

TECHNICAL SPECIFICATIONS

1.0. SCOPE OF WORK:-

The scope of work covers all INTERIOR REMODELING/RENOVATION, FURNITURE & FURNISHING, CIVIL WORK INCLUDING ELECTRICAL, HVAC & FIRE FIGHTING AT I-200, 2nd FLOOR AT WORLD TRADE CENTER NAUROJI NAGAR NEW DELHI- 110029 .

Broad scope of work -

- Civil Works including removing of existing lobby flooring, Toilet walls and rebuilding as per new layouts and re-plastering the walls / Ceiling wherever necessary.
- New flooring with PCC (Marble, Granite, Vitrified tiles, Wooden, Carpet flooring etc.), using Cement Mortar / tile pasting adhesive on the existing flooring.
- New dado work in tiles/ wall papers/ laminate/ back-painted glass/ mirror/ fabric/ acoustic panels/ decorative films/ texture paint etc.
- New False ceiling, as per approved elevation and of required type, including trap doors, under-deck insulation etc.
- Door works, as per the specifications as approved.
- Painting/ polishing/ finishing as per specifications as approved.
- Providing Aluminum partitions /wooden partition/ cupboards/ shelves in plywood board & laminate/veneer etc. as approved.
- Providing frameless glass partitions, Aluminum glazed partition, doors, etc. as approved.
- HVAC ducting and VRV and Electrical system including mechanical ventilation, low side ducting, electrical works, power distribution, suitable illumination and other associated services works as approved including integration with existing system.
- Internal signage of approved type and art-work
- Furnishing work, blinds of approved types, etc.
- Fire Fighting Works.
- Kitchen Works.
- The Scope of Work (SOW) described above is indicative. The items or part of work which are not clearly defined in this document but are required to be carried out for successful completion and commission of the proposed structure shall be deemed to have been included in the scope of work and the bidder shall have to carry out such jobs as per the best industrial practice with due approval from Architect/ EIC at no extra cost.
- As the new infrastructure is to be developed in an existing building, the planning and execution should include developing of a proper plan including integration of existing with proposed Air Conditioning, Lighting, Power distribution, etc. complete without disturbing the essential services to the rest of the building.
- Obtaining the approval for Shop Drawings finally from Architect/ EIC before execution.
- Project Management and quality control by deploying Competent Technical Personnel without any additional cost to **SBICAPS**.

- Materials used shall be as per the approved makes. No materials shall be used without the prior approval of Engineer- In-Charge.
- Sufficient number of samples/ display boards shall be submitted to facilitate approval of finishing and other items.
- Site is situated on 2ND floor and materials is to be taken up by service stairs only and labour/ workers not to use main lifts for material lifting and travelling.
- Contractor to build a temporary site office approx. 12' x 10' with all facilities of partitions, ceiling, electrical points, lights, fans, table and 5-6 chairs with a computer P.C. and printer for any necessary prints or changes required on site as per EIC.
- If required contractor shall provide **mock-up** of cabin, fittings and finishes etc. for better understanding and prior approval of the Purchaser, without any extra cost.
- All ancillary items/equipment's required to complete the job shall be responsibility of the contractor.

2.0. FACILITIES TO BE DEVELOPED:-

For the office space complete with furniture and systems/services:

- Open Office Seating
- Independent cubicle seating
- Cabin Seating
- Cabin seating with attached Secretary
- Conference Room/ Meeting Room – as per design
- Storage area/ Compactor area
- Breakout spaces
- Lobby area

Common facilities:

- Meeting Room/ Conference Room area with various sizes of meeting room, conference room.

3.0. LIST OF APPROVED MAKES:-

Standard Makes from Quality / Reputed Manufacturers to be considered.

4.0. DISMANTLED MATERIALS:

The dismantled material (unserviceable) retrieved from the site during execution of renovation works in existing area will be the property of the contractor and same to be removed from site on regular basis. All serviceable material will be property of SBICAPS and to be deposited/stacked properly in building or in the campus near by the building as per instructions of EIC.

5.0. SAFETY / SITE CONDITIONS- HEALTH & SAFETY STANDARDS TO BE ADHERED TO:-

As part of its proposal, the bidder must take full responsibility for the adequacy, stability and safety of all site operations and ensure that the methods of carrying out the work and the project by the bidder including his workers, employees, sub-contractors and vendors meet all the necessary safety standards and requirements of the HSSE standards of **SBICAPS**.

Bidder must follow covid appropriate behavior at the site according to guidelines of **SBICAPS** and the government (state/centre) that may change time to time and bidder should be well aware about it. All materials/ equipments required to follow safety guidelines, covid-19 appropriate behavior etc. must be

supplied to the workers, employees, sub-contractors and vendors of the executing agency by the bidder only like safety belt, helmet, safety shoes, PPE kit, gloves, sanitizer, mask, face shield etc.

6.0. OTHER CONDITIONS

TECHNICAL SPECIFICATIONS: Dismantling, Interior, Civil, fittings, finishes, electrical, HVAC etc. In case of any arbitration, disputes or difference whatsoever arises related to scope of work, specifications, mode of measurements or any other information that may not be available in this scope of work then CPWD specifications and/or relevant Indian Standards (IS codes) shall be referred.

7.0. GENERAL CONDITIONS

1. All Materials brought on site of works and meant to be used in the same shall be the best of their respective kinds and to the approval to the EIC.
2. Samples of all materials shall be got approved by the EIC and shall be deposited with him before the order for the material is placed with the suppliers. The material brought on the works shall confirm in every respects with approved samples.
3. The contractors shall check each fresh consignment of materials as it is brought on the site of the works, to see that they confirm in all respects to the satisfactions and/or samples approved by the EIC.
4. The EIC will have the option to have any of, the materials tested to find whether they are in accordance with the satisfaction and the contractor will bear all expenses in that connection. All bills, vouchers and test certificates which, in the opinion of the EIC or the representative, as necessary to convince him as to the quality of the materials of their suitability shall be produced for his inspection on requisition. Testing charges, if any shall have to be borne by the contractor.
5. Any material that have not been found to confirm to the specification will be rejected forthwith and shall be removed from the site by the contractors within 48 hours at their own cost.
6. The EIC shall have power to cause the contractors to purchase and use such materials, from any particular source, as may in his opinion be necessary for the proper execution of the work.
7. Workmanship: All works shall be to level plumb and square comers, edges and arises in all cases shall be unbroken and finished neat.
8. Skilled labour for the respective trades shall employed by the contractors to check to the work in progress and to instruct and extract the right kind of workmanship from the men employed on the works, Instructions given to such miseries by the architect or his representative shall be carried out with a view to get the work executed in a neat and workman like manner according to these specification.
9. The EIC may order the inspection of any finished work as he chooses and in a manner he decides, and the contractors shall bear all expenses in the connection. If the results of such inspection prove that the workmanship is not of the standard required, the work will be rejected and removed forthwith and he replaced by works of the accepted standard of quality.

8.0. WORK DETAILS

A. DISMANTLING WORK

The term ‘Dismantling’ implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified in BOQ or shown on the drawings.

1. Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided, as directed by the Engineer-in-Charge. It shall be ensured that no dust is generated while demolishing. Demolition Rules – 2016 shall be followed.
2. Necessary steps shall be taken to keep noise and dust nuisance to the minimum. All work needs to be done under the direction of Engineer-in-Charge. Helmets, goggles, safety belts etc., should be used whenever required and as directed by the Engineer-in-Charge. The demolition work shall be proceeded with in such a way that it causes the least damage and nuisance to the adjoining building and the public. Barricading shall be provided as per NGT guidelines
3. Dismantling work to be done at all heights including all tools and scaffolding.
4. It shall be carried out with proper safety measures and without hampering other activities and services running on other part of the building or the floor.
5. All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.
6. **Making opening in the masonry construction and fixing chowkhats for doors, windows and clerestory windows** Before making opening it is necessary to examine that the wall exclusive of opening is adequate to take the load coming on the structure. All the structural members supported on the walls which have direct bearing over the area in which opening is to be made, shall be properly supported with props to relieve the load from masonry wall till the lintel over the opening is strong enough to take the load. Care should also be taken not to disturb the adjoining masonry.
All precautions as explained and/or safety guidelines of **SBICAPS** should be followed in case of dismantling the external walls. The portion to be dismantled may be clearly marked on both sides of the wall. Dismantling shall be carried out from top to bottom within the marked area. The sides of the opening shall be as far as possible, parallel and perpendicular to the plane of wall.
7. Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.
8. The contractor shall maintain/disconnect existing services, whether temporary or permanent, wherever required by the Engineer-in-Charge.
9. Safety belts shall be used by laborers while working at higher level to prevent falling from the structure. Wherever, possible mechanized working platform shall be used.
10. First-aid equipment shall be made available at all demolition works of any magnitude.
11. **The rate shall include** the cost of all labor involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 meters. The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

B. PARTITION WORK

1. All internal woodwork / Plywood shall be treated with anti-termite preservative. All internal frame work shall be of Aluminum unless otherwise specified as Teakwood. All exposed edges of Plywood shall be fixed with C.P. Teak Lipping of size as directed by Architect. The skinning shall be in BWR Plywood unless otherwise specified.

