th>Thermal properties</th>
<th>0.2280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance 1/A (m2k/W)</td>
<td></td>
</tr>
<tr>
<td>Heat transition Coefficient k (W/m2k)</td>
<td>5.61</td>
</tr>
<tr>
<td>Water absorption DIN 53495 (%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Static charge</td>
<td>No antistatic treatment necessary</td>
</tr>
</tbody>
</table>
## Technical Features as per ASTM Standards:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel thickness (mm)</td>
<td>4</td>
</tr>
<tr>
<td>Weight (kg/m²)</td>
<td>5.5</td>
</tr>
<tr>
<td>Europanel, standard height</td>
<td>2500 mm</td>
</tr>
<tr>
<td>Rigidity E-J (KNm²/m)</td>
<td>0.086</td>
</tr>
<tr>
<td>Modulus of elasticity E</td>
<td>70,000 N/mm²</td>
</tr>
<tr>
<td>Tensile strength of cover sheets</td>
<td>Rm : 165 N/mm²</td>
</tr>
<tr>
<td>Water absorption (DIN 53495) (%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Linear thermal expansion</td>
<td>2.4 mm/m at 100 °C</td>
</tr>
<tr>
<td>Static charge</td>
<td>No antistatic treatment necessary</td>
</tr>
<tr>
<td>Thermal resistance 1/A (M²k/W)</td>
<td>0.0080</td>
</tr>
<tr>
<td>Heat transition coefficient k (W/m²k)</td>
<td>5.61</td>
</tr>
<tr>
<td>Temperature resistance</td>
<td>From- 50 to + 80 °C</td>
</tr>
<tr>
<td>Acoustical absorption aₙ</td>
<td>0.05</td>
</tr>
<tr>
<td>Airborne sound insulation index Rw (accord. To ISO 717-1) (dB)</td>
<td>24</td>
</tr>
<tr>
<td>Loss factor d</td>
<td>0.0057</td>
</tr>
</tbody>
</table>

### 9.03 WEATHER SEALANT

Weather Sealant should have minimum tearing strength 4.0N/mm, sore hardness 20 (ISO 868), joint movement capability ± 15% (As per ASTM C-920), one part natural core equivalent to Sika Elastosil 305, Dow Corning 791P or equivalent.

### 9.04 EPDM GASKET

EPDM Gasket should not loose its properties of elasticity and it should not become brittle or plastic before 10 years at-least.
9.05 **MEASUREMENT**

The measurement of the composite panel cladding will be done in square meter correct to two decimal places. The rate shall include providing and fixing of pallets, frame work if any, fittings and fixtures and shall includes all taxes like sales tax, work tax, if any etc. complete.

9.06 **RATE**

The rate shall be for per sqm of composite panel inclusive of all frame work, wastage, scaffolding, tools, plants, all cost of composite panel i.e. basic, excise and custom duty if any, fright, taxes or any other tax complete.
ADDITIONAL SPECIFICATIONS FOR PLUMBING WORKS

(Page No. 50 to 71)
SANITARY AND PLUMBING WORKS

1.0 ADDITIONAL SPECIFICATIONS FOR PLUMBING AND SANITARY WORKS

1.1 General

1.1.1 Scope of work

The scope of work comprises supply, installation, testing and commissioning of water supply, sewerage and drainage, sanitary fixtures and fittings, water pumping and water treatment system for NPL. The scope of work includes supply of all materials as per specifications and drawings, laying, fitting, fixing, installation and commissioning the same.

1.1.2 All the water supply, drainage and sanitary works shall be carried out strictly as per printed central PWD Specifications, 1996 Vol. (Two), 2002 Edition with upto date corrections for sanitary installation, water supply, drainage and miscellaneous works. The works related with pumps and water treatment system shall be carried out as per relevant sections of these Specifications.

1.1.3 All the water supply and sanitary works shall be carried out by the licensed plumbers approved by the Local Authorities and skilled workmen, experienced in the trade.

1.1.4 All works shall be completely concealed either within shafts or chases or in fills and dropped ceilings unless specifically shown in drawings or required otherwise.

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

1.1.6 No work shall be covered without approval of the Engineer.

1.1.7 The Contractor shall be responsible for coordinating the work with works of other trades sufficiently ahead of time to avoid unnecessary hold-ups. Hangers, sleeves, recesses, etc. shall be left in time as the work proceeds whether or not these are shown in drawings.

1.1.8 All clamps, screws, brackets, hangers and all miscellaneous steel work needed in the
work shall be fully galvanised.

1.1.9 Only specified brand of material will be used subject to the approval of the sample.

1.1.10 The Contractor shall submit as directed by the Engineer samples, manufacturer's drawings, equipment characteristics and capacity data etc. of all equipment, accessories, devices, etc. that he proposes to use in the installation, to the Engineer for approval.

1.1.11 The Contractor shall prepare and submit to the Engineer for approval before the work is commenced, all shop drawings.

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

The work shall commence only after the shop drawings are approved by the Engineer.

1.1.12 On completion of work the contractor shall submit to the Engineer one original and two copies of as-built drawings.

1.1.13 Before the work is handed over, the Contractor shall clean all fixtures removing all plaster, stickers, rust stains and other foreign matter of discolouration of fixtures, leaving every part in acceptable condition and ready for use, to the satisfaction of the Engineer.

1.1.14 All sanitaryware and fittings shall conform to I.S. standards. The Contractor shall submit samples of all fittings and fixtures proposed to be used to the Engineer for his approval. The approved samples shall remain with the Engineer till the completion of the work.

1.1.15 All workmanship shall conform to Indian Standard Codes of Practice. The fixing and finishing shall be neat, true to level and plumb. Manufacturer's instructions shall be followed closely regarding installation and commissioning.

2.0 SANITARY FIXTURES AND FITTINGS
1.2.1 Workmanship

All sanitary-ware shall be fixed in a neat workmanlike manner, true to level and plumb. Manufacturer's instructions shall be followed closely regarding installation and commissioning.

2.2.2 Protection of Fixtures

Fixtures shall be protected throughout the progress of the work from damage. Special care shall be taken to prevent damage and scratching of chromium plated fittings. Tool marks on chromium fixtures, etc. shall not be accepted.

All fixtures shall be fixed with chromium plated brass screws with washers whenever necessary.

Protective paper on fixtures shall be removed with hot water only at the final completion of work.

2.2.3 Sanitaryware

All porcelain sanitaryware shall be of first quality, free from warps, cracks and glazing defects. All sanitaryware, fittings and fixtures shall be as shown in drawings and indicated in Bill of Quantities.

2.2.4 Testing

When the installation has been completed to the satisfaction of the Engineer it shall be tested in the following manner:

a) The entire system shall be slowly filled with water, allowing any trapped air to escape.

b) When all outlets are closed the system shall be checked for water tightness.

c) Each outlet shall then be checked for rate of flow and correct operation.
3.0 PLANT AND EQUIPMENT

3.1.1 Scope of Work

The Scope of work in this subhead shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely do all work relating to the supply, installation, testing & commissioning of water pumping & water treatment equipment as described hereinafter and shown on the drawings.

The work shall include the following :-

Supply, installation, testing & commissioning of

a) Water supply pumping system.
b) Water filtration and chlorination system for domestic water.
c) Water softening system for Air conditioning.
d) All piping, valves and accessories.
e) Electrical works related with water supply pumps, water treatment plant.
f) Painting of equipment and piping.
g) Unloading of the equipment and placing in position at site.
h) Foundation of equipments as required.

3.1.2 General Requirements

a) All materials shall be new and of the best quality conforming to specifications and subject to the approval of the Engineer.
b) All equipment shall be of the best available make manufactured by reputed firms.
c) All equipments shall be installed on suitable foundations, true to level and in a neat workmanlike manner.
d) Equipment shall be so installed as to provide sufficient clearance between the
end walls and between equipment to equipment.

e) Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

3.1.3 Pumping System

3.1.3.1 Water Supply Pumps

a) Water supply pumps shall be single stage horizontal centrifugal Mono Block pumps, centre line discharge volute type delivery casing unit with closed balanced bronze impeller, stainless steel shaft, and grease or oil lubricated heavy duty ball bearings suitable for direct drive to a TEFC electric motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficiently below and above the required working pressure.

b) Pumps and motors shall be mounted on a common M.S. structure base plate.

c) Each pump shall be provided with a totally enclosed fan cooled induction motor of H.P. and R.P.M. specified in schedule of quantities.

d) Each pumping set shall be provided with a Gun Metal "Bourden" type pressure gauge with gunmetal isolation cock and connecting piping.

e) Appropriate vibration eliminating pads shall be provided with each pump.

3.1.3.2 Level Controller/Indicator

Contractor shall provide and install low voltage transistorised level controllers/indicator as specified in Schedule of Quantities. Each level controller/indicator shall be provided with required number of PVC sheathed stainless steel probes with necessary wiring and conducting.

3.1.3.3 Neoprene flexible pipe connectors

Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.
4.0 PIPING

Pipes for suction and delivery line shall be galvanised steel tubes to IS:1239 (Medium Class). Fittings shall be malleable cast iron fittings as per IS:1879.

Fullway and check valve above 80mm dia shall be CI double flanged conforming to IS-780.

Fullway and check valves 80mm dia and below shall be gunmetal conforming to IS:778.

Suction strainer or foot valve shall be gunmetal.

4.1.1 Joints

All G.I. pipes and fittings shall be provided with screw joints unless otherwise instructed.

4.1.2 Testing

All G.I. pipes shall be tested hydrostatically for a period of two hours to a pressure of 14.0 Kg/Cum. without drop in pressure.

4.1.3 Composite Pipes

All internal water supply pipes shall be Polyethylene-Aluminium-Polyethylene (PE-AL-PE) composite pressure pipes as per IS 15450 and shall be U.V. stabilized with carbon black, having thermal stability for hot and cold water, capable to withstand temperature range -40 to +80 degree Celsius. The pipe shall be made up of welded Aluminium tube (capable to sustain internal pressure) with inner and outer layer of Polyethylene bonded by adhesive layers. Fittings used should be plastic-metal composite fittings crimp/compression type (as indicated) internal sealing capable to provide perfect water tight joints, pipes and fittings shall be of approved make.

4.1.4 Water Treatment System

4.1.5 Water Filter

a) Water filter shall be sand gravel pressure filter downward flow type suitable for a rate of filtration given in schedule of quantities. The design fabrication and construction shall conform to the requirement of IS:2825.
b) Filter shall be vertical type skid mounted of required diameter. The shell shall be fabricated from M.S. plates conforming to IS:2041 suitable to withstand as design pressure given in schedule of quantities. The minimum thickness of shell shall be 6 mm and dished ends shall be 6 mm which shall include corrosion allowance and mill allowance respectively. The scaling allowance on dished ends to be considered by the bidder as per requirement of IS:2825. The filter shall have atleast one pressure tight manhole cover. Each filter shall be provided with screwed or flanged connection for inlet, outlet, individual drain connections necessary and required. Filter shall be painted inside with minimum two coats of non-toxic corrosion resistant paint and one coat of red oxide primer outside.

c) Under Drain System

Each filter shall be provided with an efficient under drain system comprising of collecting pipes, polypropylene nozzle's of manufacturer design. The entire under drain system shall be supported on M.S. plate or cement concrete supports provided by the contractor.

d) Face Piping

Each filter shall be provided within interconnecting face piping comprising of inlet, outlet and back wash complete with valves. Pipes shall be GI heavy class (65 mm & below). Pipe 80 mm dia and above shall be CI double flanges pipes with matching fittings.

e) Accessories

i) Air release valve with connecting piping.

ii) 100 mm dia Dial Bourden type gun metal pressure gauges with gun metal isolation, cock and connecting piping on inlet and outlet, causing shall be with cast aluminium stored enamel black finish cases.

iii) Sampling cocks on low water inlet and filtered water outlet.

iv) Connection with valve for air scouring.

f) Each filter shall be provided with clean and washed filter media of type and depths as recommended by the manufacturer.
g) Back Wash

Backwash flow rate shall be 400 gallons/hr./sq.ft which shall be achieved by reversal of flow from water supply pumps through the pressure filter. Backwash shall be done once in 48 hours subject to the recommendations of manufacturer.

5.0 WATER SOFTNER

a) Softener shall be suitable to give zero commercial hardness (less than 50 ppm.). Softener shall be with cation exchange resins.

b) Softener vessel shall be of mild steel with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure given in Bill of Quantities. The shell shall have a minimum thickness of 5mm and dished ends 6mm. The vessel shall be painted internally with non-toxic bitumen paint and externally with one coat of red oxide before despatch.

c) The vessel shall have an internal collecting and distribution system of manufacturer’s design.

d) Softener shall have a set of face piping for inlet, outlet, brine injection with all valves and suitable drain. Pipes shall be G.I. heavy class (65mm dia and below). Pipe 80mm dia and above shall be C.I. double flanged pipes to I.S. with matching fittings.

e) One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicating lamps.

f) One cylindrical salt saturators and measuring tanks of MS Rubber lined of capacity as given in the Bill of Quantities.

g) One orifice board for indicating wash and rinse rate to be filtered in drain sump.

h) One charge of supporting gravel, sand and “caution” resin in requisite quantity. Resin shall be of approved quality.

i) One water testing kit with instructions for testing water samples. Arrangement to install the test kit in the softening plant shall be provided with isolating valve.
j) All other accessories e.g. rotameter, water meter valves, etc., as indicated in the Bill of Quantities.

5.1.1 Chemical Dosing Pumps (for Chlorination)

a) Chemical dosing pumps shall be reciprocating type with PVC or Ebonite head and adjustable stroke with 0-100% adjustment.

b) Pump shall be driven by a totally enclosed vertical spindle motor suitable for 400/440 volts, 3 phase, 50 cycles, A.C. supply.

c) Capacity of the pump shall be as per manufacturer's recommendation.

d) As the dose rate is likely to vary depending upon the quality of water select a pump of which operating capacity can be exceeded by further 50%.

5.1.2 Solution Tanks for Chlorination

Provide one PVC/Rubber lined M.S. tank of minimum one day storage capacity for each pump considering the extended capacity of the pump.

5.1.3 Piping for Water Treatment Plant

a) Pipes shall be M.S. galvanised steel conforming to IS:1239 (medium class) with matching malleable cast iron fittings.

b) Valves 80 mm dia and above shall be cast iron double flanged fullway gate valves to IS:780.

c) Non return valve 80 mm dia and above shall be cast iron double flanged to IS:5312.

d) Valves and non-return 65 mm dia and below shall be gun metal fullway and horizontal type, preferably conforming to 778.

5.1.4 Flow Measurement

The contractor shall provide one bye-pass type Rotameter reading LPH on delivery line of filter and softener.

5.1.5 The contractor shall supply one complete set of test kit for water treatment system.
5.1.6 Painting and Clean-up

a) One completion of the installation contractor shall scrub, clean all pumps, piping, filter, softener and other equipment and apply one coat of primer.

b) Apply minimum two coats of synthetic enamel paint. Type/make of paint shall be as per Engineer approval.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by the Engineer.

d) On final completion of the work, contractor shall clean up the site and pump room of all surplus materials, rubbish and leave the place in a broom clean condition.

5.1.7 Electrical Works

5.1.8 Cables

a) Contractor shall provide all power and control cables from motor control centre to various motors, level controllers and other control devices.

b) Cables shall conform to IS:1554 and carry ISI mark.

c) Wiring cables shall conform to IS:694.

d) All power cables shall be aluminium conductor PVC insulated/PVC sheathed FRLS armoured cables of 1100 volts grade.

e) All control and wiring cables shall be copper conductor PVC insulated armoured and PVC sheathed 600 volt grade.

f) All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

5.1.9 Motor Control Centres

Cubicles switch board of floor mounted and shall be fabricated from 16 gauge M.S. sheet with dust and vermin proof construction. It shall be painted with stove enamelled paint of approved make and shade. It shall be fitted with suitable etched
plastic identifications plates for each motor. The cubicles shall in general comprise of the following:

a) Incoming main fuse switch unit with HRC fuses of required capacity.

b) Isolation switchfuse unit one for each motor.

c) Fully automatic DOL/Star Delta starters appropriate for motor rating with ON/OFF push buttons and on/off indicating neon lamps for individual motor.

d) Single phase preventer of appropriate rating for each motor.

e) Selector switch for pump operation.

f) Panel type ampere meters of appropriate rating one for each motor.

g) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.

h) Rotary switch for manual or auto operation for each pump.

i) Space for liquid level controllers specified separately in this contract.

The panel shall be prewired with colour coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switch board panel.

5.1.10 Installation, Commissioning & Guarantees

5.1.11 Installation

a) Contractor shall supply three copies of foundation drawings giving weight, vibration and other loads required for the proper designing of the foundations.

b) All equipment shall be installed in a true workman like manner true to level and grade in accordance with the best current practice.

c) Contractor shall employ sufficient and proper equipment for lifting and placing of heavy equipment and in a manner which shall not strain or cause damage to the existing structures. If any damage is done, the same shall be made good to the satisfaction of the Engineer without any additional cost.
d) The contractor shall submit detailed shop drawings showing detailed layout of the system showing dia piping, valves etc. for approval of the Engineer. The work shall be started only after approval of shop drawings submitted by the contractor.

5.1.12 Commissioning

a) On completion of the work in all its aspects, the contractor shall start up the plant in a manner normally done for the continuous operation for a period of not less than 48 hours and shall rectify and adjust the equipment for leakages and balancing the system.

b) After satisfactory commissioning of the plant, the contractor shall conduct performance tests on the pumps to satisfy the Engineer that all equipments are performing to the rated outputs any or all pumps and equipment shall be rectified or replaced if the same is not performing in accordance with the specifications.

5.1.13 Guarantees

a) On award of the work contractor shall submit a guarantee covering the quality and performance of all materials supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.

b) Contractor shall specify a suitable procedure to test the rated performance of the equipment and shall provide all necessary equipment, guages etc. for conducting such tests.

c) The guarantee shall cover a period of one year from the date of installation and handing over and commissioning of plant.

5.1.14 Completion

On completion of the job, the contractor shall hand over to the Engineer the following:

b) One flow chart drawn in ink on thick paper and mounted in a glass frame showing the flow diagram of the process including legend showing valves to be normally open or closed and instructions for operation and maintenance of the pumping equipment.

c) Five sets of operating and maintenance instructions with spare parts list and
their manufactures and/or suppliers.

c) Five sets of catalogues and drawings for all equipment supplied.

On final commissioning of the plant, contractor shall provide the services of one trained supervisor for period of two calendar weeks to train the Owners' staff in the operation and maintenance of the plant.

6.0 TUBEWELL

6.1.1 Scope of Work

The scope of work comprises construction and development of one number 200 mm bore tubewell and two No. complete system for rain water harvesting and artificial recharge structures with 200mm borewell as shown on drawing giving a minimum safe yield of 5000 GPH including drilling of borehole, collecting and recording well data, supply and installation of well assembly development of the tubewell and carrying out various tests as specified.

6.1.2 Selection of Site

The site where tube well is to be sunk or where rain water harvesting system is to be made as indicated in the drawing shall be examined by the driller and if necessary a more suitable alternative location shall be selected with the approval of the Engineer so that the chances of success of tubewell might be increased. Any previous data available with the drilling agency regarding nearby tubewells or boring made for any other purpose may be used to evolve suitable procedure for drilling, developing, testing etc. of the tubewell to be sunk.

6.1.3 Geological Data

6.1.4 Samples of drill cuttings from different strata shall be collected at suitable intervals. The samples shall be collected at every 2 metre depth drilled or at closer intervals, if a change in the strata is met with.

6.1.5 The sample shall be dried and stored in a neat cloth or polytene bags which shall be labelled clearly indicating the depth range of the strata. All such samples shall be sent to the required authority for testing, etc.

6.1.6 Drilling Time Log
As the drilling progresses, an accurate drilling time log be kept indicating the time taken to drill each 3 metre depth.

6.1.7 **Lowering of Pipe Assembly**

6.1.8 Housing pipe is provided in upper portion of the tubewell in which pumps and motor assembly shall be accommodated. The pipe shall be of heavy duty and provided at least 0.6m above the ground level to have good and strong foundation.