2. Frame Work -

First of all the shop drawings for each type of partitions/doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminum sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, partitions, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge.

3. Fixing of Frames

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with an appropriate electric drill. Partitions/Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

Where aluminum comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows, partitions etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

4. The Partitions & Paneling shall be inclusive of providing & fixing in between the aluminum frames, 50mm thick Rock insulation Slabs of Rockwool India Ltd of density 96 kgs / cumt of standard width as per the available clear distances between the existing frames as directed wherever required & instructed including above false ceiling framework (paid in separate items).
5. Measurement of Partition & Paneling shall be limited upto the False Ceiling level. However the cost towards any additional support for frameworks to be fixed to the main ceiling shall be deemed to have been considered in the quoted rates and no separate payment shall be made for supporting elements of partitions / paneling items, above the false ceiling level.
6. The rate shall be all inclusive of the necessary hardware, fittings, and fixtures & including glass & finishing for the same. The rate shall be also inclusive of pattas & bands, grooves at any level, any design in veneer, textures etc. including the necessary framing/ openings for Electrical, Telephone & AC outlets. Further it is important to note that the Glasses wherever specified for the items of Partitions & Paneling if any shall have polished edges as per the direction & thickness as indicated by the Architect or Engineer in charge.
7. The rates quoted for the Items of Partitions & Paneling of any / all types shall include the cost towards providing and fixing additional 75mm wide Patta raised over and above the given ply for design including designer grooves etc. complete as per the instructions and to the complete satisfaction. Nothing additional would be paid on account of any pattas / bands provided for the said items.
8. Measurement of height shall be taken from finished floor level up to the level of False ceiling, in case of varying heights on either side of partition, average height shall considered. The rate to include Provision of extra frame work as necessary for skirting and making cutouts for electrical switch plates, switch boxes, light fittings light etc. making provision for laying conduit; as per drawings & directions. In case of wood framework to be applied with 1 coat of anti-termite wood preservative.
9. Full Height Half- Glazed Partition
Same as in full height partition but partly glazed partition with 12mm thick toughened clear glass /as per BOQ and detailed drawings & with wooden partition below as per partition specifications etc., Complete as directed with infill and also 12 mm aluminum channel to be provided at the intersection of two materials.

10. Full Height Glazed Partition

Full Height Double Glazed Partitions to be provided with 12mm thick toughened glass using 54mm x 25mm x 2mm thick modular sections as per BOQ and approved by EIC channel on top and bottom, including cutting groove in the floor to fit channel and the gap is filled with GE silicone gel and top with MS framework to fix the channel and painting the MS framework with enamel paint, complete as per drawing and directions of engineer in charge

11. Partition Above False Ceiling

Partition above false ceiling with AL frame of 25mm x 50 mm or 50mmx50mm as per specs at 600mm x 600mm c/c. Frame to be fixed to the ceiling. All internal frame members to be screw fixed. Internal voids to be glass wool in filled for soundproofing. No finishing required. Provide required cutout for Return Air passage.

C. FLOORING WORKS

1. Marble Stone Flooring

Dressing of Slabs

Every Stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The Sides and Top surface of slabs shall be machine rubbed or table rubbed with coarse sand before paving. Thickness of the slabs shall be 18 mm as specified in the description of the Item. Tolerance of +3% shall be allowed for the thickness. In respect of Length and Breadth of slabs a tolerance of +2% shall be allowed

Polishing and Finishing

Slight unevenness at the meeting edges of slabs shall then be removed by fine chiseling and finished in the same manner as specified in except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

Measurement

Marble/ Granite stone flooring with different kind of marble shall be measured separately and in square meter correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meters.

2. IMPORTED MARBLE

Before Installation The Floor surface should be scrubbed clean with PH neutral water and wiped dry so as to ensure that no dirt, dust, grime or chemical residue remains, otherwise bonding will be ineffective Blend well the cement mortar for even distribution. Well blended mortar should have high structural strength and a high bonding force, so that heavy load will not damage the marble Installation Evenly spread cement paste on the surface followed by spreading the well blended cement mortar to a height of ADHESIVE Product Detail Gray

- Polymer modified, Cement based the adhesive should be suitable for fixing ceramic wall & floor tiles, Vitrified Tiles, Glass Mosaics.
- Surface Preparation Surface to be tiled must be dry, clean and free from all contamination, and should be suitable surfaces
- Mixing And Application Add clean water adhesive and mix thoroughly until a slump- free mortar is obtained A20 Kg. bag will require approximately 6-8 liters of water. The adhesive should be left for 30 minutes. Spread no more than 1 sq.mt at a time, apply the adhesive to the wall or floor surface. Comb the adhesive to the required depth (between 3-5mm) using a suitable trowel. Stones shall be press

firmly into position with a slight twisting action, checking periodically that good contact is maintained with the back of each piece. Leave no voids behind stones when solid-bed fixing, leaving adequate joints between individual wall and floor tiles unless self spacing tiles are used. Clean off surplus adhesive from the tile face and between joints.

- All finished Floorings tiles or marble/ granite etc. are to be covered with suitable thick polythene sheets and a layer of P.O.P spread evenly on top, for saving the finished surfaces from scratch and breakages. Nothing extra will be paid and will be considered included in the item rates.

Pre polished/ Flamed Granite slab in flooring

The granite/stone shall be of approved COLOR & shall be out of sufficient lot to cover the particular area to avoid lot/shade variation. Granite slab shall be quarried stones, hard, sound, durable and free from weathering and decay and defects like cavities, cracks, holes injurious veins, patches of soft materials and such other defects adversely affecting its strength and its appearance.

Mortar shall be composed of cement and sand unless otherwise specified. All mortar shall be prepared in accordance with IS 2250. The proportions of mortar measured by volume shall be as specified. A layer of mortar shall be spread on full width over a suitable length of the lower course. Each slab shall be properly bedded and set in position by gently taping with handle or trowel or wooden mallet. The inside faces shall be buttered with mortar before the next slab is laid and pressed against it. The joints may be either paper cut or with spacing width.

3. GRANITE LAYING

The laying of granite in Staircase treads, Lift lobby dado, landing and Risers shall be similar to laying of granite flooring as above, except that.

- The slabs cut shall be from one single piece, joints shall be paper joint, the edges shall be treated as shown in drawings.
- Anti-skid grooves shall be provided for every Tread and Landing as per detail drawing. the treads and Landing shall be projecting a minimum of 20mm from the top face of the riser.
- The cut is to be polished either on-site or at factory.
- The edge of the treads shall be fully bull-nosed / chamfered & polished to gloss as per detail drawing or approved by Engineer-In charge.

4. GRANITE SKIRTING

The pre-polished granite shall conform to the specification or requirement as that of Granite used in flooring/staircase. The thickness of the Granite used shall be 18-20mm thick and it is fixed over a backing coat of cement mortar of 1:4 of 12mm thick with a cement paste backed on the back of the granite tile. The height of the skirting shall be 100mm or as specified the top edge of the skirting shall be treated as shown in the drawing. The joints of the granite strip used in skirting are to be less in numbers and it shall be paper cut joint. The paste oozing out is wiped in a cloth and washed with water. The curing is to be for a minimum period of 7 days.

5. Italian Marble Stone Flooring

Italian marbles Quarried and processed in Italy and these marble raw stones are imported from Italy to India. Italian marble is famous for rendering a high sheen and visual appeal to the ambience in which it is installed. It is available all over world.

Italian Marble gives the rich appearance to the house floor, walls, Kitchen, rooms and bathroom with its beautiful color and special lusters. Because of its elegant visual, it is commonly used for the decorative purpose in buildings.

Other details such as dressing of slabs, laying, polishing, finishing, measurements and rates shall be as specified in the place of Indian marble stone.

6. Flamed Finished Granite Stone Flooring

The process is often referred to as a “flamed” or “thermal” finish and can be best described as creating a textured look. To achieve the style, an intense flame is held at the stone's wet surface. While firing it, the surface becomes so hot it bursts and a layer flakes away to reveal a rough, even texture. It is especially used at a location of high importance to have a great finish for designs requiring a modern aesthetic. Other details such as dressing of slabs, laying, polishing, finishing, measurements and rates shall be as specified in the place of Indian marble stone.