6.1.9 Blind pipe: It shall be provided in non-aquifer portion and below housing pipe and upto slotted pipe. The length of blind pipe should be decided on the basis of non-aquifer portion or unwanted aquifer portion which are to be cased.

6.1.10 Slotted Pipe or Screen : The screen or slotted pipe shall be provided against the required thickness of aquifer in order to allow ground water to be pumped into the tubewell.

6.1.11 The housing pipe, blind pipe and slotted pipe to be used in the tubewell shall be of mild steel ERW pipes conforming to IS-3589-1991 (or revised thereof). In order that the well assembly be centrally lowered in the bore, the housing and casing pipe to the fitted in alluvium or over burden portion of the tubewell with centralised guides specially approved by the Engineer-in-Charge. These guides shall be fitted at every 10 metre subject to minimum of 4 guides on each tubewell.

6.1.12 The slotted pipes to be used shall have lined slots of required size to give an area of 15 to 22%. The slot size should not exceed the thickness of slotted pipe. The slot size shall be within limits of 1 mm to 3 mm thickness. The length of the slot can also vary from 50mm to 80mm within the prescribed percentage area of opening allowed. The length of the slotted pipe/strainer shall not be less than 3 metre. The slotted pipe shall be attached to the housing pipe or blind pipe by means of a strong M.S. coupling and reducer of quality and design approved by the Engineer-in-Charge.

6.1.13 1.5 metre long tail of M.S. blind pipe to be provided with close bottom and lifting hook of 20mm dia bars or tail plug of approved type shall be provided at the bottom of screen pipe.

6.1.14 Painting - Before placing into the bore holes, two coats of anti-corrosive paint over a coat of red oxide primer shall be given to all mild steel pipes and other parts of the well assembly, both inside and outside.
6.1.15 **Gravel Packing** - Uniform gravel shall be used adjacent to the well screens. The gravel must be fine enough to prevent the passage through its pores, the particles from the formation materials and coarse enough to give a lesser resistance so that the head loss in flow of water through it should be relatively small.

The gravel shall consist of clean, hard, well rounded uniform particles of silica or quartz, free from dirt, foreign materials as well as flaky particles. The size of gravel will depend upon mechanical analysis of the aquifer materials for uniform aquifer. The packing of gravel around the well assembly will be a continuous process and shall start from bottom upward. The gravel shall be packed systematically in layers through 35mm dia to 50mm dia GI pipe.

6.1.16 **Drilling**

6.1.17 The driller shall employ DTH method as approved by the Engineer-in-Charge to drill the bore hole. The driller shall provide all equipments necessary for the execution of the work at his own cost.

6.1.18 The driller shall make his own arrangement for electricity and water required for drilling purposes and also for ancillary excavation. He shall also arrange for the drilling mud and mud pump etc.

6.1.19 **Lowering of Well Assembly**

The lowering of assembly shall be done by the Contractor in the presence of the person duly authorised by the Engineer-in-Charge. The driller shall submit a chart showing the position in the bore and the location where slotted pipes or strainers have been placed including the location of joints.

6.1.20 Vertically of the bore well shall be checked as per the standard approved practice.

6.1.21 **Development**

Development of tubewell shall be carried out either by over pumping or by compressed air. Standard approved methods shall be adopted for development of tubewell. Rate of compressed air or water pumping shall be decided on the basis of strata conditions and as per approval of the Engineer-in-Charge. All equipment required to develop the tubewell shall be arranged without any extra cost. Development process shall be continued until the stabilization of sand and gravel rock...
is completely assured.

6.1.22 **Step Draw Down Test**

The test shall be conducted by installing a test pump in the tubewell temporarily and pumping out water at various speeds or by throttling delivery sluice valve. At each rate of discharge pumping shall be carried out at least for 30 minutes. If the water level and discharge are found to be fluctuating, development shall be carried out for some more hours until the discharge becomes steady and sand content is within tolerable limits. The specific capacities of the well for various pumping rates shall be computed based on the step draw down test data.

6.1.23 **Yield Test**

The yield test of the tubewell shall be carried out by pumping out well water, after the well is satisfactorily developed. Pumping rate shall be increased gradually until the desired draw down is attained. The pumping shall be continued at the same draw down for at least 10 hours and may be increased to 12 hours as required by the Engineer-in-Charge. Necessary samples shall be collected and stored as per standard approved procedure and arranged for testing at approved laboratory for chemical and biological characteristics of the water. The yield test shall be carried out in accordance with tubewell department's standards as per para 5.3 of IS: 2800, Part II, 1979.

The driller shall obtain certificate of successful construction of the tubewell from the Engineer-in-Charge and the local authorities.

In the event of a tubewell declared unsuccessful by the Engineer-in-Charge, the driller shall remove the tubewell assembly by jacking or any other method approved by the Engineer-in-Charge so that no part of the well assembly is damaged.

An abandoned tubewell, after removal of tubewell assembly, shall be suitably backfilled with the natural material of the encountered and duly rammed at ground level with allowances for settlement by the driller. The cost of removal of tubewell assembly from abandoned tubewell and backfilling etc. shall be deemed to be included in the rate of boring of the tubewell, however cost of boring shall be paid.

6.1.24 **Quality of Water**

Water shall be collected during aquifer performance test and analysed chemically, as desired by the Engineer-in-Charge for different constituents depending upon the ultimate use of the water.
6.1.25 **Sanitary Sealing**

The annular space between the bore and the housing pipe shall be cement grouted upto 5 meters below ground level or upto first clay bed whichever is obtained first and two gravel feeding pipes on either side of housing pipe to the full depth of foundation to be provided.

6.1.26 **Handing Over of the Tubewell**

6.1.27 The tubewell shall be handed to the Engineer-in-Charge in a complete shape. The housing pipe shall be closed by a well cap for the period between the completion of the tubewell and the installation of the pump set. The cap shall be of such a design that it is easily removable causing no damage to the housing pipe.

6.1.28 The following information shall be furnished by the drilling agency to the Engineer-in-Charge on completion of the tubewell:

a) Strata chart of the bore hole indicating the different types of soil met with, at different depths and granular zones.

b) Samples of strata collected, neatly packed and correctly marked in sample bags;

c) Chart of actual pipe assembly lowered indicating the sizes of pipes, depth ranges where slotted 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 bore hole;

d) Hours of developing by compressed air, pump sets or by other means;

e) Results of mechanical (sieve) analysis of samples of aquifer material, wherever applicable;

f) Recommendation on the safe pumping yield, pump-setting and specification for suitable pump set;

g) Report on the chemical and bacteriological tubewells water.

h) Annexure-A, giving the required details indicated in the proforma.
ANNEXURE - A

INFORMATION TO BE FURNISHED BY DRILLER TO OWNER ON COMPLETION OF THE TUBEWELL

1) Agency constructing the tubewell
2) Location of the tubewell
3) Method of drilling adopted
4) Date of starting
5) Date of completion
6) Pilot hole or test hole ___________________________ Bit size ______________________ Bit type ________________ Bit type ________________ Hours _______________________________ from_________________ to ________________ from_________________ to ________________
7) Coring done _______________________ Bit size ________________ Bit type ________________ Bit type ________________ Hours _______________________________ Recovery _______________________________ From _______________________________ to ________________
8) Reaming ___________________________ Bit size ______________________ Bit type ________________ Bit type ________________ Hours _______________________________ From _______________________________ to ________________
9) Total depth of the bore hole ________________________________
10) Lithological log
From To Formation
_________________________ ___________________________
_________________________ ___________________________
11) Electrical log
12) Assembly of production well ___________________________ Size ______________________ Length ___________________________ Type ________________
Perforation per meter ________________________________
Housing pipe ________________________________
Blind pipe ________________________________
Strainer ________________________________
Bail plug ________________________________

13) Top of tubewell above/below ground level ________________________________

14) Size of gravel ___________________________ Quantity used before development
__________________________ quantity used during development
__________________________

15) Method used for development ___________________________ Testing
__________________________

16) Total hours of development ___________________________ total hours of testing
__________________________

17) Step draw down test : Time of test
__________________________ Speed RPM
__________________________ Discharge ____________ Period run ____________

18) Aquifer performance test : Time of test
__________________________ Speed
__________________________ rev/min Discharge ____________
1/min

19) Static water level ________________________________

20) Rated discharge in 1/min ________________________________

21) Depression head of the production well ________________________________

22) Sand contents in ppm at the rated discharge after 20 minutes of the start of the pump
__________________________

23) Sand contents in ppm at 1.5 times the normal depression after 20 minutes of the start of the pump or 20 percent in excess of rated discharge if 50 percent extra depression cannot be arranged __________________________

24) Recommendation with regard to a suitable pump __________________________
25) Further details required:
   a) Samples of strata, neatly packed in sample bags
   b) Chart of pipe assembly lowered
   c) Results of mechanical analysis of samples of unconsolidated strata
   d) Vertically test on prescribed form
   e) Chemical and bacteriological analysis of tubewell water

26) Remarks:
   Owner _______________________

   Driller ________________________________
INFORMATION TO BE FURNISHED BY THE DRILLING AGENCY

When offering to sink a tubewell, the drilling agency shall furnish the following information:

a) Suitability of the site proposed. If a more suitable point, other than the one proposed exists or is available, it should be suggested.

b) Whether a test bore hole is proposed and, if so, its diameter and depth; and

Depth of tubewell proposed;

c) Likelihood of increasing or decreasing the depth given at (b) above;

d) Method of drilling;

e) Sizes and types of pipes, strainers, or slotted pipes, etc. proposed to be used;

f) Probable yield of water to be obtained;

g) Guarantees with regard to the verticality of tubewell and sand content in discharge in parts per million at the time of handing over the well; and

h) Any other information and condition.
1.0 GENERAL

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these becomes applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications.

General Specifications for Electrical Works.


Wherever this specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.
2.0  SECTION - 1 : SUB-DISTRIBUTION BOARDS AND DISTRIBUTION BOARDS

1.1  DISTRIBUTION BOARD

Distribution Boards shall be indoor type, metal clad, floor mounted, compartmentalised, free standing, totally enclosed, air insulated, cubicle type for use on 415 Volts, 3 phase, 50 cycles system.

2.1.1  Standards

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

i.   IS:8623- Factory Built Assemblies of switchgear and controlgear.

ii.  IS:4237- General requirements for switchgear and control gear for voltages not exceeding 1000 volts.

iii. IS:2147- Degree of protection provided by enclosures for low voltage switchgear and controlgear.

iv.   IS:375- Marking and arrangement of busbars.

Individual equipment housed in the Distribution Board shall conform to the following IS Specification.


iii. Current Transformers - IS : 2705

iv.   Voltage Transformers - IS : 3156

v.   Indicating Instruments - IS : 1248

vi. Control switches & Push Buttons - IS : 6875

2.1.2  Construction.

Distribution Board shall be :-

i.   Of metal enclosed, indoor, floor mounted, free standing construction.

ii. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

iii. Provide dust and damp protection, the degree of protection being not less than IP 52 to IS:2147

Sub distribution shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of :-

i. A front framed structure of rolled/folded sheet steel channel section, of minimum
2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories.

The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 2 mm thickness and 100 mm height or 100 x 50 x 50mm MS Channel. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

ii. A side cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section. Minimum size of cable alley shall be 300 mm.

iii. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

iv. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panels should not be more than 2350mm. Operating levers/handle etc. of highest unit shall not be at a height more than 1800mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350mm.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.63mm thickness. All sheet panels shall be smoothly finished, levelled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centres shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Distribution Boards shall have the following minimum clearances.

| i.    | Between phases                | - 32 mm |
| ii.   | Between phases and neutral    | - 26 mm |
| iii.  | Between phases and earth      | - 26 mm |
| iv.   | Between neutral and earth     | - 26 mm |

Creepage distances shall comply to those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as circuit breakers shall be arranged in multi-tier formation. Cable entry for various feeders shall be either from the front through cable alley located in between two circuit sections. All cable entries shall be through glands plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuit when new feeders are added. Gland plate shall be 3 mm thick.
Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorised access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

2.1.3 Metal Treatment & Finish.

All steel work used in the construction of the Distribution Boards should have undergone a rigorous metal treatment process as follows:-

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii. A recognised phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v. Drying with compressed air in a dust free atmosphere.

vi. A finishing coat of Powder coating of Siemens gray colour.

2.1.4 Busbars

The busbars shall be air insulated and made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-91E of IS : 5082.

The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity. The neutral as well as the earth bar should be capable of withstanding fault withstand capacity. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creepage distances shall be provided on the bus bar system to minimize possibilities of fault. High tensile bolts and spring washers shall be provided at all bus bar joints/connections.

The Distribution Boards shall be designed that the cables are not directly terminated on the terminals of breaker/switch fuse/fuse switch etc. but on cable termination links. Capacity of aluminium bus bars shall be considered as 1.0 Amp per sq.mm of cross section area of the bus bar and also conforming to Table VI of CPWD specification for Internal Electrical Works ( Part I ). The main bus bars shall have continuous current rating throughout the length of Distribution Boards. The cross section of neutral bus bars shall...
be same as that of phase bus bar for bus bars of capacity upto 200Amp; for higher capacity the neutral bus bar shall not be less than half (50%) the cross section of that the phase bus bars. The bus bar system shall consists of main horizontal bus bar and auxiliary vertical bus bars run in bus bar alley/ chamber on either side in which the circuit could be arranged/ connected with front access. Bus bar shall be provided with heat shrinkable sleeves.

Connections from the main bus bars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars to be colour coded.

2.1.5 **Moulded Case Circuit Breakers.**

1.1.1.1 **General**

Moulded Case Circuit Breaker shall be incorporated in the Distribution Boards wherever specified. MCCB’s shall conform to IS : 13947 (Part-II) IEC-947(2) in all respects. MCCB’s shall be suitable either for single phase AC 230 volts or three phase 415volts.

1.1.1.2 **Frame Sizes**

The MCCB’s shall have the following frame sizes subject to meeting the fault level as specified elsewhere.

- a. Up to 100 Amp rating - 100 Amp frame.
- b. Above 100 Amp to 200 Amp - 200 Amp frame.
- c. Above 200 Amp to 250 Amp - 250 Amp frame.
- d. Above 250 Amp to 400 Amp - 400 Amp frame.
- e. Above 400 Amp to 630 Amp - 630 Amp frame.

1.1.1.3 **Constructions**

The MCCB’s cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable “ON”, “OFF” “and” “tripped” indicators. Three phase MCCB’s shall have common operating handle for simultaneous operation and tripping of all the three phases. Rotary type operating Handle shall be provided. MCCB shall be load/line reversible type. MCCB shall be load/line reversible type. MCCB shall be site adjustable type with overload setting of 80% to 100%.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermo-magnetic or static release type provided in each pole and connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contacts trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

1.1.1.4 **Rupturing Capacity**

The Moulded Case Circuit Breaker shall have a service breaking capacity (Ics) of not less than 35 KA RMS at 415 volts for Distribution Boards.

1.1.1.5 **Testing**

Routine & Type Test certificate of the MCCB as per relevant Indian Standards (IS) shall be submitted.
2.1.6 Measuring Instruments, Metering & Protection

1.1.1.1 General

Direct reading electrical instruments shall be in conformity with IS-1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between -10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

1.1.1.2 Digital Ammeters

Ammeters shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

1.1.1.3 Digital Voltmeters

Voltmeter shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

1.1.1.4 Current Transformers

Current transformers shall be in conformity with IS: 2705 (part I,II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

- Measuring: Class 0.5 to 1.
- Protection: Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of the system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

2.1.7 Miscellaneous
Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamps covers, bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

2.1.8 Cable Terminations

Cable entries and terminals shall be provided in the Distribution Boards to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

2.1.9 Labels

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of Distribution Boards. Labels shall be properly secured with fasteners.

2.1.10 Test At Manufactures Work

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates produced to the Department.

2.1.11 Testing And Commissioning

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

a) Operation checks and lubrication of all moving parts.
b) Interlocking function check.
c) Continuity checks of wires, fuses etc. as required.
d) Insulation test : Testing shall be as per CPWD specification.
e) Trip tests & protection gear test.

1.2 SUB DISTRIBUTION BOARDS

Sub Distribution Board shall be double door type with extended loose wire box at the top and suitable for flush installation. All Sub Distribution Boards shall be of three phase (415
Volts) or single phase (240 volts) type with incoming isolator or MCB and/or ELCB as in Schedule of Quantities. Sub Distribution Boards shall contain plug in or bolted type miniature circuit breaker mounted on busbars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with IS 8828-1978. Busbars shall be of electrolytic copper. Neutral busbars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All Sub Distribution Board enclosures shall have powder coated painting after metal treatment. A circuit identification card in clear plastic cover shall be provided for each distribution board.

Sub Distribution Board with single phase outgoings requirement shall be Horizontal type. Sub Distribution Board with three phase outgoings requirement shall be Vertical type. Sub Distribution Board installed in indoor dry locations shall conform to IP-52. Sub Distribution Board installed in outdoor & wet locations shall conform to IP-65.

Miniature Circuit Breakers for lighting circuits shall be of "B" series where as the circuits feeding discharge lamps (HPMV or HPSV) halogen lamps, all power outlet points, equipment/machinery shall be of "C" series (Motor circuit) types. All miniature circuit breakers shall be of 10 KA rated rupturing capacity.

Sub Distribution Board shall be provided with isolator or MCB and/or earth leakage circuit breaker as mentioned in drawings and BOQ. Earth leakage circuit breaker shall be current operated type and of sensitivity not less than 30mA unless otherwise stated. ELCB shall be mounted within Sub Distribution Board box. Sub Distribution Board box, Isolator, MCB's used shall be of one/same manufacturer. Standard size DB Box manufactured by approved manufacturer shall be used. In case size specified in BOQ is not standard size of manufacturer, in that case next standard size Sub Distribution Board box shall be used with incoming & outgoing MCB as specified in BOQ. Additional cutout/space for outgoing MCB shall be plugged with blank plates.
SECTION - 2 : POINT WIRING

This section covers the general technical requirements and measurement of the various component in Internal Electrical Installation Works.

1.1 TERMINOLOGY

The definition of terms shall be accordance with IS 732: 1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit and submain wiring, which are defined in Clause 3.2, 3.3 and 3.3.2 hereunder.

1.2 POINT WIRING

1.1.1 Definition

A point (other than socket outlet point) shall include all works necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, includes the wiring work necessary in tapping from another point in the same distribution circuit: -

a) Ceiling rose or connector (in the case of points for ceiling/ exhaust fan points, pre-wired light fittings and call bells)

b) Ceiling rose (in case of pendants except stiff pendants)

c) Back plate (in the case of stiff pendants)

d) Lamp holder (in the case of gooseneck type wall brackets, batten holders and fittings which are not pre-wired.

1.1.2 In the case of call bell points, the words “from the controlling switch or MCB” shall be read as “from the ceiling rose meant for connection to bell push”.

1.1.3 Scope

i) Following shall be deemed to be included in point wiring:

a) Conduit, accessories for the conduit and wiring cables between the switch box and point outlet, loop protective earthing of each fan/ light fixture.

b) All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.

c) Metal switch boxes for control switches, regulators, sockets etc. recessed or surface type and phenolic laminated sheet covers in case of piano type switches and outer & inner cover plates in case of modular type switches.

d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/ conduit terminations.

e) Control switch or MCB as specified.

f) Ceiling rose or connector as required.

g) Connections to ceiling rose, connector, lamp holder, switch etc.
h) Interconnection wiring between points on the same circuit, in the same switch box or from another.

i) Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets. (The length of protective conductor run along with the circuits/submains is excluded from the scope of points)

j) Based conduit or porcelain tubing where wiring cables pass through wall etc.

ii) Following shall be deemed to be included in group control point wiring:

Conduit, accessories for the conduit and wiring cables between the Switchboard/ MCBDB to the first point or wiring cable between points forming a group including loop protective earthing of each fan/light fixture. (Providing MCB/Switch is not included in this scope and will be measured separately).

All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.

Junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with Switchboard/ MCBDB for loose wires/conduit terminations.

Ceiling rose or connector as required.

Connections to ceiling rose, connector & Switch/ MCB etc.

Bushed conduit or porcelain tubing where wiring cables pass through wall etc.

1.3 **MEASUREMENT**

1.1.1 **Point Wiring (Other than Socket Outlet Point)**

Unless and otherwise specified, there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting.

No separate measurement will be made for interconnections between points in the same distribution circuit and for the circuit protective (loop earthing) conductors between metallic switch boxes.

1.1.2 **Point Wiring for Socket Outlet Points**

i) The light plug (5/6 Amp) point and power(15/16 Amp) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switchbox, another socket outlet point, or the Sub distribution board as the case may be, up to the socket outlet.

ii) The metal box with covers, switch/ MCB, socket outlet and other accessories shall be measured and paid as separate item.

iii) The power point may be 15/5 Amp or 16/6 Amp 6 pin socket outlet, where so specified in the Tender documents. (2 pin or 5 pin socket outlet shall not be permitted.)

1.1.3 **Switch Controlled Group Control Point Wiring**
1.1.4 **MCB Controlled Group Control Point Wiring**

i) In the case of points with more than one point controlled by one MCB, such points shall be measured in part i.e. from MCB to the first point outlet as one point and will be measured under group controlled point (from MCB to first point of group controlled point). Subsequent looping points i.e one point to another point in the same group will be measured under group controlled point (from one point to another point).

ii) Providing MCB is not covered in this scope and will be measured separately and shall be separately paid for.

1.1.5 **Twin Control Light Points Wiring**

i) A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side.

ii) No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

1.4 **CIRCUIT AND SUBMAIN WIRING**

1.1.1 **Circuit Wiring**

Circuit wiring shall mean the wiring from the distribution board up to the tapping point for the nearest first point of that distribution circuit, viz. up to the nearest first switch box.

1.1.2 **Submain Wiring**

Submain wiring shall mean the wiring from one Main/Distribution switchboard to another. Measurement of circuit and submain wiring.

i) Circuit and submain shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.

ii) The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether the neutral conductor is take to switch box or not.

iii) When wires of different circuit are grouped in as single conduit the same shall be measured on linear basis depending on the actual numbers and sizes of wires run.

iv) When circuit wires and wires of point wiring are run in the same conduit, circuit wiring shall be measured on linear basis depending on the actual number and
sizes of wires run in the existing conduit. As far as, practicable circuit wiring and point wiring shall be drawn in different conduit.

v) Circuit wiring and submain shall not be run in the same conduit.

vi) Protective (loop earthing) conductors, which are run along the circuit wiring and the submain wiring, shall be measured on linear basis and paid for separately.

1.5 OTHER WIRING WORKS

Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separately on linear basis along with the run of wiring depending on the actual number and sizes of wires run.

1.6 SYSTEM OF DISTRIBUTION AND WIRING

The main distribution board and branch distribution board shall be controlled or provided with linked switch fuse unit or miniature circuit breaker (MCB) of specified rating on the phase or live conductor or combined phase and neutral control gear for incoming and outgoing as indicated in the BOQ.

Distribution of submain and circuits.

As per final approved single line diagram.

1.1.1 Balancing of Circuits

The balancing of circuits in three wire or poly phase installations shall be arranged before handling to the satisfaction of the Engineer-In-Charge.

1.1.2 Wiring System

i) Unless and otherwise specified in the tender documents, wiring shall be done only by the “Looping System”. Phase of live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

ii) Lights, fans and call bell shall be wired in the ‘lighting’ circuits. 15/16 Amp socket outlets and other power outlets shall be wired in the ‘Power’ circuits. 5/6Amp socket outlets shall be wired in the ‘lighting circuits’.

iii) The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.

1.1.3 Run of Wiring

The type of wiring shall be as specified in the tender document, i.e. conduit.

Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.

In no case, the open wiring shall be run above the false ceiling without the approval of Engineer-In-Charge.

In all types of wiring, due consideration shall be given for neatness, good appearance and safety.
1.1.4 **Passing through Walls or Floors**

When wiring cables are to pass through a wall, these shall be taken through a protection (Steel/PVC) pipe or porcelain tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with porcelain, PVC or other approved material.

Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be bell mouthed and turned downwards and properly bushed on the open end.

All floor openings for carrying any wiring shall be suitably sealed after installation.

1.1.5 **Joints in Wiring**

i) No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.

ii) There shall be no joints in the through runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

iii) Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.

1.7 **CONFORMITY TO I E ACT, I E RULES AND STANDARDS**

i) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956, amended upto date.

ii) The works shall also conform to relevant Indian Standard Codes of Practice shall be followed.

1.8 **GENERAL REQUIREMENTS OF COMPONENTS**

1.1.1 **Quality of Materials**

All material and equipments supplied by the Contractor shall be new. They shall be of such design, size and materials as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

1.1.2 **Conformity of Standards**

a) All components shall conform to relevant Indian Standard Specification, wherever existing. However, for conduits, wiring cables, piano switches and socket outlets, ISI marked materials shall only be permitted.

b) The Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable.

1.1.3 **Interchangeability**

Similar parts of all switches, lamp holders, distribution fuse boards, switchgears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.
1.9 CABLES

1.1.1 Wiring Cables

Conductors of wiring cables (other than flexible cables) shall be of aluminium or copper, as specified.

Stranded aluminium conductor shall not be used in wiring cables upto and including 6 Sq.mm. size.

Unless and otherwise specified, copper conductor of size 1.5 Sq.mm. and above used for wiring shall be stranded.

1.1.2 Flexible Cables

i) Conductor of flexible cables shall be of copper. The minimum cross sectional area of conductor for flexible cable shall be 0.0006 Sq. inch (14/.0076” or 14/0.193 mm).

ii) Only 3 core flexible cables shall be used for connecting single-phase appliances.

iii) Unless armour, or tough rubber, or PVC sheath mechanically protects the flexible cables, these shall not be used in workshops and other places where they are liable to mechanical damage.

iv) Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit/ metallic casing and capping.

1.10 WIRING ACCESSORIES

1.1.1 Control Switches For Points

Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

1.1.2 Socket Outlets

5/ 6Amp and 15/ 16Amp 6 Pin socket outlets shall be installed at the following positions, unless otherwise specified.

a) Kitchen/ Pantry 23 cm above working platform and away from the likely positions of stove and sink.

b) Toilets in non-residential building – 1.25 mt. Above floor level.

c) At all other places – 23 cm above floor level.

1.1.3 Switch Box Covers

Phenolic laminated sheet of 3 mm thick of approved shade shall be used for switch box covers in case of piano type switches. For modular type switches/sockets suitable outer and inner cover plates as specified shall be provided over the standard box as recommended by the manufacturers of modular type switch/ sockets and no separate sheet cover is required to be provided.
1.1.4 Ceiling Rose

i) A ceiling rose shall not be used on circuit the voltage of which normally exceeds 250 Volts.

ii) Only one flexible cord shall be connected to ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

iii) A ceiling rose shall not embody fuse terminal as an integral part of it.

1.1.5 Lamp Holders

The standard constructional feature of manufacturers (ISI approved) of lamp holders is acceptable. Where the lamp holders are part of light fixtures the holders shall be suitable for the type of lamps used.

1.11 FITTINGS

The type of fittings shall be as specified in BOQ of tender documents.

1.1.1 Indoor Type Fittings

i) The contractors shall supply the specified model and make of the fittings. The standard constructional features of specified make and model as given in the tender document are acceptable.

ii) Where conductors are required to be drawn through tube or channel leading to the fitting, the tube or channel must be free from sharp angles or projection edge, and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

iii) Pendants in verandahs and similar situations exposed to wind shall be of fixed rod type.

iv) Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

v) Fittings shall be installed such that the lamp is at a height specified in approved drawings or as directed by the Engineer-In-Charge.

vi) Copper chokes of Fluorescent Tube light fittings shall be of Electronics type or as specified in BOQ.

1.12 ATTACHMENT OF FITTINGS AND ACCESSORIES

1.1.1 Conduiting Wiring System

i) All accessories like switches, socket outlets, call bell pushed and regulators shall be fixed in flush pattern inside the switch/ regulator boxes. Accessories like ceiling roses, brackets, batten holders, stiff pendants etc. shall be fixed on metal outlet boxes.

ii) Brass screws shall be used to fix the accessories to their bases.
iii) The switch box/ regulator box shall normally be mounted with their bottom 1.20 m from floor level, unless otherwise directed by the Engineer-In-Charge.

1.1.2 Fixing of Walls and Ceiling

i) PVC sleeves/ dash fasteners should normally be used for fixing to walls or ceiling.

ii) Plugging of walls or ceiling can be done in a better way where neatness is the first consideration. In all such cases, an approved type of asbestos or fiber fixing plug (rawl or Phil plug) with correct size of tools shall be used and done in a workmanlike manner.

1.1.3 Fans, Regulators and Clamps

1.1.1.1 Ceiling Fans

i) Ceiling fans including their suspension shall conform to relevant Indian Standards.

ii) Any additional hardware items required for installation of ceiling fans including fan hooks/ clamps as specified below, shall be provided as specified in BOQ as a separate item.

iii) All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

iv) For wooden or steel joists and beams, the suspension shall consist of MS flat of size not less than 40mm x 6mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5 cm for each flat. Where there is space above the beam, a through bolt of size not less than 1.5cm dia shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5 cm dia shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of ‘S’ form.

v) In the case of ‘I’ beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

vi) For concrete roofs, a 12mm dia. MS rod in the shape of ‘U’ with their vertical legs bent horizontally at the top at least 19cm on either side and bound to the top reinforcement of the roof shall be used.

vii) In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned under sub clause (vi) above cannot be used, or wherever specified, recessed type fan clamp inside a metallic box shall be used. The metallic box shall suitably be covered with 3mm thick phenolic laminated sheet.

viii) Canopies on top of suspension rod shall effectively hide the suspension.

ix) The leading in wire shall be of copper and nominal cross sectional area not less than 1.5 Sq.mm. and shall be protected from abrasion.

x) All ceiling fans shall be hung at a height as directed by the Engineer-In-Charge.
xi) In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.

xii) The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

1.1.1.2 Exhaust Fans

i) Exhaust fans shall conform to relevant Indian Standards.

ii) Exhaust fans shall be erected at the places indicated by the Engineer-In-Charge. Additional hardware items required for installation of ceiling fans including fan hooks/ clamps as specified below, shall be provided as specified in BOQ as a separate item.

1.1.1.3 Regulators

The metallic body of regulators of ceiling fans / exhaust fans shall be connected to earth by protective conductor.

1.1.1.4 Workmanship

Good workmanship is an essential requirement to be complied with. The entire work of manufacture/ fabrication, assembly and installation shall conform to sound engineering practice.

The work shall be carried out under the direct supervision of an engineer, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-In-Charge during the progress of work. The qualification of engineer or supervisor for overall supervision and to take instructions from the Engineer-In-Charge shall be as specified in the special conditions.

1.13 TESTING OF INSTALLATION

All the completed installations shall be tested as per specification for "Testing of Installation". Contractor will arrange visit by the Owner/Owner’s representative to the factory to witness routine tests of all major equipments.

1.1.1 Drawings

i) The work shall be carried out in accordance with the drawings enclosed with the tender documents and also in accordance with modification thereto from time to time as approved by the Engineer-In-Charge or as per the drawing prepared by the contractor based on inventory and approved by Engineer-In-Charge.

ii) All wiring diagrams shall be deemed to be ‘Drawings’ within the meaning of the term as used in the Conditions of Contract. They shall indicate the main switchboard, the distribution boards (with circuit numbers controlled by them), the runs of various mains and submains and the position of all points with their controls.
iii) All circuits shall be indicated and numbered in the wiring diagram and all points shall be given the same number as the, circuit to which they are electrically connected.

1.14 COMMISSIONING OF COMPLETION

1.1.1 Before the workman leaves the work finally, he must make sure that the installation is commissioned, after due testing.

1.1.2 Completion Plan and Completion Certificate

i) For all work completion certificate after completion of work as required by AAI shall be submitted to the Engineer-In-Charge.

ii) Completion plan drawn to a suitable scale in tracing sheet with three blue print copies of the same shall also be submitted.

   a) General Layout of the building.

   b) Locations of main switchboard and distribution boards.

   c) Position of all points and their controls indicating the circuit numbers controlled by them.

   d) Types of fittings, viz. fluorescent, pendants, brackets, bulkhead, fans and exhaust fans etc.

   e) Name of work, job number, accepted tender reference, actual date of completion, names of Division/Sub-Division, and name of the firm who executed the work with their signature.
SECTION - 3 : SPECIFICATIONS FOR METALLIC CONDUIT WIRING SYSTEM

1.1 SCOPE

This section covers the detailed requirements for wiring work in metallic conduits. This section covers both surface and recessed types of works.

1.2 APPLICATIONS

Conduit system used shall be Rigid.

Flexible conduits may only be permitted for interconnections between switchgear & DBs and conduit terminations in wall.

1.3 MATERIALS

1.1.1 Conduits

i) All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall be not less than 1.6mm (16 SWG) for conduits upto 32mm dia. and not less than 2mm (14 SWG) for conduits above 32mm dia. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.

ii) The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given size wise in Table I., and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

iii) No steel conduits less than 20mm in diameter shall be used.

1.1.2 Conduits Accessories

i) The conduit wiring system shall be complete in all respects, including their accessories.

ii) All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip accessories shall be used.

iii) Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.

iv) a) Saddles for surface conduit work on wall shall not be less than 0.55mm (24 gauge) for conduits upto 25mm dia and not less than 0.9mm (20 gauge) for larger diameter. The corresponding widths shall be 19mm and 25mm.

b) The minimum width and the thickness of girder clips used for fixing conduits to steel joints, and clamps shall be as per Table-II.

1.1.3 Outlets

i) The switch box regulator box shall be made of metal on all sides, except on the front. In case of welded mild steel sheet boxes the wall thickness shall not be less than 1.2mm (18 gauge) for boxes upto a size of 20 cm x 30 cm and above this size 1.6mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per painting specification.
ii)  
   a) Outlet boxes for light/ power sockets shall be of standard size of manufacturer to accommodate required number of modular switches, socket outlet.
   
   b) Where a large number of control switches and/ or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.
   
   iii) An earth terminal with stud and metal washers shall be provided in each DB/MS box for termination of protective conductor and for connection to socket outlet/ metallic body of fan regulator etc.
   
   iv) A metal strip shall be welded/ screwed, to the metal box as support if fan regulators are to be fixed herein.
   
   v) Clear depth of the box shall not be less than 50mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.
   
   vi) The fan regulators can also be mounted on the switch box covers, if so directed by the Engineer-In-Charge.
   
   vii) The size of the switchbox in case of piano type switches shall be as below
   
   a) Without any fan regulator/ Dimmer on the Switch box:- The size of the switch box shall be minimum 75mm x 75mm x 60mm deep to accommodate the number of switches meeting spacing requirements mentioned below.
   
   b) With electronic/ resistance type fan regulator on the Switch box:- The size of the switch box shall be minimum 75mm x 75mm x 60mm to accommodate the number of switches and fan regulators meeting spacing requirements mentioned below.

Spacing Requirements

The spacing between any edge of live terminal of Switch/ socket and the body shall not be less than 26mm at any point.

viii) The size of the switch box in case of modular type switches shall be as per manufacturer’s standard.

1.4 INSTALLATION

1.1.1 Common aspects for recessed and surface conduit works.

i) Conduit Joints

   a) The conduit work in each circuit or section shall be completed before the cables are drawn in.

   b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13mm to 19mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.
c) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

d) The Engineer-In-Charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

e) No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

ii) Bends in Conduit

a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with bending radius of not less than 7.5 cm., or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.

b) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

iii) Outlets

a) All outlets such as switches, wall sockets etc. may be either flush mounting type, or of surface mounting type, as specified in the additional specifications if any or as directed by the Engineer-In-Charge.

b) All piano type switches and accessories shall be fixed on the phenolic laminated sheet covers in flush pattern.

iv) Painting after erection

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under the painting specification.

1.1.2 Additional requirements for surface conduit works

i) Painting before erection

The outer surface of conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system, shall be adequately protected against rust, by painting with 2 coats of red oxide paint applied before they are fixed.

ii) Fixing Conduit On Surface

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one metre, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings.

Where conduit pipes are to be laid along the trusses, steel joists etc. the same
shall be secured by means of saddles or girder clips or clamps as required by the Engineer-In-Charge.

In long distance straight run of conduit, inspected type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

iii) Fixing Outlet Boxes

Only a portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

1.1.3 Additional requirements for recessed conduit works

i) Making Chase

a) The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.

b) In the case of building under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

c) In chase of exposed brick/ rubber masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

ii) Fixing Conduits in Chase

a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.

b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

iii) Fixing Conduits in RCC work

a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with all long radius, which all permit easy drawing in of conductors.

iv) Fixing Inspection Boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary. The distance between inspection/ junction boxes shall not exceed 12.5 mts in straight run.

Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate
these boxes.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS : 2667-1977.

Suitable phenolic laminated sheet cover shall be provided on the inspection box.

Suitable ventilating holes shall be provided in the inspection box covers.

v) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified.

vi) Fish wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6mm / 1.2mm (16/ 18 SWG) shall be provided alongwith the laying of the recessed conduit.

vii) Bunching of Cables

a) Cables carrying direct current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

b) Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.

c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points or outlets as the case may be.

1.1.4 Earthing Requirements

i) The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double check nuts at termination. The conduit shall be continuous when passing through wall or floors.

ii) Protective (loop earthing) conductor(s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/switchboards, terminated thereto. The conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits alongwith the cables, or shall be laid drawn in outside the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

iii) The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

iv) Gas or water pipe shall not be used as protective conductor (earth medium).
TABLE - I

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

<table>
<thead>
<tr>
<th>Nominal Cross-Sectional area of conductor in sq.mm</th>
<th>20mm</th>
<th>25mm</th>
<th>32mm</th>
<th>38mm</th>
<th>51mm</th>
<th>64mm</th>
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</thead>
<tbody>
<tr>
<td>S  B       1            2            3            4            5            6            7            8            9            10           11            12            13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.50        5            4            10           8            18           12           -            -            -            -            -            -            -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.50        5            3            8            6            12           10           -            -            -            -            -            -            -</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6.00        2            -            5            4            10           8            -            -            -            -            -            -            -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00       2            -            4            3            6            5            8            6            -            -            -            -            -</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
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<td></td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

NOTE :

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

2. The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed '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 diameters.

TABLE - II

Girder clips or clamps

<table>
<thead>
<tr>
<th>Size of Conduit</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) 20 mm</td>
<td>19 mm</td>
<td>0.9mm (20 SWG)</td>
</tr>
<tr>
<td>ii) 25 mm</td>
<td>19 mm</td>
<td>0.9mm (20 SWG)</td>
</tr>
<tr>
<td>iii) 32 mm &amp; above</td>
<td>25 mm</td>
<td>1.2mm (18 SWG)</td>
</tr>
</tbody>
</table>
1.5  SPECIFICATION FOR PAINTING

1.1.1  Scope

This section covers the requirements of painting work in internal electrical installations, carried out manually by brush. This does not cover spray painting work of factory made items.

1.1.2  Painting Work In General

1.1.1.1  Paints

Paints, oils, vanishes etc. of approved make, in original tin to the satisfaction of the Engineer-In-Charge shall only be use.

1.1.1.2  Preparation of the Surface

The surface shall be thoroughly cleaned and made free from dust or foreign matter before painting is started. The proposed surface may be inspected by the Engineer-In-Charge before the paint is applied.

1.1.1.3  Application

i)  Paint shall be applied with brush. The paint shall be spread as smooth and even as possible. Particular care shall be paid to rivets, nuts, bolts and over-lapping. Before drawing out in small containers, it shall be continuously stirred with a smooth stick, while painting work is taken up.

ii)   Primary coat of anti-corrosive paint shall be given in the case of steel work, after preparation the surface. In all cases of painting work, finishing shall be with 2 coats of paint in approved shade.

iii)  Each coat shall be allowed to dry out sufficiently before a subsequent coat is applied.