7. Wooden Flooring

Seasoning and Preservation

All timber used for timber floors shall be thoroughly seasoned in accordance with IS 1141. After seasoning the timber shall be treated with preservative in accordance with IS 401. Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

Boards

It shall be of the class of timber and thickness specified in the description of the item. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall not be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planning shall be paid for extra. Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the square butt type and shall occur over the centre line of the supporting joists. Heading joints in adjacent boards shall be placed over the same joists.

Fixing

The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminum) at the junction. The metal strip shall be fixed to the end of the planks by screws.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.

The floor shall be planned in both directions and made perfectly even, true and smooth.

8. Flooring Ceramic Tile / Vitrified Tile Flooring / Dado / Skirting

The ceramic tile shall be of approved quality, make, color, size and shape or as specified in drawings. On the approval of the sample by the Engineer In-charge, the order for the tiles shall be placed from one source and procurement done preferably from one batch/consignment to prevent any shape/shade variation. Tiles to be sorted out at site before laying.

The floor surface over which the tiles are to be laid shall be properly cleaned and wetted. 3 to 6 mm Solid bed of BALCEM GOLDSTAR or equivalent (POLYMER MODIFIED CEMENTITIOUS ADHESIVE) & in conjunction with BAL-ADMIX AD1 (POLYMER MODIFIED LIQUID) shall be applied over an area adequate

to accommodate about 20 tiles at a time. Tiles shall be washed clean and pressed on to the grout and gently tapped in its proper position. The tiles shall be placed perfectly side by side so as to have fine joints truly vertical and horizontal and in level with adjoining tiles.

The joints shall be as specified in the drawing, if grooves are to be provided, it shall not exceed 1.5mm or as specified in the drawing, and shall be done using spacers of approved quality. The excess content slurry bulging/oozing out in joints shall be removed by wiping immediately. Joints between the tiles to be filled with BAL GROUT to match the COLOR of tiles as per the manufacturers' specifications (COLOR as approved by EIC).

Thereafter, the joints shall be raked out to the required depth and loose cement/mortar shall be revved and joints shall be cleaned.

In the case of the dado, the wall surface shall be cleaned and plastered with Cement mortar 1:4 to a thickness of not less than 10 mm to form a uniform backing surface and finished rough and allowed to harden.

The tiles, which have been soaked in water, shall be cleaned and cement paste of butter-like consistency applied to the backside of tiles and the tiles shall be pressed on the wall face and gently tapped in its position. In this way, tiles shall be placed one after another starting from the bottom line and lay upwards.

The joints shall be truly vertical and horizontal, where required spacers – glass strips or ceramic strips – are used to achieve spacing between tiles of width as specified in the drawing, and the tile surface shall be of infirm level in all directions without any depressions and dulling which shall be tested by a straight edge as directed by EIC/PMC.

Curing and pointing of tiles in Dado shall be carried out as specified for flooring and as directed by Engineer In charge.

D. HARDWARE & METALS:

- Tables side units back units consoles or other articles as per schedule of quantities shall be deemed to be inclusive of all the hardware required e.g. locks, sliding channels handles / knobs, bolts screws PVC buffers for the legs of sofas chairs tables etc. as per instructions of engineer in charge.
- Screws are to match the finish of the articles to be fixed and to be round or flat headed or counter sunk as required.
- The contractor should cover up and protect the brass and bronze surfaces with thick transparent grease or other suitable protective materials renew as necessary and subsequently clean off and clear away join completion.
- Aluminum and stainless steel shall be of approved manufacturer and suitable for its particular application. Generally, surface of aluminum shall have an iodized finish or powder coated finish and both shall comply with the samples approved by the EIC All stainless steel sheets shall be 304 S.S. Japan or equivalent with gauge as specified but not thinner than 16 gauge. All exposed steel surfaces shall also have powder coated finish and shall completed with samples approved by EIC.
- All steel, brass, bronze, aluminum and stainless steel articles shall be subjected to a reasonable test for strength if so required by the EIC at the contractor's expense.
- All branching and welding are to be executed in a clean and smooth manner rubbed down and left in the flattest and tidiest way, particularly where exposed.
- Chromium plating shall be in accordance with IS standard or as per approved specification for normal outdoor conditions and shall be on a base material of copper brass or as specified.

E. PAINT AND POLISHES:

- All materials required for the works shall be of specified and approved manufacturer, delivered to the site in the manufacturer's containers with the seals, etc., unbroken and clearly marked with the manufacturer's name or trade mark with a description of the contents and color. All materials are to be stored on the site of the work.
- Spray painting with the approved machines will be permitted only if written approval has been obtained from the Engineer In charge. The paint used for sparing is to be specially prepared by the manufacturer for spray Thinning of paint made for brushing will not be allowed.
- Wood preservative shall be Ascu Green Saver or any other equal and approved impregnating wood preservative at all concealed wood work shall be treated with wood preservative.
- All brushes, tools pots, kettles, etc. used in carrying out the work shall be clean and free from foreign matter and at to be thoroughly cleaned out before being used with a different type of class of material.
- All iron or steel surfaces shall be thoroughly scraped and rubbed with wire brushes and shall be entity free from rusting mill scale etc. before applying the priming coat.
- Surfaces of new wood work which are to be painted are to be rubbed down and cleaned to the approval of the EIC.
- All exposed teakwood surfaces and teak ply surfaces and surfaces which are not treated otherwise shall be finish with stained polish to the required shade and melamine matt finish.
- All exposed cedar wood surfaces and clear ply surfaces shall be finished with ready mixed wax polish to give natural shade.
- The tendered rates shall include cost of seasoning and providing wood preservative and as given in the specification

1. Polish:-

- Pure shellac varying from pale orange to lemon yellow color free from resin or dirt shall be dissolved methylated spirit at the rate of 140 gm of shellac to 1 liter of spirit. Suitable pigment shall be added to get the required shade.
- The surface shall be cleaned. All unevenness shall be rubbed from smooth with the sand paper and well sets if variable shall be covered with a preparation of red lead and the surface filler by mixing whiting (ground chalk) in methylated spirit at the rate of 1.50kg of whiting per liter of spirit. The required staining agent shall be added to get the required sand. The surface shall again be rubbed down perfect smooth with glass paper and wiped clean.
- The polishing rubber, the most important implement in French polish shall consist of a pad of cotton wool, which acts as a reservoir for the polish and a soft white linen or cotton fabric similar to a well worn handkerchief, which acts as a filter. The rubber must never be dipped in to the polish. It should be charged by pouring the polish on the pad with the cover remove.
- The surface shall be worked upon evenly a slow figure of eight motion until the surface is coated with a thin layer of polish. The object shall be to apply a series to thin coats, allowing only a few minutes for drying between the coats, when a level and even bodied surface is obtained the work is considered ready for the second stage is spiriting off. Allowing the work to stand for at least eight hours, a fresh rubber with a double thickness of cover material shall be rubber with a double thickness or cover shall be taken and charged with methylated spirit. The surface shall be sprite off to remove the rubber marks and to give the brilliance of finish. The rubber shall be worked in the direction grain an continued till the surface is free from smears and rubber marks and left to harden off.

2. Melamine Finish:

Melamine finishing shall be done on wooden surfaces. The finish shall be Matt, glossy, semi-glossy type which shall be as approved by the Engineer In charge.

All uneven and rough surfaces shall be rubbed-using sandpaper of the required grades till a smooth surface is obtained and the surface shall then be well dusted. The nail marks/ pores in the wood shall be filled with wood filler and the surface shall be rubbed with the required grade of sandpaper so that the entire surface is uniformly smooth.

After preparing the surface as specified above, the application of a sealer coat shall be done. Wherever necessary the pores in the wood shall be again filled with wood filler and the surface shall be rubbed with the required grade of sandpaper in the presence of water so that the entire surface is uniformly smooth. Staining as required shall be done manually, application of the second coat of sealers shall be done. Finally, 3 coats of Melamine spraying, strictly under dust-free condition, shall be done, after which the surface is buffed with Wax & Oil.

The Specialists/Manufacturer's specification/instruction in using the product shall strictly be adhered to, in preference to the specification in the contract. It is preferable to carry out the process under warm weather condition. The spray gun before/after using shall be cleared thoroughly using thinner or spirit.

F. WOOD WORK / FINISHES

CARPENTRY / JOINERY

Scope of work includes Materials such as wood, labour for joinery of wooden frame and shutter, fixing of the frame and shutter, fixing of laminates or veneer, fittings and fixtures and such other related carpentry works. Wood for Furniture shall be approved, seasoned and 1st class Teak wood/ Steam Beach wood. It shall be fairly uniform in COLOR and texture. It shall be free from blemishes, hollow pockets and knots, spirals or twisted grain, warp and any kind of decay or insect attack, cupcakes, door holes, splits, cracks, pinholes, wormholes etc.

Wood shall be kiln seasoned before being planned to the required sizes, in accordance with IS 401-1982. Samples of seasoned wood and Commercial Boards/Plywood's shall be submitted to PM for approval, before placing an order. The contract shall get the wood and Commercial Board/Plywood sample tested in an approved laboratory. If desired by the PM, the Contractor shall submit all information such as manufactures/brand name, test certificate etc.

The contractor shall submit a test certificate in support of the kiln seasoning including ASCII treatment for the entire quantity of timber required for the work from the factory where seasoning has been done.

Commercial Flush Shutters of thickness 19/32/33 mm & 45 mm and of size as specified in drawings shall be solid core type with block board core and shall conform to IS 2202 1983 – part I (specification for wooden flush door shutters solid core type) IS 1003 part 1 and 2, IS 3097. Flush door shutters shall be free from twist or warp in-plane, and the four edges of the shutter shall be square. Both faces of shutter shall be sandpapered to a smooth and even texture. Tolerance on nominal thickness shall be + 0.8 mm. The thickness of shutter shall be uniform throughout with the variation not exceeding + 0.8 mm when measured at any two points.

All commercial shutters shall be internally lipped using approved wood, pressed and ready from the factory directly. In the case of double leafed shutters, rebating shall be as indicated in drawings and directed by the Engineer In charge. Where separate lipping is provided, the depth of lipping at the meeting of styles shall not be less than 35mm.

Shutters shall not be damaged during transportation, storage and fixing. Damaged shutters shall be rejected and shall be replaced with the new shutter as directed by the Engineer In-charge whose decisions will be final and binding in this regard. From the time the shutters are procured to the time they are taken up for fixing in position, the shutters shall be stored in a proper manner with adequate supports so as to avoid damages to any part, particularly the edge.

The Flush shutter shall be laminated with a plastic laminate sheet or veneer, whose samples shall be submitted along with manufacturers' brand name, test certificate etc to the PMC for approval before placing an order. The laminate/veneer sheet is protected with building paper until ready for use.

The average moisture content of all the WOODEN samples from a lot shall be within + 4% and moisture content of individual samples + 6% of the maximum permissible moisture content. For this purpose, the site of work shall be deemed to fall under climatic zone II. Seasoned wood as per IS 1141 –1973 and IS 287 – 1973 shall be the basis of acceptance.

Timber sections for frames shall be planed smoothened to accuracy on all sides to the full dimension, rebated, rounded, chamfered or moulded as shown in drawings or as directed by PM without patching or plugging of any kind before they are framed and jointed. A tolerance of + 2 mm shall be allowed in the finished cross-sectional dimensions.

The joints shall be of mortise and tendon or tongue & groove type simple, neat and strong. Joints shall fit in fully and accurately without wedging or filling. The joints shall be glued, framed, put together and pinned with hardwood or pins not less than 10 mm dia, sash bars if any shall have metered jointly with styles. Putty, where used, shall conform to IS 419-1967 and shall be a homogeneous paste and shall be free of dust, grit and other visible impurities.

After the frames are put together, they shall be pressed in position by means of a press. The contact surfaces of tendon and mortise joints shall be treated (before putting together) with bulk type synthetic resin adhesive of a make approved by the PM. Rails, which are more than 180 mm in width, shall have 2 tenons. Styles and shutters shall be made out of a single piece and shall have a 12 mm groove to receive panels.

Before the frames are fixed in position, these shall be inspected and passed by the Engineer In charge. The frame shall be placed in the proper position, secured to walls or columns as the case may be, with bimetallic fasteners, iron holdfasts etc. as shown in drawings and directed by the Engineer In charge. In case of doorframes with sills are provided, these sills shall be embedded/sunk in the floor for the full thickness of the floor. The doorframes without sills, while being placed in position, shall be suitably strutted and wedged in order to prevent warping during construction. The frame shall be protected for damage during construction. Where glazed openings are indicated, the size, thickness and type of glazing shall be provided as in the drawings and shall be lipped internally with Teak wood/ S. Beech wood. Shutters shall have provision for mortise locks where so indicated on drawings or as directed by the Engineer In charge.

Shutters shall be checked after fixing for proper location, alignment and swinging. After fixing all the fittings the shutters shall be tried again for proper closure, handling and easy movement etc., and any defects noticed should be immediately rectified as directed.

1. TIMBER:

- The timber shall be of the species stipulated in the schedule of Quantities/Drawings.
- Teak wood shall be of C.P. Teakwood variety.
- Wood for frame work/ rough wood shall be teak wood even though drawings may show Mirant/ hillock.
- All dimensions given in the schedule of quantities and drawings are the required finished size.
- Timber shall be well seasoned and kiln dried with a moisture content of 12% nominal +2% for teakwood. The contractor should get the timber tested for moisture content of wood at his own cost as per the directions of the EIC.
- All timber shall be treated with preservatives and anti termite chemicals as directed.
- All timber shall be free from worm holes, loose or dead knots or other defects and shall not suffer from warping splitting or other defects. All timber shall be approved by the EIC before use.

2. MDF BOARD/BLOCK BOARD/PLYWOOD/PARTICLE BOARD:

- MDF boards block boards/plywood/particle board etc. as specified in the approved list of manufacturers shall only be used.
- Only B.W.R. grade phenol formaldehyde bonded boards to be used.
- MDF board shall comply with I.S. 12406-1988. Manufacturer's specification shall be followed in the use of MDF boards for the various usages.

3. PLYWOOD :

Plywood for general purpose shall confirm ISI 303 iV 1975. It shall be of B.W.R. grade in the specified thickness for the commercial type B.W.R. grade plywood, Intermediate veneers in two opposite grain direction shall be 1:1. The moisture content shall not be more than 12.5% by mass. It shall be of approved make. Where B.W.P. grade is specified it should be boiling water proof conforming to I.S. Standards.

4. MELAMINE FACED PARTICAL BOARD:

It should be three layered wood based particle board, such as Nova pan melamine faced pre-laminated on both sides. Particle board should be ISI 3087FPTH (type II, 1965) marked on edges and should also confirm to German Din Standard viz DIN 66761. It should impart good bending strength, modulus of elasticity, internal bond strength and screw holding strength. Melamine faced surface should be resistant to crack at 100 and should pass cigarette burn test.

5. GYPROC FIRELINE BOARD

Gyproc Fireline Board is gypsum based interior Wall & Ceiling product used in areas where High Fire Resistance Performance is required to restrict fire to pass from one side of wall to the other side.

Gyproc Fireline Board's gypsum core incorporates glass fibers & other fire resistive additives that are encased & firmly bonded to strong pink colored paper liners. It provides fire resistance from 60 Minutes to 240 Minutes in Wall, Ceiling, Shaft wall & Beam / Column Encasement systems. Below are standard size details:

Thickness	Width	Length	Edge type
9.5 mm	1220 mm	1829 mm	TE/SE
12.5 mm	1219 mm	1829 mm	TE/SE
12.5 mm	1219 mm	2438 mm	TE/SE
15 mm	1219 mm	1829 mm	TE/SE
15 mm	1219 mm	2438 mm	TE/SE

Manufacturing Standard: EN 520:2004, Type F ASTM C1396, Type X

Properties: Thermal Conductivity: 0.24 (w/m²K)

Thermal resistance: 0.05 for 12mm thick board

0.06 For 15mm thick board

Board Colour: Pink face paper

Brown reverse side paper

Edges: Taper edge along length of board

Square edge along width of board

Flexural breaking load of Gyproc Firestop as per EN 520: 2004, Type F :

For 12.5 mm board: Transverse direction (N) = 210 , Longitudinal Direction (N) = 550

For 15 mm board: Transverse direction (N) = 250 , Longitudinal Direction (N) = 650

6. GYPROC HABITO BOARD

Characteristics of Habito board : Calcium sulphate dihydrate encased in paper liners, with glass fibers and other additives. The Habito boards are part of a new generation of products specially designed to give flexibility of loading anywhere on the drywall to utilise space in a fast and functional way.

It Complies with EN 520:2004 – Type A, D, R, I. standards.

Properties:

Thermal Conductivity: 0.24 (w/m⁰K)

Thermal resistance: 0.05 (m²K/w) for 12.5mm thick board

Board Colour:

Faced with ivory coloured paper

Reverse faced with brown coloured paper

Edges: Taper edge along length of board

Square edge along width of board

Flexural breaking load of Gyproc Habito Board as per EN 520: 2004, Type A,D,R,I :

For 12.5 mm board: (size 1220x2440) Transverse direction (N) = 850 , Logitudnal

Direction (N) = 1100

7. PRE LAMINATION / VENEERING TREATMENT

Before Lamination/Veneering the Commercial Flush board with Laminate/ Veneer sheet, the surface to be laminated/veneered should be thoroughly cleaned, all cracks and nails holes filled as directed. The laminate sheet shall be fixed using the approved quality adhesive recommended by the manufacturer and applied strictly in accordance with their instruction/specifications. The adhesive shall be applied on both member in a thin layer and while still tacky, it shall be spread evenly with steel in both directions to assume full contact with the adhesive / Fevicol / SR. A constant and even pressure is applied for not less than 24 hours to ensure good bonding of the sheet to the board. The laminate/veneer surface shall be cleaned as recommended by the manufacturer of all stains/ adhesive marks etc.