1.1.1.4  Precautions

All furniture, fixture, glazing, floors etc. shall be protected by suitable covering. Al stains, smears splashing, dropping etc. shall be removed. While painting of wiring etc. it shall be ensured that the painting of wall and ceiling etc. is not spoiled in any way.
SECTION – 4 : SPECIFICATION FOR L.T CABLES

1.1 GENERAL

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer’s instructions. The cable shall be delivered at site in original drums with manufacturer’s name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

1.2 MATERIALS


1.3 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of Engineer-In-Charge. Cable laying shall be carried out as per CPWD specifications.

1.4 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

1.5 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoiding of cable joints. This apportioning shall be got approved from Engineer-In-Charge before the cables are cut to lengths.

1.6 LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 metres. Cables shall be laid at depth of 0.75 metres below ground level. A cushion of sand total of 250mm shall be provided both above and below the cable joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3 metre long loop shall be provided at both end of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

1.7 PROTECTION OF CABLES
The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cables is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic, shall be protected by running them through Hume Pipes of suitable size.

1.8 EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surface, roadways, side walks, kerbs wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-In-Charge.

1.9 LAYING OF CABLES ON CABLE TRAY/ SURFACE OF WALL/ CEILING

Cable shall be laid on perforated M.S. Cable tray. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/ saddles. Care shall be taken to avoid crossing of cable.

1.10 CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

1.11 CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

1.12 TESTING OF CABLES

Prior to installation, burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

a. Before laying.
b. After laying.
c. After jointing.
On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer-In-Charge.

a. Insulation Resistance Test (Sectional and overall).

b. Continuity Resistance Test.

c. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.
SECTION - 5 : SPECIFICATION FOR CABLE TRAY

1.1 CABLE TRAY

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel, sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanised or painted to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part-II -1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-In-Charge, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth terminal of the switch boards at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

Cable laid on cable tray shall be clamped on the tray at suitable intervals as per CPWD specifications.
7.0 SECTION - 6 : SPECIFICATIONS FOR CONDUITING & WIRING FOR TELEPHONE SYSTEM

1.1 GENERAL
Contractor shall supply & install conduit & wiring including Telephone Tag Blocks, telephone outlet, cover plate, outlet boxes etc. complete as required.

7.1.1 CONDUITING
Conduit for telephone system shall be carried out in MS Conduit. Separate conduit shall be provided for Telephone cables.

1.2 WIRING
Each telephone outlet shall be wired in conduit with 0.60mm dia annealed tinned copper conductor PVC insulated and PVC sheathed unarmoured cable from floorwise Telephone Tag Block. Main Telephone tag block shall be fixed on ground floor. Floorwise tag block shall be wired from Main telephone tag block with multipaired armoured 0.60mm dia annealed copper conductor PVC insulated & PVC sheathed cables.

1.3 OUTLETS
All telephone outlet shall be modular plate type accessories with RJ 11 Jack outlet. Cover plate shall match in shape & finish with other light and power accessories.

1.4 TELEPHONE DISTRIBUTION BOARD
Telephone Tag Block shall be fabricated from 1.63 mm thick M.S. Sheet duly powder coated after metal treatment. Telephone Distribution Board shall be equipped with krone type tag block of size as mentioned in BOQ. Tag block shall be double jumpering type and shall be suitable for termination of extra pair provided in wiring/cabling of each outlet. Box shall have hinged cover and finish shall match with aesthetic finish of the building.
SECTION - 7 : SPECIFICATION FOR EARTHING

1.1 SCOPE

This section covers the essential requirements of earthing system components and their installation. For details not covered in these specifications, IS Code of Practice on Earthing (IS : 3043-1987) shall be referred to.

1.2 APPLICATION

i) The electrical distribution system is with earthed neutral (i.e. neutral earthed at the transformer/ generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the substation, as well as in the internal/ external electrical installations.

ii) Earthing system is also required for lightning protection, computer installations etc. for function reasons.

iii) Earthing requirements are laid down in Indian Electricity Rules, 1956 as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

1.3 MATERIALS

The material of earth and earth conductor shall be as specified in BOQ.

1.1.1 Earth Electrodes

The type of earth electrode shall be any of the following:

a) Plate/ Pipe earth electrode as specified in BOQ.

1.1.2 Electrode materials and dimensions

The materials and minimum sizes of earth electrodes shall be as specified.

1.1.3 Earthing Conductor

The earthing conductor (protective conductor from earth electrode upto the main earthing terminal/ earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper and in the form of wire or strip as specified. The size of earthing conductor shall be as specified.

1.4 HARDWARE ITEMS

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrode and forged tinned brass in case of copper plate electrodes.

1.1.1 Protective (Earth Continuity/ Loop Earthing) Conductor

i) The material and size of protective conductors shall be as specified.

ii) Unless otherwise specified, GI conductor should not be ordinarily used as
protective conductor within any circuit beyond a Distribution Board downstream.

1.1.2 **Location For Earth Electrodes**

Normally an earth electrodes shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases electrodes may be located further away from the building, with the prior approval of the Engineering-In-Charge.

1.5 **INSTALLATION**

1.1.1 **Electrodes**

1.1.1.1 **Various Types Of Electrodes**

i) a) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in drawing.

   b) In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-In-Charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

ii) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level. The installation shall be carried out as shown in drawing.

iii) When more than one electrode (plate/pipe) is to be installed, a separate of not less than 2m shall be maintained between adjacent electrodes.

1.1.1.2 **Artificial Treatment of Soil**

When artificial treatment of soil is to be resorted the electrode shall be surrounded by charcoal/coke.

1.1.1.3 **Watering Arrangement**

i) In the case of plate earth electrodes, a watering pipe of 20mm dia. medium class GI pipe shall be provided and attached to the electrodes as shown in the drawing and a funnel with mesh shall be provided on the top of this pipe for watering the earth.

ii) In the case of pipe electrodes, a 40mm x 20mm reducer shall be used for fixing the funnel with mesh.

iii) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.

iv) A cast iron/MS frame with MS cover of 6mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

1.1.2 **Earth Conductor**
In the case of plate earth electrodes, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.

In the case of pipe earth electrodes, the earthing conductor shall be secured as indicated in drawing using a through bolts, nuts and washers and terminating socket.

The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15mm dia GI pipe in the case of wire, and by a minimum of 40mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be fixed on walls.

The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and, Bolt nut and washer in case of strip conductor.

1.1.3 Earth Bus And Main Earthing Terminal

In all installations, main earthing terminal shall be provided at the main switchboard. This may be in the form of earth stud or single earth bar depending on the type of the switchboard.

Following conductors shall be terminated on to the main earthing terminal.

a) Earth connection from electric supply company (where provided)
b) Earthing conductor from electrode.
c) Protective conductors
d) Equi-potential bonding conductors.

1.1.4 Protective (Loop Earthing/ Earth Continuity) Conductor

Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/terminal of the upstream switchboard by protective conductors.

Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.

1.1.5 Earth Resistance

The earth resistance at each electrode shall be measured. The earth electrode shall have ohmic resistance less than 1 ohm as measured by an approved earth testing apparatus.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-In-Charge, at additional cost as per the provisions of the contract.

1.1.6 Marking

i) Earth bars/terminals at all switch board shall be marked permanently, as 'E'.
ii) Main earthing terminal shall be marked 'SAFETY EARTH- DO NOT DISCONNECT'.
9.0 SECTION - 8 : LIGHTNING PROTECTION SYSTEM

1.1 SCOPE

This section covers the detailed requirements of installation of lightning conductor system for protection of buildings against lightning. For details not covered in these specifications, reference may be made to IS : 2309-1989.

9.1.1 Application

This system shall be provided where specified.

1.2 PRINCIPAL COMPONENTS

The principal components of a lightning protective system are:

a) Air terminations  
b) Down conductors  
c) Joints and bonds  
d) Testing joints  
e) Earth terminations  
f) Earth electrodes

1.3 MATERIALS

The materials of air termination, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected against corrosion. The material shall be as specified.

1.4 LAYOUT

1.1.1 The system design and layout shall be done in accordance with Is: 2309-1989 and specified in the Tender documents. The work shall be carried out as per approved drawing.

1.1.2 Air Terminations

i) Air termination network may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical finial is, therefore, not regarded as essential.

ii) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.

iii) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9 m from the nearest horizontal protective conductor.

iv) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves from a closed network.
v) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the air termination network.

vi) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be boned to the down conductors of the taller portions, in addition to their own down conductors.

1.1.3 Down Conductors

i) The number and spacing of down conductors shall be as specified or as directed by the Engineer-In-Charge.

ii) Routing

a) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged, as evenly as practicable around the outside wall of the structures.

b) The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.

c) Metal pipes leading rainwater from the roof to the grounds may be connected to the down conductors, but cannot replace them. Such connections should have disconnecting joints.

iii) Provision When External Route Is Not Available

a) Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhang. In such cases, the down conductors may be housed in an air space provided by a nonmetallic and noncombustible internal duct and taken straight down to the ground.

b) Any suitable covered recess, not smaller than 76mm x 13mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or non-metal sheathed cable.

c) In cases where an unrestricted dust is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the buildings.

1.5 Installations

1.1.1 General

i) The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in the event of a lightning strike.

ii) Conductors shall be securely attached to the building, or other object to be
protected by fasteners, which shall be substantial in construction, not subject to breakage, and shall be of galvanized steel or other suitable materials, with suitable precautions to avoid corrosion.

iii) The lightning conductors shall be secured not more than 1.2 m apart for horizontal run, and 1 m for vertical run.

1.1.2 **Air Terminations**

All air terminal shall be effectively secured against overturning either by attachment to the object to be projected or by means of substantial bracings and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixing should be simple, solid and permanent, due attention being given to the climatic conditions and possible corrosion.

1.1.3 **Down Conductors**

i) The down conductor system must, where practicable, be directly routed from the air termination to the earth termination network, and as far as possible, be symmetrically placed around the outside walls of the structure starting from the corners.

ii) a) Practical reasons may not sometimes allow the most direct route to be followed. While sharp bends, such as arise at the end of a roof are in-escapable (and hence permissible), re-entrant loops in a conductor can produce high inductive voltage drops so that the lightning discharge may jump across the open side of a loop.

b) When large re-entrant loops as defined above cannot be avoided, such as in the case of some cornices or parapets, the conductors should be arranged in such a way that the distance across the open side of a loop complies with requirement indicated above or parapets should be provided with holes through which the conductor can pass freely.

iii) Bonding to prevent side flashing

Any metal in, or forming a part of the structure, or any building services having metallic parts which are in contact with the general mass of the earth, should be either isolated from, or bonded to the down conductor. This also applies to all exposed large metal items having any dimension greater than 2 m whether connected to the earth or not.

1.1.4 **Joints And Bonds**

1.1.1.1 **Joints**

i) A lightning protective system should have as few joints as possible.

ii) Joints should be mechanically and electrically effective, for example, clamped, screwed, bolted, crimped, riveted or welded.

iii) With overlapping joints, the length of the overlap should not be less than 20mm for all types of conductors.

iv) Contact surface should first be cleaned, then inhibited from oxidation with a suitable non-corrosive compound.

v) Joints of dissimilar metals should be protected against corrosion, or erosion from
the elements from the elements, or the environments, and should present an adequate contact area.

vi) Gas pipe no case shall be bonded to the lightning protective earth termination system.

1.1.5 Bonds

i) Bonds have to join a variety of metallic parts of different shapes and composition, and cannot therefore be of a standard form.

ii) There is the constant problem of corrosion and careful attention must be given to the metals involved i.e. the metal from which the bond is made, and those of the items being bonded.

iii) The bond must be mechanically and electrically effective, and protected from corrosion in, and erosion by the operating movement.

iv) External metal on, or forming part of a structure, may have to discharge the full lightning current, and its bond to the lightning protective system should have a cross sectional area not less than that employed for the main conductors.

v) Structures supporting overhead electric supply, telephone and other lines must not be bonded to a lightning protective system without the permission of the appropriate authority.

1.1.6 Test Joints

Each down conductor should be provided with a test joint in such a position that, while not inviting unauthorized interference, it is convenient for use when testing.

1.1.7 Earth Termination Network

i) An earth station comprising one or more earth electrodes as specified, should be connected to each down conductor.

ii) Each of the earth stations should have a resistance not exceeding the product given by 10 ohms multiplied by the number of earth electrodes to be provided therein. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding.

iii) If the value obtained for the whole of the lightning protecting system exceeds 10 ohms, a reduction can be achieved by extending or adding to the electrodes, or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network, and should be taken into account when assessing the overall value of resistance to earth of the installation.

iv) A reduction of the resistance to the earth to a value below 10 ohms has the advantage of further reducing the potential gradient around the earth electrode when discharging lightning current.

v) Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.
10.0  
**SECTION - 9 : CABLE MANAGEMENT SYSTEM - WALL AND FLOOR**

1.1  
**WALL MOUNTED**

Supply, installation, testing and commissioning of cable trunking system below working plane to distribute Power, Data and Telecom cables. The system should comply with all relevant sections of the 16th edition of IEE wiring regulations.

Cable trunking shall comprise of base & lid with snap-fit lid and allied accessories such as cable dividers, cable retainers, tee, flat tee etc. The system shall have provision to accept cable dividers to arrive at upto four compartments. The system shall have cross sectional dimensions of 100mm height and 50mm in depth and with a body thickness of 2.5 mm.

System shall be non-corrosive and should have excellent resistance to mineral acids, alkalis and detergents.

Material used are non flame prorogating and a Class 1 spread of flame achieved when tested in accordance with the requirements of BS 476 Part 7, BS 4768 Part 4 Heavy Duty classification and BS 4662.

Cable trunking system shall have provision to accept mounting boxes that snap fit in to the profile.

Colour: White
SECTION – 10 : LIGHTNING CURRENT ARRESTOR (CLASS B) AND SURGE PROTECTION DEVICE (CLASS C)

1.1 LIGHTNING CURRENT ARRESTOR (CLASS B) AND

11.1.1 Lightning Protection Device shall provide the following

A lighting arrester of class B type (as per IEC 61312, VDE 0675) with triggered spark shall be used.

The lightning arrester components shall have a protection level of <0.9 KV for systems with nominal voltage < 330V AC.

The lightning arrester components shall have a maximum continuous voltage across the SPD 335V AC.

The lightning arrester components shall be tested to withstand at least 50 KA of lightning test current of a 10/350µs waveform described by IEC Standards.

The lightning arrester components shall have a response time of <100 nano sec.

The lightning arrester components shall have an operating temperature range of -40°C to +85°C.

Connection made in parallel by using connecting cables of at least 16 Sq mm for class between each phase of the device and the neutral to the device as per TT configuration.

1.2 SURGE PROTECTION DEVICE (CLASS C)

1.1.1 Surge Protection Device shall provide the following:

The SPD component shall be designed to withstand a one time surge of up to a 40KA test current of a (8/20) µs waveform according to IEC 1024 application guide A and ANSI/IEEE C62.41.1 Category C Area.

The SPD component shall have a SPDT contact rated for 250 V AC, 1A used for remote indication/ visual indicator of circuit integrity.

The SPD component shall have a rating of IP 20 according to IEC.

The SPD component shall have modular with field replacement capacity without the removal of any wires nor shall it interrupt the power to be protected equipment. Bases shall have the ability to be coded to accept only the correct voltage plug.
The SPD component shall have integral label holder to mark each terminal block.

The SPD component shall have an operating temperature range of at least -40°C to +85°C.

The SPD component shall have a response time < 25µs.

The SPD component shall be testable with check master.

Connection made in parallel by using connecting cables of at least 10 sq mm for class C between each phase of the device and the neutral to the device as per TT configuration.
12.0 SECTION - 11 : TESTING OF INSTALLATION

1.1 SCOPE

This section describes the details of test to be conducted in the completed internal electrical installation, before commissioning.

1.2 GENERAL

1.1.1 Tests

On completion of installation, the following tests shall be carried out :-

i) Insulation resistance test.

ii) Polarity test of switch.

iii) Earth continuity test.

iv) Earth electrode resistance test.

1.1.2 Witnessing of Tests

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-In-Charge by the Contractor. All test results shall be recorded and submitted to the Department (AAI).

1.3 INSULATION RESISTANCE

The tests described below shall be made before the installation is permanently connected to the supply. For these tests large installations may be divided into groups of outlets, each containing not less than 50 outlets. For the purposes of this code the term ‘outlet’ includes every point and every switch except that a socket outlet, appliance or luminaire incorporating a switch is regarded as one outlet. The test voltage for insulation resistance measurement shall be 500 V.

When measured with all fuse links in place, all switches (including, if practicable, the main switch) closed and, all poles or phases of the wiring electrically connected together, the insulation resistance to earth shall be not less than 1 mega ohm.

When measured between all the conductors connected to any one phase or pole of the supply and, in turn, all conductors connected to each other phase or pole the insulation resistance shall be not less than 1 mega ohm. Wherever practicable, so that all parts of the wiring may be tested, all lamps shall be removed and all current-using equipment shall be disconnected and all local switches controlling such lamps or other equipment shall be closed. Where the removal of lamps and/or the disconnection of current-using equipment is impracticable, the local switches controlling such lamps and/or equipment shall be open. Particular attention shall be given to the presence of electronic devices connected in the installation and such devices shall be isolated so that the test voltage does not damage them.

Where equipment is disconnected for the tests prescribed above, and the equipment has exposed conductive parts required by these clauses to be connected to protective conductors, the insulation resistance between the exposed conductive parts and all live parts of the equipment shall be measured separately and shall comply with requirements of the appropriate Indian Standard and the insulation resistance shall not less than 0.5 mega ohm.
1.4 POLARITY TEST OF SWITCH

In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor, throughout, and such conductor, shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

In a three wire or a four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled, or marked for connection to one of the phase conductors of the supply.

The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to earth. Glowing of test lamp to its full brilliance, when the switch is in 'ON' position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

1.5 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. The electrical resistance of the same along with the earthing lead, but excluding any added resistance, or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

1.6 MEASUREMENT OF EARTH ELECTRODE RESISTANCE

1.1.1 Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode. A measured current is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C' and the potential difference between the electrode 'A' and auxiliary potential 'B' is measured. The resistance of the test electrode 'a' is then given by

\[ R = \frac{V}{I} \]

Where,

R - Resistance of the test electrode in ohms

V - Reading of the voltmeter in volts

I - Reading of the ammeter in amps

1.1.2 i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

ii) If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

1.1.3 At the time of test, the test electrode shall be separated from the earthing system.

1.1.4 The auxiliary electrodes shall be of 13mm diameter mild steel rod driven upto 1 m into the ground.

1.1.5 All the three electrodes shall be so placed that they are independent of the resistance area.
of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode C shall be placed at least 30 m away from it and the auxiliary potential electrode ‘B’ shall be placed mid-way between them.

1.1.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C upto 50 m, and each time placing the electrode B mid-way between them.

1.1.7 On these principles, “Megger Earth Tester” containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

1.7 TEST CERTIFICATE

On completion of an electrical installation or an extension to an installation, a certificate shall be furnished by the Contractor, countersigned by the certificate supervisor under whose direct supervision the installation was carried out. The certificate shall be in the prescribed form in addition to test certificate required by the local Electricity supply authorities.
FORM OF COMPLETION CERTIFICATE

I/We certify that the installation detailed below has been installed by me/us and tested and that best of my/ our knowledge and belief it complies with Indian Electricity Rules 1956, as well as the Contract Specifications.