All Wooden and Veneered surface shall be water cut melamine finished after it has been approved and passed by the Engineer In charge. All portions of timber-built into masonry or abutting a concrete portion of the building or buried in ground shall be coated with boiling coal tar or another type of approved wood preservative or primer before fixing them in position.

All fittings and fixtures for the doors, storage and worktops shall be as indicated in the schedule shown in the drawings. The samples along with manufacturer's / brand name, test certificate etc, shall be submitted to the Engineer In-charge for approval before placing order.

8. LAMINATES:

- Thickness of the laminate to be used shall be 1.0/ 1.25 mm as per item specified.
- Joints in laminates will not be permitted until and unless the same is unavoidable or is required as per the drawings.
- Measurements: Length and breadth of the plan area of the finished work shall be measured correct to a cm. no deductions shall be made for small openings like switch cockets, AC grills/ diffusers, light fixtures etc, nor shall extra material or labour involved in such openings shall be provided. Rate shall include provision access panel with MDF panel. Rate to include decorative work with sunk raised levels in false ceiling. Rate shall include all scaffoldings staging etc.
- The tendered rates shall apply for all floors heights.
- All chair stands shall be 5-prong tilting as approved by EIC / Architects, with a diameter of 25-1/2 inches, and finished with powder coating of high quality. In case M.S stands are approved, the same shall be embossed M.S with a seven-tank antirust treatment procedure before powder coating.

- All castors shall be of approved make, quality and type. They shall be glass reinforced nylon castors, with twin wheels having independent movement, and with a load carrying capacity of 100 Kg. per castors.

9. CORIAN (Solid Acrylic Surface)

- **Composition:** Corian should be solid, non-porous surfacing material homogeneously composed of acrylic resin (also known as Poly Methyl Meth Acrylate or PMMA), and natural minerals.
- **Clearances:** The recommended expansion clearance with UN-caulked Corian joints should be minimum $30.5 \times 10 \times 6 \times (\text{length of the Corian piece}) \times (\text{biggest temperature range expected in mm. Joints to be caulked should be approximately 3 mm wide to allow satisfactory caulk penetration and expansion.}$
- **Joints:** corner joints should be made square (butt) rather than mitred. All Corian joints should be reinforced. The edges to be joined should be straight, smooth and clean. Joints should only be made with "Joint Adhesive for DuPont Corian. Make cutouts with a router equipped with a sharp 9.5mm diameter (minimum) carbide bit.
- **Corners of a cutout must be rounded to 5 mm radius and edges smoothed, top and bottom, all around a cutout. L- and U- shaped corners need smooth, 13mm radius inside corners. For hob cutouts corners should be reinforced with a Corian corner block.**
- **Sealants and Adhesives:** FDA-listed silicone sealant sold by DuPont or its distributors should be used to achieve the best performance and color match. Vertical panels of Corian may be installed over suitable substrates, including water-resistant gypsum board, marine grade plywood and ceramic tiles. Use "Silicone Sealant" for DuPont Corian whenever low flame spread is required. In other cases, light colored elastic polyurethane adhesive or Type I (ANSI A 136.1-1967) elastic solvent based spread mastic adhesives may also be used. **DO NOT USE WATERBASED ADHESIVES.** Install countertops on perimeter framing support (without added substrate) using small amounts of silicone sealant. For making joints in countertops, repairs and custom edges, "Joint Adhesive for DuPont Corian" is required. When used in accordance with manufacturer's instructions, it provides a smooth.

10. SHOP DRAWINGS:

The contractor shall submit shop drawing for approval all joinery details for total furniture. Shop drawings shall relate to site measurements and shall show in detail the construction of various parts of the work, the method of jointing, thickness and type of material, the finishes to be applied to the various exposed surfaces, details of anchoring, joints, welds, fastening and all other relevant information.

G. ACOUSTIC INSULATION

Dry Wall Insulation helps attain acoustic privacy and fire rating. Twiga Insul slabs are to be placed in the cavities of the grid structure for partition wall. Both side of the grid is then covered with single or multiple layers of Ply. With 50mm, Twiga Insul slabs of density 48 Kg/m³, STC value of 34 , 67 dB and thermal resistance (R-value) of 0.75 to 3.33 sq.m K/W can be obtained.

The overall Thermal transmittance or U-value should be less than 0.44 W/sq.m. K to conform requirement. The insulation should conform to non-combustibility, Class-P(not easily ignitable), Class 1(surface spread of flame NIL), as per BS 476 standards.

H. POWDER COATING

The process of coating is basically.

- Degreasing
- Watering
- Picking/chromatin
- Water rising
- Phosphating
- Oven heating and
- Cooling at room temperature etc.

VAPOCURING-

Vaporing finish shall be done for Metal surfaces exposed to both interior and exterior atmosphere. The putty material, hardener, base coats material, Polyurethane coat material and the paints used shall strictly be in accordance with the manufacturers' specification.

Heating shall be at 70°C. The temperature may be varied depending on the hardener added with the color in the specified recommended proportion. The surface to be vapocured should be first made free from dust, dirt, grease or any such foreign material. The porches of Vapocuring shall be done under a dust-free environment and basically consist of

- Preparation of the surface
- Putty Work
- Spray coat either mixed with hardener or otherwise
- Heat treatment
- Polyurethane coating, etc.

I. FALSE CEILING

1. Item includes false ceiling in design with **coves & curves**, Suspending system and frame work shall match layout of A.C. Ducts / grills, electrical / fire protection wiring / fixtures, Return Air grills etc. Rate to include provision of extra height (Total Floor to floor height is 4.5 Mtr approx.) supports for frame work needed due to layout referred above and fixtures etc. Rates to include necessary scaffolding. **(PAYMENT WILL BE DONE FOR PLAN AREA ONLY).**
2. The false ceiling design can be stepped / curved/architectural design, cove etc. However only board surface area shall be measured for the purpose of payment. Nothing extra for design or curve. Existing floor to slab height on the site shall vary. Ceiling shall be hung from the existing slab through hangers. Rate quoted in the tender shall be applicable for all floor levels /all floor height (approx. 4.5 Mtr floor to floor approx.) including scaffolding, etc. complete. The rate of false ceiling items also includes 6 mm ply backing for supporting light fixtures in the false ceiling. The rate of false ceiling items also includes making all necessary cut outs & frame work for electrical fixtures / air conditioning work coves etc.
3. For technical details B.O.Q, drawings and technical specifications shall be referred, in case any details which are not available in these documents manufacturer's standard details shall be referred and that must be approved by EIC prior to procurement and supply at site.
4. **Mineral Fibre Board False ceiling**
Mineral Fiber Ceiling Tiles shall be made of granulated high-density Mineral Wool as the main material and top production technique which gives it superior features of fire-proofing, sound absorption, heat insulation & sag resistance. They are cost effective and are mainly used for acoustics and decoration. Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and patterns and shall be of 15mm/ 16mm thick Beveled Tegalur edge type.
Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the

Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Mineral Fibre tiles shall have the following properties:

- (a) Surface: Shall be of approved texture, design and pattern.
- (b) Dimensions: 595mm x 595mm x 16mm thick Beveled Tegal edge type. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.
- (c) Relative humidity: 99% RH resistant.
- (d) Fire resistance: Fire performance as per BS:476 (Part-6 & 7)
- (e) Thermal conductivity: 0.052 W/m-K – 0.057 W/m-K
- (f) Acoustic control: Noise reduction coefficient (NRC) = 0.50 to 0.60
- (g) Light reflectance: >85%.
- (h) Weight: 3.10 Kg/m² (for 16mm thick) & 5.29 Kg/m² (for 20mm thick)
- (i) Suspension system: Suspension system shall be made of interlocking metal T-grids of hot-dipped all round galvanized steel.

J. **HVAC works**

Composite Main contractor will be hiring a proper HVAC contractor with minimum 10 years experience in field and also will take prior permission from Architect/ EIC regarding the same and take their approval before start of work.

Contractor's Scope of Work

The scope of work proposed under this contract includes supply, installation, testing and commissioning of the complete HVAC system as elaborated in design drawings, detailed specifications and bill of quantities.

The scope shall cover Supply and Installation of all necessary equipment including CHW Ceiling Suspended AHU, CHW Cassette Units, VRV, Split System, Inline fans etc. **(Double air handling units and associated MS heavy class CHW piping with insulation, valves, AHU Electrical Panel & cabling etc. shall be as existing to be checked by vendor)**

Scope of work also includes supply, fabrication and installation of GSS ductwork, grilles/diffusers and insulation as required.

Routine testing, pressure testing of fabricated components, balancing and Commissioning of the entire HVAC system and performance testing as per system requirement shall also be covered in the scope.

The Contractor shall be responsible to complete the entire work under scope in all respect in line with the contract documents and with the directions of and to the satisfaction of the Architects/Consultants.

The Contractor shall furnish all labour, materials and equipment (except those to be supplied by the Purchasers, if any) as listed under bill of quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of complete HVAC system.

The scope shall also cover supply and installation of materials, equipment, appliances and incidental work not specifically mentioned herein or noted on the drawings or documents as being furnished or installed, but which are necessary and customary to make a complete installation. Supply of such material/equipment and execution shall be carried out in accordance with the most latest IS codes and IS specifications. In the event of non availability of relevant IS codes/specifications, good engineering practices shall be adopted.

9. **TECHNICAL CLAUSES**

1. Design Drawings

The drawings prepared by the Consultants are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation, and report to the Architects/Consultants any discrepancy and obtain clarifications. Any changes found necessary for co-ordination and installation of this work with other services and trades shall be made with prior approval of the Architects/Consultants and Purchaser without any additional cost to the Purchaser.

2. Site visit & Shop Drawings

The contractor shall visit the site and shall satisfy himself as to condition under which work is to be performed. No claim for consequences of ignorance at the later date shall be entertained. He should also check and ascertain the location of existing structure or equipment or any other situation which may effect the work.

The contractor shall submit five sets of shop drawings for air distribution system layout, Electrical panels & Equipment Layout drawings for approval of the Purchasers/Architects. Contractor shall also submit technical submittals for all major items including AHUs, VRV system, inline fans, piping & Valves, Ducting & GS sheet, grilles, diffusers, fire dampers, insulation material, electrical components etc. for the approval of the Purchasers/Architects.

Five sets of detailed shop drawings of all equipment and materials including AHU Room, Water cooled split units, ducting, piping, ventilation system, electrical work associated with the HVAC system required to complete the project as per specifications and as required by the Architect/ Consultant. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all equipment, also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

If the Architect/Consultants makes any amendment in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Architect/Consultant, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Architect/Consultant. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Architects/ Consultants ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.

Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quadruplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics. Data of a general nature shall not be accepted.

Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail nor does it any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.

Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or

any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Architect/Consultant.

Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the Architect/Consultant, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Purchaser.

Within two weeks of approval of all the relevant shop drawings, the Contractor shall submit to the Architect/Consultant four copies of comprehensive itemized price list of recommended imported and local spare parts and tools covering all equipment and materials in this contract. The Purchaser shall make arrangements to procure these spare parts and tools.

3. Material & Workmanship

All material used in work shall be of the best quality, obtainable and of approved list of manufacturers and shall conform to latest Indian Standard specifications unless otherwise stated.

4. Erection and Supervision

The Contractor shall depute engineers from time to time of commencement of installation work to inspect all relevant foundation/fabrication and other necessary facilities to make improved action if felt necessary. However, a qualified experienced engineer to be deputed at site beginning from commencement of HVAC activities at site & till handing over of the project.

5. Testing and Commissioning

On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Consultants without any extra cost to the Purchaser. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Consultants and the Purchaser. All tests shall be carried out in the presence of the Consultants and Purchaser's representative.

Testing and commissioning shall include furnishing all labour, materials, instruments etc. and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations.

Maintenance Services for the complete HVAC installation shall be provided during the defects liability period of one year.

The initial tests shall include but not be limited to the following:

- i. To operate & check the proper functioning of all electrically operated components like compressor motor, pumps, blowers, fans and other electrical motors etc.
- ii. To test and check the switchgears etc. and other safety & control devices ensuring proper functioning.
- iii. To check and balance the water flow in the water circuits so that flow rate through various equipments is as per design.

- iv. To check for leaks in the system & perform pressure testing.
- v. To check alignment of motors, Belts and other dynamic equipments.
- vi. To check all control settings to ensure smooth & proper functioning of the system.

6. Samples & Technical Submittals

Samples, make or brand of all the materials must be got approved by the Architect/Consultants/Purchaser in writing before they are brought to the site. Nothing extra shall be paid for presenting samples of any item as desired by Purchaser/Architect/Consultants.

Technical submittals of all the major items or as desired by the Architects/Consultants incorporating complete technical details in line with the tender specifications & catalogue prior to procurement of equipment/material shall be submitted for the approval.

7. Contradiction between BOQ, Specifications and Drawings :

In the event of conflicts between BOQ, Specifications and Drawings, the BOQ shall take precedence over the specifications and drawings. Keeping the general intent of the scope of work under said contract, the Architects/Consultants would interpret the requirements of the design intent & contract and their decision shall be final and acceptable to all concerns including the contractors.

- 8. Purchaser reserve the right to relax or modify any condition listed in conditions of the contract in overall interest of the work.
- 9. All tools, plant and machinery provided by the contractor shall, when brought to the site, be deemed to be exclusively intended for construction and completion of this work and the contractor shall not remove the same or any part thereof without the consent of the Architect / Purchaser.
- 10. The rates quoted by the contractor shall be all inclusive keeping in mind the specifications, additional and special conditions in view and nothing extra shall be payable whatsoever.
- 11. Unless otherwise provided in the schedule of quantities the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building. Nothing extra shall be payable to him on this account.
- 12. The equipment's erected, commissioned at site should be suitable for maximum temperature of 50 degree C.
- 13. The electrical installation shall be carried out in accordance with Indian electricity rules, relevant Indian standard such as IS 732, IS 3043 and the requirements stipulated by local statutory body such as electrical inspectors for such installations. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.
- 14. The equipment and materials to be supplied shall conform to the requirements of the relevant IS standards.
- 15. The work shall be executed strictly as per the specifications drawn and "Approved for Construction Shop

Drawings” and to the entire satisfaction of the Purchasers/Architects.

16. Completion Drawings & Documents -After completion of the work, the contractor shall furnish four sets of completion documents complete with “As Built Drawings”.

17. The contractor shall ensure good conduct of the workman at the site of work.

10. **SPECIFICATIONS- MAIN EQUIPMENT**

1. **AIR HANDLING UNITS (AHUs)**

Scope

The scope shall be supply, installation, testing and commissioning of double skin air handling units, conforming to these specifications and meeting all design parameters as mentioned in the “Bill of Quantities”, appendices and drawings.

The air handling units shall be draw-thru type comprising of various sections such as mixing box, filter section, coil section, fan section etc., as mentioned in the “Bill of Quantities”. The Air handling units shall be factory tested for rated efficiency.

Material of Construction & Design

The housing shall be so constructed that it can be delivered at site in total/SKD conditions depending upon the requirement. Inner panels shall be constructed out of 24 gauge (0.63mm) plain galvanized sheet and outer panels shall also be made out of 24 gauge (0.63mm) pre painted galvanized steel sheet. Width of each panel shall not exceed 750mm. Insulation shall be injected polyurethane foam in between the double skin panels of thickness as mentioned in the BOQ. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

AHU framework shall be made out of extruded aluminium hollow sections filled with preformed insulation section. Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work.

Drain Pan

Drain pan shall be made out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be insulated with closed cell elastomeric insulation of thickness as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.

Centrifugal Fan & Motor

The AHU fan section shall house the DIDW backward curved centrifugal fan/s .The fan shall be backward curved floor standing double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel having thickness not less than 14gauge. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The fan shall be selected for speed not exceeding 1000 RPM. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall generally not be more than 2000 FPM or as mentioned in the BOQ. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to

casing with the help of fire retardant canvass constructed out of imported fabrics. Centrifugal fans shall conform the detailed specifications of fans elaborated in the preceding clause.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 10% over limit load plus transmission losses.

Fan motors shall be suitable for operation on $415 \pm 10\%$ volts, 50 cycles, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

Cooling /Heating Coils

Coil section shall house the chilled/hot water coils having 12.5 mm to 16 mm dia tubes of wall thickness not less than 0.5mm with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Material of construction of header associated with cooling coil shall be copper. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm.)

Pre -Filters Section with Filters

Filter section shall house the washable synthetic type air filters having anodized aluminium frame. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter face velocity shall not exceed 450 FPM. Filters shall fit so as to prevent by-pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Pre filters shall conform the detailed specifications as elaborated in the preceding clause under sub head "Filters".

Accessories

Each air handling unit shall be provided with manual air vent at highest point in the cooling/heating coil and drain plug at the bottom of the coil.