Electrical Installation at ________________________________

Voltage and system of supply ________________________________

1) **Particulars of work :-**
   a) **Internal Electrical Installation**
      
      | No. | Total Load | Type or system of wiring |
      |-----|------------|--------------------------|
      | i)  | Light point |                          |
      | ii) | Fan point   |                          |
      | iii) | Plug point  | a) 3 pin 5 Amp           |
                                | b) 3 pin 15 Amp           |
                                | c) Others                 |
      b) **If the work involves installation of underground cable**
      i) Total length of underground cable & its size.
      ii) No. of Joints : End Joint :
                       Tee Joint : 
                       St. through joint :

II) **Earthing :-**
   i) Description of earth electrodes.
   ii) Number of earth electrodes.
   iii) Size

III) **Test Results of Wiring :-**
   a) Insulation resistance.
      i) Insulation resistance of the whole system of conductors to earth ______________ Mega ohms
      ii) Insulation between the phase conductor and neutral
          Between phase R and neutral . . . . Mega ohms
iii) Insulation resistance between the phase conductors in case of poly phase supply

Between phase R and neutral . . . Mega ohms
Between phase Y and neutral . . . Mega ohms
Between phase B and neutral . . . Mega ohms

b) Polarity test

Polarity of non linked single pole branch switches.

c) Earth continuity test

Maximum resistance between any point in the earth continuity conductor including metal conduits and main earth lead . . . ohms.

d) Earth electrodes resistance

Resistance of each earth electrode

i) . . . . . ohms
ii) . . . . . ohms
iii) . . . . . ohms
iv) . . . . . ohms

e) Lightning Protective System

Resistance of the whole of lightning protective system to earth before any bonding is effected with earth electrodes and metal in/on the structure . . . ohms.

Signature and Name of Contractor

Signature and Name of the NPL Engineer
CAPACITY OF LIGHT AND POWER CIRCUIT

1) Lighting circuit shall not have more than 10 points of light, fan, socket outlet or connected load of 800 W whichever is less.

2) Power circuit shall be designed based on load where specified, otherwise the norm of one KW per circuit is to be followed.

3) Not more than 2 power outlets shall be connected in one power circuit.
ADDITIONAL SPECIFICATIONS FOR FIRE FIGHTING & FIRE ALARM WORKS

(Page No. 119 to 164)
1.0 Scope of Work

1.1 The scope of work for the Building consists of the following, but is not limited to the same:

1.1.1 Hydrant System consisting of Internal Hydrant Risers, External Hydrant Ring, Hydrant Stations with all accessories such as Hydrants, Hoses, First Aid Hose Reel, Branch Pipe etc.

1.1.2 Pumping System consisting of Hydrant Pump, engine operated Standby Pump, Jockey Pump, Terrace Pump and equipments such as Valves, strainers, piping, Instrumentation and Motor Starting System.

1.1.3 Supply of Fire Extinguishers.

1.1.4 Exit Signages.

1.1.5 Providing cable seals and fire barriers.

1.2 HYDRANT SYSTEM

1.2.1 The Lab Building shall be protected by Internal Hydrants on all Floors and shall be located on the corridors. Six number of Risers shall be provided.

1.2.2 On each Floor with each Riser there shall be a Hydrant Station having one number Hydrant, 2 nos. RRL Hose and a Branch Pipe. The Hydrant Station shall also be provided with a First Aid Hose Reel consisting of a 36 metre length 20 mm dia double braided rubber hose wound on a drum bracket with aluminium alloy bracket and piping. This set shall be connected to the Hydrant Riser through a 25 mm dia Ball Valve.

1.2.3 The Terrace shall have an Air Vessel with drain and Pressure Guage to absorb pressure surges and water hammer effect when any of the main pumps start.

1.2.4 All piping shall be Mild Steel and shall have welded jointing for pipes above 50 mm dia.
1.3 PUMPING SYSTEM

1.3.1 To cater for the Hydrant and Sprinkler Systems, the following pumps are being provided:

<table>
<thead>
<tr>
<th>No.</th>
<th>Pump Type</th>
<th>Discharge</th>
<th>Head</th>
<th>Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hydrant Pump</td>
<td>2280 LPM</td>
<td>70</td>
<td>Electric</td>
</tr>
<tr>
<td>2.</td>
<td>Standby Pump</td>
<td>2280 LPM</td>
<td>70</td>
<td>Diesel Engine</td>
</tr>
<tr>
<td>3.</td>
<td>Jockey Pump</td>
<td>180 LPM</td>
<td>70</td>
<td>Diesel Engine</td>
</tr>
<tr>
<td>4.</td>
<td>Terrace Pump</td>
<td>900 LPM</td>
<td>35</td>
<td>Electric</td>
</tr>
</tbody>
</table>

1.3.2 Each Pump shall have a Gate Valve on the Suction Side as well as Gate Valve and Non Return Valve on the Delivery Side. The Delivery of each Pump shall be connected to the Common Delivery Header.

1.3.3 The Pumps shall be single stage type coupled to motor and at 1450 RPM. The Diesel Engine driven pump shall be 1450 RPM. The Engine shall be multi cylinder Heat Exchanger cooled type. All Pumps shall have mechanical seal.

1.3.4 There shall be common Strainers on the Suction manifold with stainless steel mesh to segregate the debris. The Strainers shall have top lift removable flange for cleaning.

1.3.6 An Air Vessel shall be provided in the Pump House for the Hydrant System. The Air Vessel shall be partly filled with water and shall provide for dampening effect to prevent water hammer when the Pump starts. The Air Vessel shall be provided with pipe spool piece on which pressure switches shall be fitted. The Pressure Switches shall be connected to the Starter on the Pump Starter Panel.
SPECIFICATIONS FOR FIRE PROTECTION WORKS

2.0  FIRE PUMPS

2.1  General

2.1.1  The Pumps shall be single stage designed for continuous operation and shall have a continuously rising head characteristic without any zone of instability.

2.1.1  The head vs. capacity, input power vs. capacity characteristics, etc. shall match to ensure load sharing and trouble free operation throughout the range.

2.1.1  In case of accidental reverse flow through the pump the driver shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed.

2.1.4  The motor shall have a 15% margin of power rating over the rated pump input power.

2.1.5  In case the Pump & Motor are from different manufacturers, the contractor under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.

2.1.6  The pump shall be capable of a minimum of 150 percent of rated capacity at a total head of not less than 65 percent of the total rated head. The total shut-off head shall not exceed 120 percent of total rated head on the pump.

2.1.7  An automatic air release valve shall be provided to vent air from the pump. This valve shall be located at the highest point in the discharge line between the pump and the discharge check valve.

2.1.8  Pumps coupled with motor on a common platform shall perform smoothly without any excessive noise or vibration.

2.2  Pumps Casing

2.2.1  The casing shall be capable of withstanding to the maximum pressure developed by the pump at the pumping temperature.

2.3  Impeller

2.3.1  The impeller shall be of stainless steel and the bush shall also be of stainless steel.

2.4  Pump

2.4.1  The pumps shall be horizontal type split casing.

2.4.2  The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings.

2.4.3  All screwed fastners shall tighten in the direction of normal rotation.
2.4.4 All Pumps shall be provided with Mechanical Seal.

2.5 **Shaft**

2.5.1 Shaft size shall be selected on the basis of maximum combined shear stress.

2.5.2 The shaft shall be of stainless steel ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibrations and torques coming in during operation.

2.5.3 Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft and shaft sleeve.

2.5.4 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation. The sleeve shall be of stainless steel.

2.6 **Pump Shaft-Motor ShaftCoupling**

2.6.1 All shafts shall be connected with adequately sized flexible couplings of suitable approved design. Necessary guards shall be provided for the couplings.

2.7 **Base Plate**

2.7.1 A common base plate mounting both for the pump and drive shall be provided. The base plate shall be of rigid construction, suitably ribbed and reinforced.

2.7.2 Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.

2.8 **Vibration & Balancing**

2.8.1 The rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced at workshop. All pumps shall be fitted with rubber expansion joints on suction and discharge sides and anti vibration mounting on foundation.

2.9 **Instruction Manual & Tools/Spares**

2.9.1 A comprehensive instruction manual shall be provided by the contractor indicating detailed requirements for operation, dismantling and periodic operation and maintenance procedures.
2.10 INSTALLATION OF PUMPSETS

2.10.1 Foundation:

2.10.1.1 A solid vibration free and levelled foundation of concrete shall be made. The foundation shall depend upon the size and weight of the motor pumpset and the nature of the ground.

2.10.2 Erection:

2.10.2.1 Only lifting eyebolt shall be used to lift the motor. Ensure the eyebolt is fully tightened in the threaded hole and shoulder of eyebolt butts with the surface of the hole. Avoid jerks and jolts to the motor to avoid bearing getting damaged.

2.10.2.2 Motor should be mounted on the flat baseplates. The motor should be raised by atleast 15 mm to allow freed passage of air underneath for better cooling.

2.10.3 Alignment:

2.10.3.1 Flexible coupled motors shall require an accurate alignment as solid coupled machines. Use Feeler Guage and Dial Guage during motor-pumpset alignment. The gap between the faces of two half couplings should be maintained by 0.05 mm. Check the Angular and Radial Alignment, the trenches should be within 0.05 mm to 0.1 mm.

2.10.4 Earthing:

2.10.4.1 The motor body should be effectively and securely earthed by fixing copper or aluminium strip on the foot by the earthing screw provided. The other end of the strip shall be connected to the earthing system. If 3 1/2 or 4 core cables are used for power supply the earthing core of the cable should be connected to the earthing terminal provided inside the terminal box.

2.10.5 Cable Termination:

2.10.5.1 All terminal nuts and fixing bolts shall be fully tightened. Use correct size of cable corresponding to the current rating of the motor. Larger cable would need bigger cable socket, which may result in lesser clearance between terminals. The minimum safe clearance between phase to phase to earth is 10 mm as per Standard.

2.10.5.2 It is to be ensured that the gland is holding the cable tightly and there is no appreciable gap left between the gland packing and the cable.

2.10.6 Induction Resistance:

2.10.6.1 All new motors or where an existing motor has been stored for any length of time in damp situation, the insulation resistance of the windings both between Phase and to Earth should be taken by means of 500 volts DC Megger. The insulation resistance should not be lower than 1 Mega Ohm when the motor is cold.
2.10.7  Installation and Foundation:

2.10.7.1  Pump when properly installed and when given reasonable care and maintenance, should operate satisfactorily for a long period.

2.10.7.2  The pump should be as near the liquid source as practical so that a short direct suction pipe may be used.

2.10.7.3  It should be placed so that it will be accessible for inspection during operation. Provide necessary floor space around for inspection and servicing.

2.10.7.4  The foundation should be sufficiently substantial to absorb vibration / normal shock and to form a permanent rigid support to the full area of base plate.

2.10.7.5  The foundation template with hanging foundation bolts, sleeves and washers shall be placed in position over the pit and shuttering fixed around it. The bolt, washer and sleeve should be free from oil and may be provided with a mixture of neat cement.

2.10.7.6  The purpose of the sleeve is to allow movement of the bolts for final positioning to register with the bolt holes in the base plate).

2.10.7.7  The concrete should be 1:2:4 mix. Contact faces of the forms and pit should be wetted before pouring concrete. The pouring of concrete should be continuous and should be completed in one operation.

2.10.7.8  The foundation should extend at least 15 cm beyond each side. The depth and side extensions should be suitably increased for locations having poor soil conditions.

2.10.7.9  The foundation should be cured for at least 7 days before the equipment is put on it. Keep the foundation wet for the entire setting period of 28 days.

2.10.8  Levelling and Alignment:

2.10.8.1  Remove the template and mount the complete unit with the baseplate on the foundation.

2.10.8.2  Secure enough rectangular steel blocks, strips and pack them under baseplate on each side of the foundation bolt so that the baseplate is clear from the foundation surface by 2 cms to 4 cms.

2.10.8.3  Adjust the metal supports until the shafts of the pump and driver are level. Have the coupling halves disconnected and check the flange faces as well as the machined suction and discharge connections of the pump for horizontal and vertical positions by means of machinist's level. Correct the position, if necessary, by adjusting the metal supports under the baseplate. Tighten by hand all the bolts by means of nuts and lock washer.

2.10.8.4  A flexible coupling should not be used to compensate for misalignment of the pump and driver shafts.

2.10.8.5  The coupling halves are to be disconnected during the levelling process and they are to remain disconnected till the final check is made after the pipe connections are made.

2.10.8.6  After each change during alignment it is necessary to recheck the alignment both angular and parallel.
2.10.9 Grouting:

2.10.9.1 With the correct alignment and after the concrete foundation has set, the foundation bolts should be tightened evenly but not too firmly, leaving the steel packing in place. Recheck for level and alignment and correct.

2.10.9.2 Mix the grout, using 1 volume of cement to 2 volumes of sharp clean sand, pour the grout through the space between the drain planking and the baseplate.

2.10.9.3 When the grout has hardened, usually about 48 hrs after pouring, tighten foundation bolts fully.

2.10.10 Check for level and alignment.

2.10.10.1 Starting of Motor:

2.10.10.2 Disconnect coupling of motor side to coupling of pump side.

2.10.10.3 Check supply voltage which should be same as per rated voltage of the motor as marked on the name plate.

2.10.10.4 Check all external connections, rating of fuse, setting of protective devices to ensure that they are correct and as per the relevant connection diagram.

2.10.10.5 Check ball and roller bearings and bearing housing to ensure that they are correctly charged with grease. For replenishing, if necessary, fresh grease of lithium base should be used. Lithium base grease should conform to Grade 2 of IS:1002.

2.10.10.6 For first starting, stop the motor immediately. After starting if there is no fault signs, start the motor for some time and check all electric and mechanical connections.

2.10.10.7 Check direction of rotation before coupling to a load. Direction of rotation can be reversed by interchanging any two line lead.

2.10.10.8 After the motor has started the following shall be checked:

2.10.10.9 Check that there is no abnormal vibration of the motor while it is running on load and noise of the bearing.

2.10.10.10 Check the full load current drawn by motor in all three phases. A motor should never be allowed to operate on higher current than stated in the name plate.
3.0 ELECTRIC MOTORS

3.1 The motor shall be designed not to draw starting current more than 3 times normal running current. It shall be designed for continuous full load duty. The motor shall be full load duty & shall be capable of handling the required starting torque of the pumps. Speed of motor shall be compatible with the speed of the pump.

3.2 The cooling fans shall be directly driven from the motor shaft.

3.3 Motors shall be enclosed type and shall have a dust tight construction with suitable means of breathing and of drainage to prevent accumulation of water from condensation.

3.4 All components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved.

3.5 The rating and design shall conform to relevant IS specification.

3.6 The motors shall be Squirrel Cage TEFC Induction type.

3.7 The motors shall be wound for Class-F insulation, and the winding shall be vacuum impregnated with head and moisture resisting varnish, and glass wool insulated to withstand tropical conditions.

3.8 Two independent earth points shall be provided on opposite sides of the motor for bolted connections.

3.9 415 Volt power terminals shall be suitable for receiving 1.1 kv grade armoured power cables.

3.10 The cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.

3.11 Motor shall be suitable for +/- 10% variation in voltage and +/- 3 % variation in frequency.
4.0 DIESEL ENGINE

4.1 General

4.1.1 The diesel engine shall be of multicylinder type four stroke cycle with mechanical (airless) injection, cold starting type.

4.1.2 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection. This will also provide interchangeability of parts.

4.1.3 All parts susceptible to temperature changes shall have tolerance for expansion and contraction without resulting in leakage, misalignment of parts or injury to parts.

4.2 Starting

4.2.1 The engine shall be capable of both automatic and manual start. Generally the engine shall start automatically, but in case of the auto-start system failure the engine shall be capable of manual start. Engine shall be able to start without any preliminary heating of combustion chamber; cranking mechanism shall also be provided. All controls / mechanisms which have to be operated in the starting process, shall be within easy reach of the operator. A day oil tank of adequate capacity constructed in M S sheet shall be provided as per manufacturer’s guide line.

4.2.2 A high torque D.C. motor charged by battery shall initiate automatic start of diesel engine. The battery shall hold adequate retainable charge to provide the starting of the diesel engine. Starting power will be supplied from one set of storage batteries. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression.

4.2.3 The battery shall be used for no other purpose other than starting of the engine and shall be fully charged at all times with provision for trickle & boost chargers. After start of the engine the charger shall be disconnected, the battery being fed from the engine dynamo.

4.3 Governing System

4.3.1 The engine shall have a speed control device which will control the speed under all conditions of load. The governor shall be suitable for operation without external power supply.

4.3.2 The Governor shall offer following features:

4.3.2.1 An adjustable governor to regulate engine speed within a range of 10% between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

4.3.2.2 An over speed shutdown device to shutdown the engine at a speed approximately 20% above rated engine speed with manual reset, so that the automatic engine controller will indicate an over speed signal until the device is manually reset to normal operating position.
4.4 Fuel System

4.4.1 The diesel engine is to run on High Speed Diesel, the tank provided being enough to hold the volume required for 6 hours (minimum) continuous operation. The Day Oil Tank shall be supplied by the Engine Manufacturer. The Tank shall be of M S sheet of thickness approved by the Engine Manufacturer with an internal lead sheet lining to prevent contact between tank and oil.

4.4.2 Tank shall have indications for Low Fuel Level, Float Switch, Fuel Level Indicator with Shut Off Nozzle and shall be duly calibrated.

4.5 Engine cooling System

4.5.1 The Diesel Engine shall be cooled by Heat Exchanger and the Contractor shall make arrangements for continuous supply of such water from Underground Tank and provided with pressure reducing arrangement.

4.6 Accessories

4.6.1 The engine shall be mounted on a base plate of fabricated steel construction. Adequate access shall be provided to the big end and main bearings, camshaft and governor drives, water jackets etc.

4.6.2 The engine shall have a base plate made from M S sections. There shall be reasonable space at the big end, camshaft, water jackets, governor drives and main bearings.

4.6.3 The engine shall be provided with intake and discharge duct work, inlet filter and silencer, outlet muffler, expansion joints, dampers etc. as necessary for efficient operation. Intake air should be taken from inside the building in which the engine is located, but the exhaust should be discharged into the air at a location as desired by the Owner.

4.6.4 The engine shall have two number batteries of 180 Ah each and consisting of 25 plates each.

4.7 Instrumentation

4.7.1 The diesel engine shall be provided with adequate instrumentation. The gauges etc. as required are provided for in the Engine Panel.
5.0 CONTROL PANEL

5.1 General

5.1.1 The Panel shall be fabricated with 16 SWG for Doors and Covers and 14 SWG for frame and of CRCA M.S. Sheet Construction with Red Oxide Primer and finally with approved colour paint to be stove enamelled. The busbar shall be of aluminium with PVC sleeving of appropriate colour code, have a minimum current carrying capacity of 400 Amps. Colour shade shall be RAL 7032 as per DIN and shall be powder coated.

5.1.2 The Panel should be cubical compartmentalised type with separate cable chamber & Busbar Chamber. The Control terminals & Power terminals should be separated and necessary ferrule markings, Colour code shall be followed. A space for 300 mm shall be provided at the Bottom of the panel and necessary M.S. channel for the foundation shall be provided. The ammeter & voltmeter shall be 96 mm sq. size and all the HRC fuses rupturing capacity should not be less than 80 K.A.

5.1.3 The Busbar calculation shall be made for 1 Amp / mm² for Aluminium. The necessary interlocks shall be provided as per system description. The fuse switch/switch fuse unit shall be IS:4064-1978 and HRC fuse links shall be IS:2208-1962 or IS:9224-1979.

5.1.4 The Contractor shall submit the drawings, interconnections diagram for approval of the Client/Consultant. Drawings shall indicate cable inlets, outlets, chamber dimensions and front and side elevations. Further, the Contractor shall also submit complete schematic of the electrical circuits for all pumps from the point of cable entry upto supply to the pumps. This drawing shall take into account all fuses, contactors, switches, meters etc.

5.1.5 The apparatus and circuits in the panels shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

5.1.6 Provision shall be made in the panel for terminating the incoming cables as required in the single line diagram. Only Top entries shall be permitted and all cables shall be provided with cable terminations.

5.1.7 Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

5.1.8 Equipment shall conform to the latest applicable Standards as mentioned. In case of conflict between the Standards and this specification, this specification shall govern.