Performance Data

Air handling units shall be selected for the lowest operating noise level. Technical submittal of air handling units shall be prepared for Consultants approval prior to procurement as mentioned under Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.

Testing

Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Air flow measurements shall be carried out by an anemometer and temperature measurements by accurately calibrated thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

2. **VARIABLE FREQUENCY DRIVES**

Scope

This section describes the type of frequency converter to be supplied for fan speed control. The drive shall not be a general purpose product, but a dedicated HVAC engineered design.

The manufacturer shall demonstrate a continuous period of manufacture and development for at least 25 years.

The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and troubleshooting capability from his own local facility. A training course shall be provided by the manufacturer to the consultant / contractor / maintenance engineers.

The manufacturer shall provide full technical detail of the product, with catalogues, dimension drawings, weights etc. and each drive shall be provided with a full technical manual.

Equipment supplied must conform to recognized International Standards and be manufactured to ISO 9001, BS 5750 part 1 & 2 and carry the C.E. Mark on EMC Compliance.

Frequency converters shall be suitable for use in either a 'Stand Alone' mode, complete with all necessary protection or as part of centrally controlled system via a Serial Communication Loop to the main Building Management System (B.M.S.) via in-built RS 485 port (as explained at 3.20 m)

Technical Requirement

The frequency converter (F.C.) shall convert Local Voltage $V \pm 10\%$, 3 Phase, 50/60 Hz utility power supply to an adjustable output voltage and frequency. The FC must be capable of delivering full value of fundamental true RMS output voltage to the motor equal to the mains input voltage to the FC at full load and speed. In the event the FC cannot meet this requirement an oversized motor at least one frame size higher must be selected. The FC manufacturer must document this capability.

The voltage to frequency ratio shall be suitable for fan control. It should not be possible to set a constant V/F ratio, to prevent damage to connected equipment and to optimize energy usage.

The F.C. shall work in conjunction with any I.E.C. standard design motor and shall not require the motor to be de-rated, or cause the motor temperature to rise above the class 'B' rise expected on normal mains operation. The Motor Shall not require an external blower even at slow speed running.

When selecting the FC, care shall be taken to ensure that protection against electro fluting of motor bearings and/or damage to the motor windings shall be provided. This shall be provided by the inclusion of :

- a) Insulated motor bearings
- b) Soft switching IGBT's in the FC
- c) LC Filters fitted to the FC

The F.C. shall use AMA (Automatic Motor Adaptation) techniques so that operators do not have to input motor characteristic and ensuring proper motor operation, optimize motor performance, improve start capabilities and compensate for motor cable variances.

The F.C. shall be capable of controlling parallel motors of mixed ratings, and allow disconnection of any machine whilst running without causing tripping. The F.C. shall be capable of running with no motor connected for service functions.

The F.C. shall be fully tested at the converter manufacturers works, including motor loading.

Certificates of Compliance should be available on request.

The F.C. shall be of sufficient capacity to provide a quality wave form so as to achieve full output torque of the motor, without causing additional heat rise. The operating conditions shall include:

- a) Minimum efficiency at 100% load - 96%
at 20% load - 92%
- b) Rated input voltage (local voltage) -10%, 3 phase, 50/60 Hz \pm 2 Hz.
- c) Working ambient temperature range -10°C to +45°C, humidity to 95% RH, and vibration of 0.7G.RMS in 3 directions
- d) Output frequency range - 0.5 to 1000 Hz.
- e) Output voltage range 0 to full mains input voltage, 3 phase even at full mains voltage -10% input.
- f) The drive shall allow connection of motors one frame size larger and 4 sizes smaller than the nominal converter rating.
- g) VFD shall be limited to 110% of rated current for 60 seconds and 160% torque for 0.5 seconds
- h) The F.C. shall accept 0-10 VDC, 4-20 mA, or resistive inputs as a control signal.
The F.C. shall provide two output relays to provide signals including - ready, run, tripped, and be programmable for other selected information. Two analogue outputs of 4-20 mA or 24 VDC shall be programmable to transmit speed or other parameters to the B.M.S. In addition, 2 x digital outputs shall provide 24Vdc to signal choice of 27 conditions to the BMS.
- i) The F.C. shall log and display "Total kW-hrs consumed" and "Total Hours Run" by the motor without additional instrumentation and the facility to "Reset".
- j) 20 preset speeds shall be available (programmable values) for duties such as night setback, smoke extract and morning boost settings.
- k) The F.C. shall provide 4 skip frequencies of adjustable bandwidth to overcome mechanical or air resonance.
- l) A parameter lock shall be incorporated to prevent unauthorized resetting of parameters.
- m) The FC shall be capable of running from an external DC source during periods of mains interruption.
- n) Drive acoustic noise shall not exceed 65DbA at full load and 60DbA at 50% load.

Drive Design Requirements

The F.C. shall contain as standard within it's enclosure D.C. Link filtering with both inductive and capacitive elements to control the mains borne harmonics. The document 'Electrical Supply Industry Recommendation G 5/3 limits for harmonic currents in the U.K.' or IEEE519, 1992 shall be used for the basis of calculation of T.H.D. for the point of common coupling. On request, the F.C. manufacturer shall provide T.H.D. figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, etc. feeding the F.C.s to allow this calculation to be made.

The F.C. shall comply with E.M.C.(Electromagnetic compatibility) (R.F.I. Control) document EN55011 as an integral part of its design, incorporating EMC/ RFI Filters to meet both EN55011 Class 1A (150metres) and Class 1B (50 metres). It shall conform to immunity standard IEC 801 parts 2-5. Must carry the C.E. Mark of Compliance.

The drive shall be capable of automatically reconnecting to a spinning fan, forward or reverse running, without tripping, following mains interruption or on transfer from bypass running.

The F.C. design shall comprise a diode input bridge, fixed voltage D.C. link section with both inductors and capacitors to form a filter, and inverting bridge comprising I.G.B.T.'s (Insulated Gate BiPolar Transistors) . All equipment must be housed within the F.C. enclosure.

The inverting bridge shall be controlled by a 32 bit processor and A.S.I.C.'s (Application Specific Integrated Circuits) to produce a V.V.C. Plus (Voltage Vector Controlled) enhanced P.W.M. waveform naturally resulting in full motor voltage, torque and sinusoidal current of mains supply quality in the motor circuit. Other forms of current source or 6 pulse converters are not accepted.

The F.C. shall protect itself against input transients to VDE0160 class W2; loss of mains phase (3 phase measurement); loss of motor phase (3 phase measurement); grounding of any output phase; loss of speed reference (runs at last setting/preset speed/close down-programmable).

The F.C. shall use overriding frequency fold back control techniques to prevent damage in the event of excessive load during either running or starting.

The F.C. shall model the motor in its software to predict motor overheating without the use of thermistors in the motor. When overheat is predicted, an alarm or automatic shutdown shall be initiated.

The F.C. shall exhibit near unity fundamental power factor at all loads and speeds, and should not require the addition of external A.C./D.C. line reactors for power factor improvement, harmonic control or prevention of zero voltage notching.

The output circuit shall be of such a design, as to allow unlimited switching of the motor circuit, at any load/speed without causing damage to the I.G.B.T. output stage and without needing auxiliary control switching.

F.C.'s shall have self adjusting modulation frequency control from 2.0 kHz to 14 kHz. The control form shall be such as to allow the F.C. to deliver full output at all times without derating, by optimizing the switching frequency dependent on the output load.

Full galvanic isolation between power and control components shall be incorporated to ensure compliance with VDE 0160 P.E.L.V. (Protective Extra Low Voltage) to prevent damage to B.M.S. interface and ensure operator safety. Short circuiting of the control terminals shall not damage the control card.

The F.C. shall include an A.E.O. (Automatic Energy Optimization) circuit to continuously adjust the voltage to frequency ratio and optimize the motor magnetizing current based on the actual torque requirement of the motor at different speeds to optimize motor energy consumption and prevent heating of motor at low speeds.

The design shall include a full 2 zone, 2 setpoint P.I.D. controller as standard to provide closed loop control direct from upto 2 signal transmitters without the need for external signal conditioning.

The F.C. shall not exhibit an inrush current when a 'start' signal is given, and current must not exceed 110% at any time to prevent damage to connected equipment.

The F.C. design shall include a motor preheat circuit to prevent condensation forming in the motor during shutdown periods. The F.C. shall not be damaged if it is energized with a 'start' signal without a motor connected. The F.C. shall provide as standard:

- a) Heat sink over-temperature protection.
- b) Under-voltage protection.
- c) Over-voltage protection.

Display to be in selectable language.