- IS:13947 (Part 2&5), 1993 - Low voltage switchgear & control gears
- IS:2147, 1966 - Degree of protection
- IS:13947 (Part 4, Sec.I),1993 - Contactor for voltage not exceeding 1000V AC.
- BS:60947-4-1, 1992:IEC:158 - Contactors
- IS:375, 1993 - Marking and arrangement of bus bars
- IS:694, 1990 & IS:8130, 1984 - PVC Insulated cables and aluminium conductor
5.1.9  **CONSTRUCTIONAL FEATURES**

5.1.9.1  Switchgear panel shall be:

a) of the metal enclosed, indoor, floor mounted modular type
b) made up of the requisite vertical sections
c) of dust and vermin proof construction
d) provided with a degree of protection of IP-52
e) easily extendable on both sides by the addition of vertical sections after removing the ends covers.
f) provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.
g) provided with labels on the front indicating the switchgear designation.
h) provided with cable entry facilities at top with 3mm thick removable gland plates and necessary cable glands. For 1 core cables these plates shall be non-magnetic.
i) of uniform height of not more than 2450mm
j) of single front execution
k) provided with neoprene gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.
l) provided with aluminium busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.

5.1.9.2  Operating devices shall be incorporated only in the front of the Switchgear.

5.1.9.3  The switchgear shall be provided into distinct vertical sections each comprising:

a) A completely metal enclosed busbar compartment running horizontally.
b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.

c) Enclosed vertical busbars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical busbars.

d) A vertical cable alley covering the entire height. The cable alley shall be minimum 200mm wide for motor control modules and 500 mm wide for circuit breaker controlled modules.

e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

5.1.9.4 Each vertical section shall be equipped with space heaters which may be located in the cable alley.

5.1.9.5 One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.

5.1.9.6 All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

5.1.9.7 For draw out type, modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing.

5.1.9.8 Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.
5.1.9.9 In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

5.1.9.10 After isolation of power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the busbars and adjacent circuits live.

5.1.9.11 The withdrawl chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

5.1.9.12 Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance of cable connections to any one circuit with the busbars and adjacent live circuits. Adequate number of slotted cable support arms shall be provided for dressing the cables.

5.1.9.13 All doors shall be provided with concealed type hinges and captive screws with padlocking arrangement.

5.1.9.14 The withdrawable chassis housing circuit breakers shall be of the fully drawout type.

5.1.9.15 The withdrawable chassis housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully-drawout, or fixed type.

5.2 Diesel Pump Panel:

The Panel should consist of the following:

5.2.1 Battery:

5.2.1.1 It should be lead acid of minimum 180 Ah capacity.

5.2.2 Engine Instruments and Control Panel:

5.2.2.1 It shall be complete with required connections to set and comprising:

5.2.2.2 Water temperature gauge (dial type)

5.2.2.3 Lubrication oil pressure gauge.

5.2.2.4 Lubrication oil Temperature gauge.

5.2.2.5 RPM indicator.

5.2.2.6 Automatic Start Stop Device.

5.2.2.7 Manual: The Engine can be manually operated by means of Push Buttons.

5.2.2.8 Start Stop and Failure Control Device.

5.2.2.9 Start key for manual starting.
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.2.10</td>
<td>Stop Push Button for manual stopping of engine.</td>
</tr>
<tr>
<td>5.2.2.11</td>
<td>Starting failure indication by lamp and Horn Unit.</td>
</tr>
<tr>
<td>5.2.2.12</td>
<td>Engine temperature very high indication by audio alarm.</td>
</tr>
<tr>
<td>5.2.2.13</td>
<td>Lubrication oil Pressure low indication by audio alarm and automatic stopping of engine.</td>
</tr>
<tr>
<td>5.2.2.14</td>
<td>Engine over speed indication by red lamp with engine over speeding audio alarm.</td>
</tr>
<tr>
<td>5.2.2.15</td>
<td>Engine set in operation indication by green lamp.</td>
</tr>
<tr>
<td>5.2.2.16</td>
<td>Mains supply available indicated by yellow lamp.</td>
</tr>
<tr>
<td>5.2.2.17</td>
<td>Push Button for Audio Alarm reset.</td>
</tr>
<tr>
<td>5.2.2.18</td>
<td>Push Button Failure Indication by lamps.</td>
</tr>
</tbody>
</table>
5.3 **Power Cable:**

The Power Cables shall be PVC insulated PVC sheathed aluminium conductor armoured cable conforming to IS:1554-1988 (Part - I) with upto date amendments or revision. The cable shall be laid directly in ground, pipes, masonry ducts, cable tray surface of wall etc. as shown on drawings.

5.3.1 The cable shall satisfy the following tests as per relevant IS codes:

5.3.1.1 Insulation Resistance Test (Sectional) and overall).

5.3.1.2 Continuity Resistance Test.

5.3.1.3 Earth Continuity Test.

5.3.2 All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Indian Electricity Rules. The contractor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all expenses of conducting such tests.

5.4 **Cable Tray:**

5.4.1 The cable tray shall be fabricated out of slotted/perforated MS Sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. The Cable Tray shall be fabricated from cold rolled MS sheets of 2 mm thickness.

5.4.2 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200 mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scrapped and removed before the installation.

5.4.3 Factory fabricated bends, reducers, tee/cross junctions etc. shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

5.4.4 The entire tray and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust and finished with two coats of spray paint of approved make synthetic enamel paint.

5.4.5 The cable tray shall be bonded to the earth terminal of the switch bonds at both ends.

5.4.5 Cable tray shall be supported by 10 mm dia MS Rods at interval of 100 cm by using dash fasteners.

5.5 **Earthing**

5.5.1 All equipments installed shall be earthed by making proper connection by means of copper cables / wires to the main earthing system.
6.0 CODES AND STANDARDS FOR PUMPS AND MOTORS

6.1 PUMPS

6.1.1 The pumps shall perform to the standards and codes as given below:

6.1.2 IS:1520 Horizontal centrifugal pumps for clear, cold and fresh water.

6.1.3 BS:599 Methods of testing pumps.

6.1.4 PTC:8 ASME Power Test Codes - Centrifugal Pumps.

6.2 MOTOR

6.2.1 The following codes shall be applicable for the motor.

6.2.2 IS:325 Induction motors, three-phase

6.2.3 IS:900 Induction motors, installation and maintenance, code of practice for

6.2.4 IS:7816 Guide for testing insulation resistance of rotating machines.

6.2.5 IS:4029 Guide for testing three phase induction motors.

6.2.6 IS:3043 Code of practice for earthing.

6.2.7 Further to those stated above, the design, manufacture, installation and performance of motors shall conform to the latest Indian Electricity Act and Indian Electricity Rules. The motor shall also be acceptable to the Tariff Advisory Committee.
7.0 FIRE FIGHTING ACCESSORIES

7.1 Piping

7.1.1 Pipes of the following types (depending upon the description of item) shall be used:

7.1.2 MS / GI pipes conforming to IS:1239, ISI marked ( heavy / medium grade, as required ) for pipes of sizes 150mm NB and below) suitably treated on the out side to prevent soil corrosion as per IS:10221.

7.1.3 Piping ( for Pipes upto 150 mm dia )

The pipes shall be manufactured by Electric Resistant Welded ( ERW ) / High Frequency Induction Welding or Hot Finished Welded process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps / strips conforming to IS :10748.

The following manufacturing tolerances shall be permitted on the tubes and sockets:
 Thickness : Shall not be less than 10 percent.
 Weight : Shall not vary by more than 10 percent either way.

The pipes shall satisfy the following table with regard to diameter, thickness and weight of tube.

Screwed tubes shall be supplied with threads as per IS:554. Each tube shall be tested for hydrostatic test for leak tightness as an in process test at the manufacturer's works. The finished pipe shall be tested for Tensile Strength, Elongation, Bend Test and Flattening Test.

7.1.4 Piping ( for Pipes from 150 mm dia onwards )

The pipes shall be manufactured by Electric Resistant Welded ( ERW ) Electric Fusion Welding or Induction Welding process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps / strips conforming to IS :10748 by butt welding longitudionally or spirally. The weld shall be continuous. The pipes shall conform to the Tensile Test, Hydraulic Pressure Test and Mechanical Tests as per IS:3589. The pipes shall also conform to the requirements of the Outside pipe dias as laid down in IS : 3589. The tolerances on the pipe body shall not vary more than 0.75 percent of that prescribed in the above mentioned Code. All pipes shall be of minimum 6 mm wall thickness. Pipes shall be supplied with bevel edging.

7.1.5 MS / GI pipe upto 150 mm dia shall have all fittings as per IS:1239,part II (heavy grade) while pipes above 150 mm dia shall be as per IS:3589 inclusive of IS marking.

7.1.6 For MS / GI pipes upto 50 mm dia screwed jointing shall be adopted, while for pipes above 50 mm dia welded or flanged connections shall be used. Only electro galvanised nuts / bolts shall be used.
7.1.7 The different type of pipes / fittings shall conform to the following:

<table>
<thead>
<tr>
<th>Type of Pipe / (Dia)</th>
<th>Size</th>
<th>Grade</th>
<th>Ends / Fitting</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>M S / GI Pipes</td>
<td>Upto 50 mm dia</td>
<td>Heavy</td>
<td>Screwed</td>
<td>IS:1239 (Part I)</td>
</tr>
<tr>
<td>G I Fittings</td>
<td>- do -</td>
<td>Heavy</td>
<td>- do -</td>
<td></td>
</tr>
<tr>
<td>M S / G I Pipes</td>
<td>Above 50 mm dia and upto 150 mm dia</td>
<td>Heavy</td>
<td>Bevel, Butt Welded, 3 layers</td>
<td>IS:1239 (Part I)</td>
</tr>
<tr>
<td>M S Fittings</td>
<td>- do -</td>
<td>Heavy, machine formed from IS marked Heavy Grade Pipes</td>
<td>- do -</td>
<td></td>
</tr>
<tr>
<td>M S Pipes</td>
<td>Above 150 mm dia</td>
<td>6 mm wall thickness</td>
<td>Bevel, Butt welded, 3 layers</td>
<td>IS:3589</td>
</tr>
<tr>
<td>M S Fittings</td>
<td>- do -</td>
<td>Schedule 40</td>
<td>- do -</td>
<td>IS:3589</td>
</tr>
</tbody>
</table>

7.1.8 Hangers and supports shall be capable of carrying the sum total of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipelines movements as necessary. All guides, anchors, braces, dampeners, expansion joints and structural steel to be attached to the building / structure, trenches etc shall be provided by the Contractor. Hangers and components for all piping shall be approved by the Engineer in Charge. Hangers / supports to be used shall be as per the drawing enclosed. Anchoring fasteners shall be rated to take minimum 0.4 ton load and shall be as per approved make. Hangers shall be at 3.0 M intervals. Additional supports shall be provided at bends etc. Angles for pipe supports should not be less than 40 x 40 x 6 mm size. Cutting shall be by gas cutter. All cut edges and weld surfaces shall be grounded to a smooth finish.

7.1.9 The piping system and components shall be capable of withstanding 150 per cent of the working pressure including water hammer effects and test pressure upto 12.0 kg/cm².

7.1.10 Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of strategic points to facilitate erection and subsequent maintenance work.

7.1.11 All welding shall be carried out by a certified welder only. The Contractor must produce the Welder's Certificate.

7.1.12 All pipe to pipe receiving edges shall be bevel finished to a clean edge by an electric grinder. A requisite gap determined by the thickness of the weld electrode shall be given between the joints before start of welding.

7.1.13 Weld Electrodes shall be of approved make, of grade and type as suitable for the job. This shall be satisfied by the Consultant before start of work.

7.1.14 Joints shall be given a first weld in full width without burrs on the full dia of the pipe. Welding
shall be carried out vertically from the surface to be welded. Weld fluxes shall not be so plastic such as to fall or drip down.

7.1.15 After application of first coat the weld shall be ground and then another layer of welding shall take place. The weld shall also be cleaned by grinding. Similarly, a third weld shall also be applied.

7.1.16 All pipe cutting shall be by oxy acetylene gas welding only. The cut surface shall be cleaned and ground by an electric grinder before further welding.

7.1.18 For supports angle pieces shall be cut by oxy acetylene gas and cleaned by electric grinder. All cutting for bolt inserts shall be by electric drill.

7.2 **Valves**

7.2.1 Sluice valves / Butterfly valves / Ball Valves will be used for isolation of flow in pipe lines. For sizes up to 50 mm, gate valves shall be outside screw rising spindle type and shall be as per IS: 778 Class-I and Class-II, as applicable. For sizes 80 mm to 300 mm, gate valve shall be as per IS: 780, PN=1.0 and shall be of outside screw and non rising type and cast iron double flanged. The valves shall, however, be tested to PN:1.6.

7.2.2 Gate valves shall be provided with a hand wheel arrangement. Gate valves shall have back setting bush to facilitate gland renewal during full open condition.

7.2.3 Non-return valves shall be cast iron spring action swing check type. An arrow mark in the direction of flow shall be marked on the body of the valve. These valves shall conform to IS:5312. The flap shall be of cast iron and flap seat ring of leaded gun metal.

7.2.4 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections. Drain lines will have valves for draining.

7.3 **Hydrant**

7.3.1 Hydrant valve shall be as per IS: 5290 of gun metal. The valve shall be oblique type complete with hand wheel, quick coupling connection, spring and gun metal blank cap as per I.S.:5290. The hydrant shall be fixed on Hydrant Riser through a 80 mm dia spool piece, at approx. 1.2 mtr from floor level. The Hydrant shall be IS marked. Orifice plate in 6 mm thick stainless steel with orifice of 32 / 40 / 50 mm dia shall be provided with each Hydrant.

7.3.2 The Hydrant shall be constructed from gun metal as per IS, and finished to a smooth polish on screwed ends. The Hydrant shall have screwed inlet of 75 mm dia, flanged type with 4 nos holes. The outlet shall be 63 mm female instantaneous oblique type. The spindle shall be of gun metal with cast iron wheel. The Hydrant shall have a PVC plug with chain fixed to the main body of the Hydrant. The Hydrant shall conform to IS:5290. The Hydrant shall be tested to 25 kg / cm² test pressure. All threaded joints shall be sealed with A.Holdtite. The lug shall be wing type.
7.4 **First Aid Hose Reel**

7.4.1 The hose reel shall be drum type with hub wheel ties. The supply pipe shall be of aluminium alloy and be a part of the suspension assembly. The drum shall rotate freely on the assembly. The drum shall be fabricated from GI sheet of minimum 18 guage thickness.

7.4.2 The hose reel shall be directly tapped from the riser through a 25 mm dia pipe, the drum and the reel being firmly held against the wall by use of dash fasteners. The hose reel shall be swinging type (180 degrees) and the entire drum, reel etc shall be as per and IS:884 including marking. The rubber tubing shall be of IS:444 marked and rayon double braided. The nozzle shall be 6 mm dia ABS plastic rotating head shut off type. A Ball Valve shall be used to shut off the water supply to the hose reel.

7.4.3 A MS bracket shall be fixed on the wall to which the First Aid Hose Reel shall be bolted. The bracket shall be of 40 x 40 x 5 mm thick MS angle to form a square of 400 x 400. This shall be fixed on the wall. The MS bracket shall have two nos. Vertical MS strips of size 50 x 6 mm fixed on the bracket. The F A Hose Reel shall be fixed on this strip. After approval of sample further units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer.

7.5 **External Hose Cabinets**

7.5.1 Each hydrant / Fire Brigade inlet shall be housed in a Hose Cabinet of 0.7 M x 0.45 M x 0.3 M. The Hydrant Cabinet shall hold single headed hydrant, 2 nos. Hoses and 1 no. Branch pipes or Fire Brigade Inlets.

7.5.2 The cabinet shall be of 3 mm thick aluminium sheets with 25 x 25 aluminium framing members. The sheet shall be rivetted to the frame. The Box shall have a single shutter with glass of 8 mm thickness.

7.5.3 The aluminium work shall be powder coated with red paint. The words "Yard Hydrant", "Hydrant" etc. shall be painted in white (or red on the glass) in 75 mm high letters. The hose box shall be lockable with socket spanner. All horizontal surfaces shall be sloped adequately with water discharge holes. Vents shall also be located on sides of the Hose Box.

7.5.4 A brick pedestal with brick wall complete with plaster shall also be constructed for supporting the hose box. All surfaces shall be plastered with 1 : 4 ratio (1 cement : 4 fine sand) mortar.

7.6 **Air Vessel**

7.6.1 The Air Vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter acting pressure surges whenever the pumping set comes into operation. It shall be normally partly full of water, the remaining being filled with air which will be under compression when the system is in normal operation. Air vessel shall be fabricated from 8 mm thick MS plate with dished ends and suitable supporting legs. It shall be provided with a 100 mm dia flanged connections from pump, one 50 mm drain with valve, one water level guage and 25 mm sockets for pressure switches. The air vessel shall be hydraulically tested to 20.0 kg / cm² pressure for 30 minutes. All Valves shall be Ball Valves in gunmetal.

7.6.2 The Vessel shall be at least 1.5 M long (excluding dished ends) and shall be of 150 mm dia.
7.7 Fire Brigade Inlet

7.7.1 Fire Brigade Inlet Connection shall be taken directly to the Riser. It shall comprise of four instantaneous male inlet coupling with plug and steel chain. The Inlet shall have a dual plate wafer type non return valve and a Butterfly Valve on the line upto the Riser. The Fire Brigade Inlet shall be complete with necessary components like special fittings of medium quality MS bends, flanged tees etc. The plug shall be of moulded PVC.

7.7.2 Fire Brigade Inlet for Tank Filling by Fire Brigade shall be four way with gun metal instantaneous male inlet coupling connection for connection with Fire Brigade vehicles.

7.7.3 The inlets shall be provided with ABS Quality by Plastic Blank caps with chain and arrangement for attaching the blank cap & chain to the FB inlet.

7.8 System Drainage

7.8.1 The system shall be provided with suitable drainage arrangements with GI piping of 40 mm dia, complete with all accessories, and provided with 40 mm dia ball valve.

7.9 Valve Pits

7.9.1 A masonry pit of internal dimension 1.0 x 1.0 x 1.0M depth shall be built to accommodate each of the valves placed externally. Walls shall be of 75 class designation brick work in cement mortar 1:5 (1 cement:5 fine sand) with 116 kg CI manhole cover with frame (500 cm internal dia). The Top Slab RCC shall be of 1:2:4 mix (1 cement : 2 coarse sand : 4 graded same aggregate 20 mm nominal size) and inside plastering with cement mortal 1:3 (1 cement : 3 coarse sand) 12 mm thick. The manhole chamber shall be internally finished with commercial grade white glazed tiles.

7.10 Pressure Gauge

7.10.1 The Pressure Gauge shall be constructed of die cast aluminium. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type Pressure Gauge with a scale range from 0 to 16 Kg / CM square and shall be constructed as per IS: 3624.

7.11 Painting

7.11.1 All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as " TO RISER NO. 1 " etc. All necessary protection to adjacent objects shall be taken by the Contractor. Flanges, Nuts, bolts, Gate and Non Return Valves shall not be painted.
7.12 Butterfly Valve

7.12.1 The Butterfly Valve shall be suitable for waterworks and tested to minimum of 20 kg / sq cm pressure. The Valves shall fulfil the requirements of AWWA (American Water Works Association) C 504, API 609 and MSS-SP-67.

7.12.2 The body shall be of cast iron to IS:210 in circular shape and of high strength to take the minimum water pressure of 20 kg / cm². The disc shall be heavy duty ductile iron with anti corrosive epoxy or nickel coating.

7.12.3 The valve seat shall be of high grade nitrile rubber and shall be teflon coated or silicon coated. The Valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be of EN 8 grade carbon steel.

7.12.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages. The flap shall be of ductile iron and nylon coated.

7.12.5 The Valves shall be supplied with manual gear operated opening / closing system by lever as required by the specifications.

7.13 Couplings

7.13.1 Couplings shall be of gun metal, machined and polished to requirements. Both Male and female couplings shall be fitted into each other smoothly and without any unnecessary force. Couplings shall IS:903 marked with the name of the manufacturer. The coupling shall be tested to 25 kg / cm² test pressure. The Male couplings shall be provided with lugs for inserting female coupling. The lugs of the coupling shall be wing type.

7.14 Branch Pipe

7.14.1 The Multi purpose Branch Pipe shall be constructed from Gunmetal / aluminium alloy and finished to a smooth polish. The Branch shall have hook for control and grip type handle for holding. The Branch pipe shall be able to give straight stream, high pressure fog, jet and shut off, all provided by the operation of the handle - lever. The Fog Nozzle shall be as per IS:903. The Branch Pipe shall be tested to 20 kg / cm² pressure.
SPRINKLER SYSTEM

8.1 Pendant type Sprinkler Head

8.1.1 Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal dia outlets.

8.1.2 The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches at 68° / 79° C. Certificate from manufacturer is to be submitted.

8.1.3 The nominal bore shall be 15 mm dia and colour of liquid shall be Red / Yellow.

8.1.4 The Sprinkler head shall be UL listed.

8.1.5 The sprinklers below false ceiling shall also be provided with a double plate captive rosette assembly to seal the junction between the between the pipe and the false ceiling.

8.2 Upright type Sprinkler Head

8.2.1 Upright sprinkler heads shall be similar to Pendent type in material construction and performance but designed to throw water Droplets upwards in umbrella fashion, to cool the underside of ceiling and extinguish any fire involving combustibles above false ceiling.

8.2.2 The Sprinkler head shall be from Approved Makes. The nominal bore shall be 15 mm dia and the colour of liquid shall be red.

8.3 Powder coated Sprinkler with Powder coated Twin plate Rosette

8.3.1 The Sprinkler Head shall be same as Pendant type above but powder coated white. The Sprinkler head shall be provided with a double plate powder coated rosette that shall seal the gap between the false ceiling and the sprinkler head.

8.3.2 The adjustment allowable shall be 12 mm. The lower part shall have flared ends that shall fit tightly into the upper piece.
8.4 Installation Control Valve for Sprinkler

8.4.1 The Installation Control Valve shall be double seated clapper type check valve. The Body and cover shall be made from Cast Iron to ASTM A 126B. The seat and seat clamp shall be made from brass as per ASTM B16. The sealing to the seat shall be neoprene gasket.

8.4.2 It shall be vertically mounted and the direction of water travel shall be indicated on the surface. It shall be rated to 12 Kg / cm².

8.4.3 A By-pass check valve shall be fitted to adjust minor and slow variations in water pressure for balancing so as to avoid any false alarm.

8.4.4 A brass strainer shall also be provided at the point of water supply to the Alarm gong. A Retarding Chamber shall also be provided. The Chamber shall be able to balance the water pressure in case of water line surges.

8.4.5 Each Installation Control Valve shall have two sets of Pressure Gauges with brass ball valve type shut off.

8.4.6 A Water Motor Alarm. shall also be provided. This shall be mechanically operated by discharge of water through an impeller. The drive bearing shall be weather resistant. A strainer shall be provided on line before the nozzle. The Gong piece shall be constructed from brass to ASTM B16. The Housing and Housing Cover shall be pressure die cast aluminium.
9.0 **Codes & Standards**

9.1 The following codes and standards and their subsequent modifications shall apply for the design, manufacture, shop testing, erection, fabrication at site, testing and trial operation of piping, valves and specialities requirements:

9.1 IS:554. Dimensions for pipe threads where pressure tight joints are required on the threads.

9.2 IS:638. Sheet rubber jointing and rubber insertion jointing.

9.3 IS:778 Copper alloy gate, globe and check valves for water work purposes.

9.4 IS:780. Sluice valves for water-works purposes (50 mm to 300 mm).

9.5 IS:901. Couplings, double male and double female, instantaneous pattern for fire fighting.

9.6 IS:1239 Mild steel tubes, tubulars and other wrought (Part I & II) steel fittings.

9.7 IS:884. Swinging type wall mounted hose reel with drum,

9.8 IS:388. Hose tubing.

9.9 IS:4038 Foot valves for water-works purposes.

9.10 IS:5290 Landing valves.

9.11 IS:10221 Anti corrosion treatment for underground MS pipes.

9.12 IS:5312 Swing check type reflux (non-return) valves.

SPECIFICATIONS FOR FIRE ALARM SYSTEM

Scope:

The scope of work includes the following:

1. Intelligent Addressable Fire Detection System for the Metrology Building.
2. Emergency Public Address System in common areas.
3. Access Control System.

Contractor shall co ordinate with AC, elevator & Electrical Contractors working.

The Contractor shall get the Fire Fighting Systems approved from the Local Fire Authority without any cost to the Owner. He shall carry out the approval work in conjunction with the Fire Fighting Contractor.

Fire Alarm System Description

The Metrology Block shall be provided with an Intelligent Addressable Fire alarm System with Photo Electric Multi Criteria Detectors in all air conditioned areas. Areas not directly air conditioned such as store rooms shall also be provided with smoke detectors. Areas above the false ceiling shall be provided with Smoke Detectors. Labs shall be provided with VIEW (Notifier make) Detectors. The Electrical Rooms shall be provided with HARSH (Notifier make) detectors.

Provision of Multi Criteria Smoke cum Heat Detectors in areas :

All air conditioned areas including corridors, equipment rooms, store rooms.

Provision of Highly Sensitive VIEW Detectors in areas :

All LAB Rooms.

Provision of Heat Detectors :

Areas susceptible to smoke discharge.
Areas open to the atmosphere and not air conditioned such as entry areas or staircases.

Provision of Manual Call Box :

At all staircases entry points on all levels.
Internal areas in corridors etc.
Other areas where Call Point is required as per code.

Provision of Hooter cum Strobe:

At staircases.
All corridors and public areas shall be provided hooters.
Large Rooms
At locations desired by Client / Codes.

**Provision of Sounder based Detectors:**
VIP Rooms and areas.

**Provision of Repeater panels:**
One no per Floor.

**Provision of Fault Isolators:**
Inbuilt with Detectors.

**Provision of Input Modules:**
For NO / NC signal from Flow Switches of Sprinklers.

**Provision of Output Module:**
For tripping AHUs.
For initiating Hooter cum Strobe. Not more than 2 Hooter cum Strobe per Module. Output Modules shall be programmable to allow operation only in area of fire.

**Provision of Response Indicators:**
For Detectors above false ceiling.

**Provision of Duct Detector:**
For air sampling for return air of AHUs.
INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

Scope of Work

1.1.1 The Design consists of a multi loop Intelligent Addressable Fire Alarm System with the multiple Loop Panel located on the Ground Floor along with accessories such as Sensors, Call Points, and Alarm signals located as per drawing.

1.1.2 The Building shall have an Intelligent Addressable Fire Alarm System for all areas from Ground Floor onwards. The System shall have Class A Wiring. Field Devices shall include Sensor Devices, Manual Call Box, Input Card (from Flow Switch and Magnetic Contact), Output Modules to switch off AHUs etc. Strobes and shall be provided with Output Module on common areas. Fault Isolators shall be provided as required.

1.1.3 The scope of work under this head shall include designing, supplying and installing of Intelligent Addressable Fire Detection cum Alarm System for the Building and shall cover areas marked by the line diagram plus any other area which may be decided subsequently, to be protected by the Fire Alarm system. The work under this system shall consist of furnishing all materials, equipments and appliances and labour necessary to install the said System, complete with Detectors, Panel, Speakers, Manual Push Button Stations, Input Modules, Output Modules, Relays etc for disconnecting other systems such as A H Us and electric supply etc.

1.1.4 It shall include laying of cabling ducts, conduits and power supply etc, necessary for installation of the System with supply of detectors of appropriate type as indicated in the specification and Schedule of Quantities. Any openings / chasing in the wall / ceiling required to be made for the installation shall be made good in appropriate manner.

1.1.5 The Bidder shall also undertake to trip from the Fire Alarm Panel through the use of Switches individual A H U activated by the fire signal of specified detectors.

Design Description

1.2.1 The System shall have a multi loop panel and distributed as per drawing. All Devices shall be connected directly to the Loop. The P A System shall be independent from the Fire Alarm System.

1.2.2 Loop cabling shall be A class.

1.2.3 The Panel shall have necessary Logic Software and Hardware built into it for time delay starting of strobe and for hooters. Further, AHUs of each Floor shall be shut off only when any detector on that floor operates an alarm.
1.3.0 **Specification:**

1.3.1 The design, supply and installation and testing of the entire fire alarm system shall conform to NFPA 72. The detectors shall conform to relevant codes for Fire Alarm Systems.

1.3.2 A general line diagram showing the circuit, and spacing of detectors is enclosed. However, this line diagram is mainly for guidance of the Bidders and wherever it may be at variance with NFPA 72, the latter shall be followed.

1.4.0 **Intelligent Addressable type Rate of Rise type Heat Detector**

1.4.1 The Heat Detector shall be Intelligent Addressable detector with its own manually-set digital code and be able to give a single digitised output to the Fire Alarm Panel regarding its condition. The Detector shall employ the thermistor principle for heat sensing and the fixed temperature setting shall be at 57° Centigrade. It shall be able to communicate with the Fire Alarm Panel by the electrical pulses emitted from the Panel. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.

1.4.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

1.4.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).

1.4.4 The detector shall have a micro processor that shall have a environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The micro processor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector everyday.

1.4.5 The Base of the Detector shall be interchangeable with other Smoke Detectors and the construction shall be of polycarbonate or any approved proprietary flame retardant material. LEDs shall be provided to indicate locally alarm condition. The enclosure shall meet IP 22 protection grade.

1.4.6 The Detector shall meet the requirements of NFPA / EN 54 and shall be specifically approved by UL. It shall be possible to test the Detector’s working both from the Panel as well as locally by means as designed by the Bidder. The approved coverage per Detector for unhampered areas shall not be less than 50 M².

1.4.7 The detector shall be protected from reverse polarity or faulty zone wiring. It shall also be possible to test the detector in the field through use of magnet or test devices. The circuitry shall be solid state devices and sealed to prevent damage from dust, dirt or humidity. The circuitry shall be protected against usual electrical transients and electromagnetic interference.
1.4.8 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit/loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.

1.4.9 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.

1.4.10 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

1.5.0 Intelligent Addressable Photo Electric type Smoke Detector

1.5.1 The Photo Electric Smoke Detector has an optical sensing chamber that operates on the light scattering principle and responds to those particles that form optically dense smoke. When smoke enters the sensing chamber it scatters light which is received by a photo cell. The signal is amplified and digitised for reception by the Panel. The Detector shall activate on receiving smoke particles in the 0.5 to 10 micro metre range. The detector shall be completely solid state with L E D indication at the base. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.

1.5.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

1.5.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).

1.5.4 The detector shall have a micro processor that shall have n environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The micro processor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector everyday.

1.5.5 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion. The light source intensity shall automatically adjust to compensate for possible effects of dirt and dust accumulation in the sensor/lens. The Smoke density in the chamber shall be measured by a optical system built within the detector. The detection principle shall employ a multiple light pulse coincidence circuit in order to prevent the false alarms. The detector shall be provided with response indicator (LED) and the sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure of voltage variation.
1.5.6 Neither its performance shall be affected by air current up to 10 mtr per second. The detector shall be suitably protected against dust accumulation / ingress. All detectors shall be identical in construction design and characteristic to facilitate easy replacement. The detector housing shall be damage resistant made of polycarbonate or proprietary self extinguishing material. The detector shall have a screen to prevent entry of insects into the sensor.

1.5.7 The coverage per smoke detector shall be up to a minimum of 80 M². This coverage area will reduce depending upon structural configurations or partitions etc. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Buttons in the same circuit. The sensitivity of detector shall be set adjusted by the supplier to suit the site requirement.

1.5.8 It shall have in-built safety device to monitor the removal and pilferage of the detector. The detector also must have facility for remote indication.

1.5.9 The Base of the Detector shall be interchangeable with other Smoke or Heat Detectors. The enclosure shall meet IP 40 protection grade.

1.5.10 The Detector shall meet the requirements of NFPA and be approved by UL. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.

1.5.11 It shall be possible to mount the detectors in Duct Casting Units for sampling of Supply Air from the A H Us.

1.5.12 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit / loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.

1.5.13 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.

1.5.14 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

1.6.0 Fire Alarm System

1.6.1 The Fire Alarm System shall conform to NFPA 72 in respect of design and installation, and it shall give Audio / Visual Alarm signals when the temperature in case of Heat Detector or smoke density in case of Ionisation or Photo Electric Detector exceeds the pre-set limit. The system shall give pin point location of fire with warning system and voice communication for commands and instruction if required. All Panels shall have 16 bit processors.

1.6.2 The System shall be Computer aided micro processor based with central control and monitoring facility. The basic function of the System shall be to be able to achieve pin point location of alarm indication. Secondary functions such as pre warning of possible alarm situation, self diagnosis, checking upon faulty detectors and switching on / off of unrelated activities such as A H Us or Power Supply shall also be possible in this System. In case of more than one panel, all panels shall have peer to peer communication. Both panels shall be independent in operation for the area it serves. Master - slave configuration shall not be acceptable.
1.6.3 Each Loop shall have a minimum capacity of 120 detectors in a circuit. The Fire Alarm Panel itself shall have have the mother boards / transponders / interface of each zone built-in.

1.6.4 Annunciation (Hooter Alarm) facility shall also be inbuilt into the Panel, the Panel being able to initiate alarm signal for any particular set - in this case a floor - hooter as required. The signal shall be transferred to the relevant channel in the P A System.

1.6.5 The system shall be fully supervised for all fault conditions with distinctive alarms operated for fault and fire conditions. Test push buttons / features shall be provided to test the electronic circuits and detector conditions.

1.6.6 The Panel shall be so programmed that when a particular detector or group of detectors give a fire signal the Panel should be able to trip an individual A H U automatically. The respective Loop Card shall be so programmed that in case of Fire conditions in a area air conditioned by an AHU the Panel shall be able to trigger a Relay through the Output Card that shall shut off the AHU through an additional Contactor provided in the AHU Panel by the AC Contractor.

1.6.7 The Basic System Functional Operation shall be as follows:

1.6.8 The Panel LED shall flash and Panel piezo-electric signal in the control panel shall actuate.

1.6.9 The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

1.6.10 The Panel shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

1.6.11 All system output programs assigned via control-by-event/ logic equations to be activated by the particular point in alarm shall be initiated.

1.7.0 Addressable Manual Call Box

1.7.1 Manual Push Button shall be of Break Glass or Pull down type units, completely encased in a plastic housing with provision for cable or conduit coupling. The Manual Push Button shall have the word prescribed in clear bold letters on facia window "In Case of Fire Break Glass / Pull Down".

1.7.2 The Manual Call Box Station shall be fully addressable with its own set code and operated by digitised signals sent from the Panel. The Voltage range shall be from 15 V to 28 V. It shall have protection as per IP 33.

1.8.0 Addressable Fire Alarm Control Panel

1.8.1 The Fire Alarm Control Panel shall be micro processor based fully Intelligent Addressable Analogue Control Unit which shall control all Intelligent Addressable detectors, Manual Call Stations and Switching Systems (for disconnecting A H U and power supply) connected to it and other Input Devices such as Magnetic Contacts and Flow Switches.

1.8.2 All addressable units shall be connected to the Panel through the Loop Cards and shall be addressed through individualised numbers. The Panel shall be able to obtain analogue value / percentage obscuration value for all detectors in the circuit through a pulsed digitalised current data. The Panel shall be able to analyse all analogue inputs from all addressable units, and through its own software and ambient level screening the Panel shall be able to identify Fire, possible Fire or Fault conditions. The Unit supervision shall be dynamic and continuous.
1.8.3 The Fire Alarm Panel shall itself have all Loop Cards in it. No isolated mother board or transponder is being considered. Each Loop shall have a capacity of 120 detectors.

1.8.4 The Panel shall also give adequate warning signal whenever there is dust accumulation in detectors, and upto the point of its replacement it should be possible to change the level of ambient alarm calibration condition either by the use of software programme operable by the Owner or by resetting the detector.

1.8.5 Short circuiting, loose wiring or missing units shall also be reported at the Panel with pin point or segment-wise location. In such cases, the System through the use of Fault Isolators shall be able to isolate that segment between the two fault Isolators.

1.8.6 The Panel shall have a minimum 2 x 40 character Liquid Crystal Display Alpha - Numeric type on it to indicate immediately all conditions. In case of testing of the System from the Panel, the Display shall be able to give status of analogue value of all detectors being tested. The Panel shall also be able to carry out continuous self monitoring when in normal condition.

1.8.7 The Panel shall have either an in-built or external printer coupled to the Panel which shall log all events with time. The printout shall clearly indicate the event - Fire / Pre Alarm / Fault etc, the Unit address and time.

1.8.8 The Panel shall also be able to discriminate between false alarms and fire conditions, as well as priority selection of alarm address in case alarm activates in two or more remotely located Units simultaneously. In such cases, the Manual Call Box shall be reported first, group of sequentially laid detectors ( in one room for example ) second and a detector with the greatest obscuration over a period of time third.

1.8.9 The Panel shall also be able to actuate Switches automatically in case of Fire condition, that of A H Us and Power Supply. The Bidder will be required to design and install the System in operation in coordination with the relevant Contractors. The Bidder will not be allowed to charge extra on this account, and such charges shall be included in his package.

1.8.10 In this respect the Bidder is required to take note of Clause relating to cutting off of AHUs given above. The Bidder shall indicate in his Bid what facilities shall need to be provided by the Client for completion of this mechanism.

1.8.11 The System shall be fail safe and adequate safe guards should be under taken that in the event of a failure of a part of the System it shall not handicap the complete System. The Mother Board shall be of Modular Construction.

1.8.12 The Bidder shall undertake the responsibility of the complete installation, commissioning, user trials, training and maintainance of the System as required. The Bidder shall take all responsibility for preparation and installation of System Soft Ware into the Panel. The Soft Ware shall be such so as to be easily operated by the Owner's Personnel, is secured against Software errors, ability to be upgradable so as to incorporate more Detector Units or replacement / changing of Detector Units, can incorporate more features at a later date such as Illumination Control, Security etc.

1.8.13 The Panel shall have its own Battery Back up. The Battery shall be of sealed maintenance free type of capacity minimum 25 Ah capacity.

1.8.14 The Panel shall be totally enclosed dust and vermin proof type made of minimum 18 guage dust inhibited sheet with even baked finish. The panel shall be of completely solid state design.
1.8.15 The logic circuitry shall be based on high noise immunity solid state hardware employing modular construction.

1.8.16 The System shall meet the NFPA 72 standards and all equipments excluding cabling and wiring shall be listed with UL.

1.8.17 The Panel shall have software to cater to the change over of any of the operating Loop Cards to an extra Loop Card. Other software necessary to actually change the terminals of a Loop from an existing Loop Card to the extra Loop Card shall be carried out at site as and when required. Charges for such software, loading, test run etc. shall be indicated when required.

1.8.18 Peer to peer communication between panels shall be provided with event of each panel being provided on the other panel.

1.8.19 The Panel shall also have programmable Automatic Day/ Night Sensitivity Adjustment, Drift Compensation by which the detector’s sensitivity threshold level due to dust shall be automatically adjusted over time. The panel shall also upload/download System Database to PC Computer. The System shall also allow Walk Test.

1.8.20 The Fire Alarm Control Panel shall be capable of supporting interactive Colour Graphics Package complete with history logging. All the zone shall be displayed with colour coded graphics that indicate the status of each zone and its location.

1.8.21 The Main Processor Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the central processing unit. The CPU shall contain and execute all control-by-event/logic programs for specific action to be taken if an alarm condition is detected by the system.

1.9.0 Power Supply

1.9.1 The control panel shall derive 230 Volts power from main supply. A standby power supply shall be immediately available in the event of failure of normal supply and shall automatically be connected so as to maintain the equipment in condition such that fire alarm originating from the operation of detector can be given.

1.9.2 Suitable arrangements shall be incorporated to prevent secondary batteries from discharging through the charging equipment in the event of its breakdown or a failure in the supply.

1.9.3 Necessary automatic changeover from normal to standby DC supply in case of main supply failure shall be provided by the Contractor.

1.9.4 In addition to the batteries, a battery charger suitable for operation on the auxiliary power shall be supplied. The capacity of the charger shall be such that the same can boost charger the battery (within 8 hrs) while supplying the rated load of the fire detection and annunciation system. Facilities shall be provided to limit the voltage supplied to fire detection and alarm system to their rated values during the time of boost charging. The charger shall normally supply the battery trickle charging current and the DC load of the fire detection and alarm system. In case the AC supply on the input side of the charger fails the necessary power for the complete fire detection and alarm system including P A shall be supplied by the battery.

1.9.5 Switches, fuses, overloaded devices, voltmeter, ammeter and earth fault indicating device shall be furnished for the power supply system.
1.9.6 Visible and audible annunciation for troubles or failure in the power supply system like "Charger Failure", "Battery Low Voltage", etc shall be provided.

1.9.7 Battery earth / fault indication / annunciation shall be included in the panel.

1.9.8 The electronic cards to be used in the battery chargers shall be of PCB type with male /female type plug-in contacts

1.9.9 Automatic boost / trickle charging facility shall be included in chargers.

1.10. **Intelligent Addressable Multi Criteria Photo Electric cum Heat Detector**

1.10.1 The Detector shall be provided with both Smoke and Heat Sensor. The Photo Electric part shall have an optical sensing chamber that operates on the light scattering principle and responds to those particles that form optically dense smoke. When smoke enters the sensing chamber it scatters light which is received by a photo cell. The signal is amplified and digitised for reception by the Panel. The Detector shall activate on receiving smoke particles in the 0.5 to 10 micro metre range. The detector shall be completely solid state with L E D indication at the base. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.

1.10.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

1.10.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings ( those operating in offices and those in corridors ).

1.10.4 The detector shall have a micro processor that shall have n environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The micro processor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector everyday.

1.10.5 The Heat Sensor shall consist of a thermistor for heat sensing and the fixed temperature setting shall be at 57° Centigrade.

1.10.6 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion and shall actuate on rate of heat rise increasing over the factory set threshold. The light source intensity shall automatically adjust to compensate for possible effects of dirt and dust accumulation in the sensor/lens. The Smoke density in the chamber shall be measured by a optical system built within the detector. The detection principle shall employ a multiple light pulse coincidence circuit in order to prevent the false alarms.
1.10.7 The detector shall be provided with response indicator (LED) and the sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure of voltage variation.

1.10.8 Neither its performance shall be affected by air current upto 10 mtr per second. The detector shall be suitably protected against dust accumulation / ingress and it shall be free from maintenance and functional test at intervals. All detectors shall be identical in construction design and characteristic to facilitate easy replacement. The detector housing shall be damage resistant made of polycarbonate or proprietary self extinguishing material. The detector shall have a screen to prevent entry of insects into the sensor.

1.10.9 The coverage per smoke detector shall be upto a minimum of 80 M². This coverage area will reduce depending upon structural configurations or partitions etc. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Buttons in the same circuit. The sensitivity of detector shall be set adjusted by the supplier to suit the site requirement.

1.10.10 It shall have in-built safety device to monitor the removal and pilferage of the detector. The detector also must have facility for remote indication. The Base of the Detector shall be interchangeable with other Smoke or Heat Detectors. The enclosure shall meet IP 40 protection grade.

1.10.11 The Detector shall meet the requirements of NFPA and be approved by UL. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.

1.10.12 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit / loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.

1.10.13 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.

1.10.14 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

1.11.0 Conduits

1.11.1 These shall be 16 G. Mild Steel Welded and having perfectly circular tubing and capable of being cleaned and tight fitting joints. Conduits shall be laid either surface or in recessed as required and it shall be protected from rust by one coat of iron oxide, and one coat of Red Enamel Paint.

1.11.2 Above false ceiling cables shall be drawn off from the conduits laid on the slab. The cables shall be drawn through flexible P V C conduits including all necessary supports, clamps etc as required.

1.11.3 Where conduits have to be installed under R C C slabs, the Bidder shall use drill guns and P V C dash fasteners for screwing of saddles for exposed conduits.
1.12.0 **Addressable Switch (Output Module)**

1.12.1 The Switches shall be addressable and commandable Units controlled from the Fire Alarm Panel that shall automatically energise circuits to disable electrical circuits for A H Us or Power Supply etc.

1.12.2 The Bidder shall take note of relevant Clauses given above. He shall be required to specifically inform the Owner about what facilities he shall require from the Owner or the Air Conditioning Agency working at site for tripping off the A H Us.

1.12.3 The Switch shall also be used to operate a group of strobes or a group of electronic hooters through the use of a Power Supply Unit, or shall operate a Magnetically operated Door Closing Device by de magnetising the unit.

1.13.0 **Addressable Duct Casting Unit**

1.13.1 The Duct Casting Units are to be directly installed in the air conditioning ducts for detecting any hazardous quantity of products of combustion being carried through the ducts.

1.13.2 The complete unit shall consist of aluminium or poly carbonate housing to accomodate a Ionisation or Optical Detector with plug - in facility and sampling tubes, one for air inlet and the other as the air outlet.

1.13.3 The Inlet tube shall extend into and across the duct width (from 0.5 metre to 3.0 metre), the outlet tube shall be of fixed length of 7.5 cm length.

1.13.4 When the A H U blower fans shall operate a continuous cross sectional sampling of air from the duct shall flow through the housing containing the detector. The outlet tube shall return the sampled air into the duct.

1.13.5 The functional requirements of the Duct Casting Unit shall be:

1.13.5.1 Uniform Sensitivity - irrespective of air velocity - upto 1200 metres per minute.

1.13.5.2 It shall function on the Venturi principle, with aluminium venturi tubes.

1.13.5.3 The Duct Casting Unit shall be compact, easy to install and with the facility to dismantle the cover or detector for maintenance purposes.

1.13.6 The housing shall be mounted outside the duct, the probe tubes shall be inserted through the duct by cutting precision sized holes into it and sealed with rubber gaskets.

1.13.7 The Duct Casting Unit shall be UL approved.

1.14.0 **Cables and Wires**

1.14.1 Cables shall be Zero Halogen FRLS stranded and insulated for armoured and unarmoured. The conductor shall be stranded shielded as required copper conductor.

1.14.2 The entire installation shall be tested to Electricity Rules and as per IS:732 (1973) with amendments. The cables shall be laid as per IS:1255 (1967).

1.14.3 Loop cabling shall be 2 core 1.5 sq mm stranded copper conductor cable.
1.14.4 All terminals shall be done with thimbles and ferrules.

1.15.0 Sounder Base

1.15.1 Specific Detectors as per the requirements given in the drawings and schedule of Quantities shall have Sounder Bases. On activation of the specific Detector on which the Sounder is mounted, the Sounder shall initiate beeping. The Sounder shall be activated only after the detector crosses the Alarm threshold, and not the Pre Alarm level. The Sounder circuit shall be solid state and its Power Driver shall be derived from the available power in the Intelligent Addressable circuit or through an independent power supply circuit. The Sounder shall work on 24 Volts. The Sounder Output shall be 50 dB minimum.

1.15.2 In case of the Sounder, the Detector's performance shall not be disabled on account of the Sounder being disabled. The Detector shall still be able to communicate directly with the Panel.

1.15.3 In case the Bidder is unable to provide a single unit of Addressable, Intelligent Detector with Sounder Base, then he shall quote for the above as given below:

Detector with Sounder Base: Intelligent Addressable Detector with Output Card or Device, Electronic Sounder and necessary hard wiring to make a complete unit.

1.16.0 Response Indicator

1.16.1 Response Indicator shall be fabricated from 16 gauge M.S fabricated box or in aluminium casing. The Response Indicator shall glow clearly in case the detector to which it is connected gives an alarm signal. The word "FIRE" shall be clearly written on the visible face of the box. There shall be two numbers of red LEDs to compensate for fusing of either LED.

1.17.0 Repeater Panel

1.17.1 The Repeater Panel shall be provided with an LCD Display Unit of 2 lines of 40 characters that shall provide alpha numeric information on the fire / fault signal with zone number.

1.17.2 For accessing the LCD display a keypad operation shall be provided. The keypad shall have Help Menu and other functions controlled from either Function Keys or by a combination of keypad numbers. By using the Keypad one can scroll through the event list for at least a month.

1.17.3 The Processor shall be rugged with non volatile memory. Due to voltage fluctuations and change from normal to standby current there shall be no variation in the software or programmed logic sequence. The Repeater Panel shall be provided with a Buzzer / Sounder to indicate Alarm, which shall generate automatically in case of an alarm in the area to which the Repeater Panel is connected / programmed.

1.18.0 Addressable Input / Interface Module

1.18.1 The Input Module shall be used to receive signals from the NO / NC contacts such as Flow Switches. They shall also be able to be connected directly to a batch of Conventional Detectors and shall power the conventional detectors through it. Power Supply Unit, if necessary, shall be included in the cost of the Input Module itself. Power Supply Unit shall
include Rectifier and Step Down Transformer, as applicable.

1.19  **Personal Computer**

1.19.1  The P C shall be a personal computer (PC) based central, with full 32 bit processor (Intel Pentium Core 4 Duo or higher), 2.4 GHz minimum clock speed, minimum of 8 GB of RAM, 40GB ESDI hard disk drive, 19’’ TFT Monitor, high performance video graphics array (VGA) driver, high speed DVD-R/RW and all other miscellaneous components to meet the highest specifications. Notwithstanding the foregoing guidelines, the Work Station shall be to the latest state-of-the-art performance for similar systems and shall be operated by the use of an optical mouse connected to the station without the need of keyboard entry.

1.19.2  The PC shall be configured such that external media of any kind may not be loadable at Operator level which could pose the threat of external virus infection or compromise the operating system.

1.19.3  A Keyboard having 101-keys which includes full upper/lower case ASCII keyset, a numeric keypad, dedicated cursor control keypad, and a minimum of 30 programmable function keys.

1.20.0  **Addressable VIEW Detector**

1.20.1  The VIEW Detector shall allow for very early smoke detection by using of laser diode with lens and mirror optics. The light beam shall combine with the sensing algorithms to differentiate between the dust particles and actual smoke.

1.20.2  The detector shall provide for drift compensation, maintenance alerts. Its sensitivity shall be between 0.03 % to 1.0 % obscuration levels.

1.20.3  The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

1.20.4  The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).

1.20.5  The detector shall have a micro processor that shall have n environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The micro processor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector everyday.
1.21.0 **Addressable HARSH Detector**

1.21.1 The HARSH Detector shall provide early warning for Electrical areas. The Detector shall employ a fan to provide for air suction into the system. The detector shall be provided with a filter to screen out dust particles.

1.21.2 The filter shall be replaceable and the detector shall be resistant to water vapour.

1.21.3 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

1.21.4 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).

1.21.5 The detector shall have a micro processor that shall have n environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The micro processor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector everyday.

1.22.0 **Amplifier:**

1.22.1 The Amplifier shall be 4 x 240 Watts (RMS) and rack mounted and hard wired to each other. It shall be capable of running on 240 V AC or 12 / 24 V DC. The Amplifier shall have Dual Tone Control, Level Indicators and cater to complete frequency range.

1.22.2 The Amplifier shall be Rack Mounted within the housing of the Fire Alarm Panel. It shall have Microphone Channel Volume Control, Microphone / Auxillary Selector, Volume, Bass and Treble Control with LED type level Bargraph.

1.22.3 The Audio Signal Quality shall have a Frequency Response from 80 Hz to 16,000 Hz. Distortion shall be less than 5%.

1.22.4 Output for Loud Speakers should be operable from a 100 V Terminal for Line Matching Transformer type Speakers. The Amplifier shall also have the facility of direct dial-in and talk for certain restricted office telephones.

1.23.0 **P A System Accessories**

1.23.1 The P A System shall have multi channels and 6 Zone Floor Selector Console. The Zones shall be solid state card type, rack mounted in card slots. Cards shall be of Philips / AKG / Panasonic / Sony etc. The Console shall be fabricated from 16 gauge M S sheet and stove enamelled. All cards shall have push button controls. The Console shall also have push button type All Call facility. The Console shall be prewired and connected to the Fire Alarm
Panel through the Amplifier for automatic alarm / voice announcements through the Hooter / Speakers.

1.23.2 Other accessories shall be a goose neck cardoid microphone, professional grade cassette deck, change over panel for transfer from hooting to voice, mains panel for power supply and monitor panel all mounted in a rack of 16 gauge and stove enamelled complete as required.
2.0 **ACCESS CONTROL PANEL:**

2.1 The System shall include:

2.1.1 The System shall consist of Controllers for main entry.

2.1.2 Magnetic Locks shall be provided at all Staircase Doors. All Magnetic Locks shall disarm in case of a fire signal.

2.1.3 The panel shall be totally enclosed dust and vermin proof type made of 16 guage dust inhibited sheet with even baked finish. The panel shall be of microprocessor based solid-state design. The logic circuitry shall be based on high noise immunity solid-state hardware employing modular construction. Logic cards shall be of epoxy fiberglass construction. The system shall operate satisfactorily from 5 degrees C to 50 degrees C and 95 % humidity.

2.1.6 The Access Control Panel shall control entry or exit of staff and outsiders to the Office by the use of Proximity Cards, Card Readers and Magnetic Locks.

2.1.7 The panel shall be able to control entry / exit through the Main Entry Door including entry and exit card readers. The panel shall be microprocessor controlled with individual programming for different doors.

2.1.8 The door shall be programmable for complete locking, selective entry / exit for different card holders, selective refusal after defined hours for identified card holders and manual overrides. The door opening period shall also be programmable from 3 seconds onwards. Specific card holders such as handicapped persons shall be given extra door opening time.

2.1.9 The Panel shall be able to receive signals from all door at the same time, check the data, and by logic command sequence, provide input to the Magnetic Lock to release or lock the door.

2.1.10 The Door under normal conditions shall remain locked, and shall be openable only by the use of Proximity Cards or by Manual over ride.

2.1.11 The Manual Over ride (Push to Exit) (where ever provided) for the Entrance Door shall be from the Reception or by a Security Officer at the gate. The cost of the extra Manual Over ride including cabling and soft wiring shall be included in the cost of the Panel itself.

2.1.12 The Manual Over ride shall be used by the persons to supercede any door locking instructions from the Panel so as to facilitate the entry of any person without the use of a Proximity Card.

2.1.13 The time period of the closing of the door shall also be variable, depending upon the time required by the Owner to keep the door open. This facility shall be used for the entry or exit of Executives and VIPs.

2.1.14 The Panel shall be able to provide all necessary information through a PC, if so required, on the entry and exit of any person or persons over a period of time. The information shall be precise, giving the time of entry and exit including date and month. The PC shall store information of first entry of each person and last exit of the same person for each day.

2.1.15 The Panel shall be provided with non-volatile memory to log all events (minimum 24 hours) in its memory for a printout at a later period. Before any logging data is to wash, the Panel shall provide adequate and advance warning of the occurrence of such activity.

2.1.16 The Panel shall be capable of programming such that it shall store all data of specific person
or persons of their entry and exit for a month and more.

2.1.17 The Panel will receive information from the Card Reader, check with the pre-programmed input on the particular card and determine whether door Strike shall be unlocked.

2.1.18 The Panel shall have an inbuilt 7 Ah sealed maintenance free battery as standby in case of power failure. The Panel shall also be provided with an inbuilt voltage transformer to regulate power supply voltage.

2.1.19 The Bidder shall indicate along with the offer how Panel microprocessor failure shall be tackled. It is to be noted that in case of the failure of the Panel or any of its main components such as the microprocessor or other hardware, the doors shall be openable without recourse to dismantling of the door.

2.1.20 The Bidder shall also indicate how failure of any particular Card reader shall be attended. The failure of the Card Reader shall not affect the opening or closing of the door. If necessary, such instructions shall be given by the Panel superceding all instructions to the relevant Card Readers.

2.1.21 The Panel shall be programmable for routine Card Entry and Exit operations during normal office hours. During non-office hours, especially during late hours, the Panel shall be so programmed that it accepts Cards of only those persons authorized for such purpose.

2.1.22 The Access Control PC shall be connected to the Office LAN for off line printing of records.

2.1.24 These time zones shall be usable for:

Selecting different card access operation modes.

Automatic locking/unlocking of the controlled door.

Automatic arming/disarming of the intrusion monitoring modes.

Turning system timers on and off.

2.1.25 Each cardholder shall be assigned up to 16 access groups.

2.1.26 It shall be possible to pre-program up to 255 holiday dates so that all panel operations will change accordingly. The panel shall adjust itself to leap year computations automatically.

Protection against unauthorised tampering of the card reader keyboard with programmable time lockout shall be provided. When an invalid card has been used, the system shall be able to reject it. If multiple use of such an invalid card is attempted, the card reader shall be able to immediately reject reading any cards for a period of time. When such a card lockout occurs, the card reader shall inhibit all cards from gaining access for a period of time.

2.1.28 The card reader and panel shall have anti-passback programme feature built-in as a standard feature. Anti-passback shall be for a single door or a group of doors.

It shall be possible to temporary inhibit/lock out the card reader from normal usage by software so that no cardholders can gain access, until this mode has been reset.
Usage

Each cardholder shall be able to change his/her own PIN on the card reader itself without the needs of having it done at the central computers. Change of any cardholder’s PIN code shall not affect the rest of the users’ PIN codes.

When a new PIN is changed, the Controller shall broadcast the new PIN automatically, to all other Controllers where the same cardholder ID is stored, and to update them automatically. This is to enable user to enter the PIN at other card reader units using their new PIN.

Each Controller database shall have a memory capacity for a minimum of 20,000 cardholders (upgradeable to 40,000), each having a programmable 4 to 6 digits (Personal Identification Number) PIN codes.

The PIN for each card number in the database shall be unique. The capacity of the card numbers in the database shall not be decreased due to the use of PIN for each card.

It shall be possible to allow a cardholder to carry only one card, where that card can function as a normal access card, or as an arm/disarm card, or as a guard tour card, or a combination of any of these functions. All cards shall be generic in nature and the TCU shall be able to reassign the function(s) of each card.

The minimum type of card functions shall be:

- Normal access card
- Arm/disarm card
- Control on/off card (used for turning on/off equipment or functions)
- Dual card sub-function feature

Time limited use card with a start and expiration date. This is especially so for Visitors.

It shall be possible to control the use of any type of card, both during and after office hours.

It shall be possible to program cards for a limited number of days use only, such as for contract workers.

2.2  CARD READER :

2.2.1  Proximity type cards shall be used. The Card Reader shall be able to read the encrypted cards and transmit the information to the panel. The card reader shall have a internal reader that shall decipher the card number including accuracy of the information. An LED shall indicate that the card has been accepted. The green LED shall indicate that the cardholder can proceed on opening the door.

2.2.2  The Card Reader's MTBF (Mean Time Between Failure) shall also be indicated by the Bidder.

2.2.3  The Card Reader shall be able to scan data from 75 mm distance and transmit the same to the Panel.

2.2.4  Access Control for Basement Car Parking shall be provided with Active Card Reader.

2.2.5  Additional Proximity Cards shall be provided for visitors along with complete colour tags.
2.3  **PROXIMITY CARD:**

2.3.1  The Proximity Card shall be Wiegand protocol Reader. The card shall be rigid without being crimped or folded. The data shall also be scratch, etch, dust and moisture resistant.

2.3.2  The Card shall not be easily foldable unless the Card can withstand the stress and still provide accurate data to the Card Reader.

2.3.3  Scratches and other minor abrasions on the surface should not affect its performance.

2.4  **Automatic Magnetic Door Release Unit**

2.4.1  The function of Door Release Unit shall be to keep doors closed until disengaged by the Controller. The Door shall normally be in closed position. The Door shall be provided with a top end mounted Door Closer. The Door and Closer shall be provided by Owner. Power supply unit shall also be provided by the Bidder complete as required.

The System shall work either in 24 V or 220 V with a 300 Kg holding force. The Equipment shall also have a Push Button Release facility. The Door Plate shall be fixed to the shutter of the Door and a solenoid unit located in the frame. The Unit shall be continuously energized to operate the magnet. In case of a positive Card Reader fire the unit shall be demagnetized so as to release the door.
1. STANDARD DETAILS

2. TENDER DRAWINGS
# STANDRAD DETAILS

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# METROLOGY (STANDARDS) BLOCK AT NPL, NEW DELHI

## TENDER DRAWINGS

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