The Local Control Panel (keypad of FC) of FC shall display in 4 line alpha-numeric characters in plain English language, the following operating parameters:

- a. Energy consumed in kW-Hr.
- b. Power consumed by motor in kW
- c. Run time of motor in Hours.
- d. Current drawn by the motor in Amperes.
- e. Voltage applied to motor terminals by FC in Volts
- f. DC link voltage in Volts
- g. Output Frequency in Hz.

- h. Percentage of maximum output frequency in %.
- i. Motor Speed in RPM
- j. Thermal Load on Motor in %

3. **VARIABLE REFRIGERANT VOLUME SYSTEM**

Scope

The scope shall be supply, installation, testing and commissioning of air cooled variable refrigerant Volume (VRV) system conforming to these specifications and meeting all design parameters as mentioned in the “ Bill of Quantities” and drawings. Variable Refrigerant Volume System shall be a standard product, however all these specifications shall fully comply.

Type

Unit shall be heat pump type consisting of outdoor units and multiple indoor units, each suitable to facilitate cooling during summer & monsoon and heating in winter as per the requirements.

It shall be possible to connect minimum 10 indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually.

Compressor installed in outdoor units shall be equipped with all inverter compressors up to 20 HP and in bigger machines for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to 165M with maximum 50M level difference **without any oil traps**.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant gas before delivering at site.

Units shall be factory finished with paint as per manufacturer's standard . However, shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

Capacity

The refrigeration capacity of VRV outdoor and indoor units shall be as mentioned in the “Bill of Quantities” and as reflected on the drawings.

Outdoor Unit

The unit shall be heat pump type with automatic changeover in different seasons.

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed heavy gauge mild steel panels coated with a baked enamel finish. The unit should be completely factory wired, tested with all necessary controls.

All outdoor units shall have minimum two scroll compressors and be able to operate even in case of breakdown of one compressor. In case of outdoor units above 20HP, the outdoor unit shall have multiple inverter compressors so that the operation is not disrupted with failure of any compressor and if one compressor malfunctions, other continues to provide emergency operation smoothly till repair is effected. The unit shall be provided with duty cycling arrangement for multiple inverter compressors to facilitate sequenced operation of the machine for better stability and prolonged life.

The outdoor unit shall be modular in design and should be allowed for side by side installation. The unit shall be provided with its own microprocessors control panel.

The outdoor unit should have anti-corrosion paint free steel plate for easy mounting of unit.

The machine must have sub cool feature to use coil surface more effectively thru proper circuit/bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.

The outdoor unit should be fitted with low noise, aero spiral design fan with grill for spiral discharge airflow to reduce pressure loss and should be fitted with DC fan motor for better efficiency. The noise level shall not be more than 60dB (A) at normal operation measured horizontally 1M away and 1.5M above ground. For Residential application or wherever night operation is required the unit shall be suitable to operate on nighttime quiet operation mode having minimum three step of operation sound level i.e. 55dB to 45dB. Wherever required or as shown on the drawings the unit shall be selected for high external static pressure (ESP) not less than 78Pa (8mm WG) to meet long exhaust duct connection requirement.

The outdoor unit shall be designed to operate safely when connected to multiple fan coil units.

The unit shall be suitable to operate on environment friendly R 410A refrigerant.

Compressor

The compressor shall be highly efficient, high COP scroll type and capable of inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement.

All outdoor unit shall have multi-steps of capacity control to meet load fluctuation and indoor unit individual control. All parts compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

Inverter compressor shall preferably by Reluctance DC inverter compressor for higher efficiency and improved reliability.

Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be covered by anti-corrosion resin film. The unit should be with e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

Refrigerant Circuit

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves at condenser end. The equipment must have in built refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safety operation of the system.

Safety Devices

VRV system shall be provided with all safety devices as required and to ensure safe operation of the system, but not restricted to the following :

- a. High pressure switch.
- b. Low pressure switch.
- c. Fuse.

- d. Fan drive overload protector.
- e. Fusible plug
- f. Overload relay.
- g. Overload protection for inverter.
- h. Fan motor safety thermostat

Oil Recovery System

Each unit shall be equipped, with an oil recovery system to ensure stable operation with long refrigerant piping.

The system must be provided with oil balancing circuit to avoid poor lubrication.

Anti-corrosion Treatment

Outdoor units should be designed with anti-corrosion specifications as detailed below for use in area, which are subject to salt damage and atmospheric pollution as specified in the BOQ.

The portion of machines like side panel, outer panel, bottom frame, which are exposed to corrosive atmosphere, should be of alloyed hot-dip zinc coated steel plate, coated with corrosion protection powder polyester resin coating on both inner and outer surfaces in thickness of 64 micron or more.

Finned coil protection net should have coating of resin coating containing ultraviolet ray absorbent. Fan and its fan protective net should be with weather resistant polypropylene resin.

The copper pipe –aluminium fins shall be special acrylic resin coated and internal supports, frame, control box shall also be hot-dip zinc coated steel plate and with rust preventive powder coating of 64 micron or more on inner and outer surfaces.

All screws and bolts used in outdoor unit shall be provided with SUS410, Zinc-nickel alloy plating, zinc chrome acid film treatment and rust inhibitor coating.

Indoor Units

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type capacity and size of indoor units shall be as specified in detail Bill of Quantities.

Indoor unit shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the rooms. The indoor units shall have following features :

- a. The address of the indoor unit shall be set automatically in case of individual and group control.
- b. In case of centralized control, it shall be set by liquid crystal remote controller.
- c. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.
- d. The cooling coil shall be made out of seamless copper tubes and have continues aluminium fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.
- e. Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall slide away type and neatly inserted.

- f. Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.
- g. Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

The indoor units shall generally be of following type :

Ceiling Mounted Ductable Type Unit

Each Indoor unit shall be ceiling mounted ducted type, as specified in scope of work. It shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation. The unit shall have high static fan for Ductable arrangement.

Ceiling Mounted Cassette Type Unit (Multi Flow/ Round Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Noise level should not be more than 35 dB at low speed.

Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.
Each unit shall have high lift drain pump, fresh air intake provision (if specified) Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same decorative panel size** for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

Ceiling Suspended Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling.
The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

High Wall Mounted Units

The unit shall be wall mounted type. The unit includes pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

Floor Standing Type

Unit shall be suitable for floor standing arrangement. The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

Centralized Type Remote Controller

(Optional, if specified in BOQ)

A multifunctional compact centralized controller shall be provided with the system.

The controller must be necessarily a graphic Controller type to act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment, It should have ease of use for the user and must have a user friendly colored touch screen, icon display and color LCD display.

- a. It shall be able to control up to 64 groups of indoor units with the following functions
- b. Starting/stopping of Air-conditioners as a zone or group or individual unit.
- c. Temperature settling for each indoor unit or zone.
- d. Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
- e. Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
- f. Display of air conditioner operation history
- g. Daily management automation through yearly schedule function with possibility of various schedules.
- h. The controller shall have wide screen user friendly color LCD (Liquid Crystal Display) and can be wired by a non polar 2 wire transmission cable to a distance of 1KM away from indoor unit.

Heat Reclaim Ventilation Unit.

In order to achieve the purpose of better indoor air quality, the Heat Reclaim ventilation (HRV) unit must exchange the heat between supplied fresh air and exhausted air in order to bring the outside air closer to indoor temperature and humidity conditions. Thus it must recover the thermal energy of exhaust air and reuse it for supplied fresh air. This must lead to ventilation without increasing the load and thus saving in running cost.

It shall be possible to interlock this HRV system with operation of VRV system to simplify installation and improving the efficiency of air-conditioning. It shall be possible to set automatic ventilation mode so that heat exchange mode and ventilation mode can be automatically selected to enhance energy conservation.

The casing of the HRV unit shall be made of galvanized steel plate, insulation with self extinguishable polyurethane foam. The HRV must have air filters of multi directional fibrous fleeces type.

The heat exchanger element must be designed without any moving parts for higher durability and reliability, It should have high permeability high efficiency specially processed paper which is flame retardant and fungi proof to keep air clean.

The unit must be provided with built in multi directional fibrous filter.

The unit must have optimized design of fan and air flow passage to make it compact and supply air & exhaust air passage must be arranged in such pattern so as to prevent mixing of supply (fresh) and exhaust air.

The unit must be suitable for single phase power supply and have their control panel.

4. SPLIT UNITS

Scope

The scope of this section comprises supply, installation, testing and commissioning of self contained air cooled split type air conditioning units each comprising of an outdoor and single/twin indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

Outdoor Unit

Outdoor unit shall be an air cooled condensing unit suitable for out door installation conforming to the following specifications.

a. Unit Base & Casing

Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, condenser coil etc.

b. Compressor

i. Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

ii. Rotary Compressor

The rotary compressor shall be an industrial quality rugged, cast iron, hermetic/ semi hermetic compressor with capacity control side valve , oil sump heater & differential pressure refrigerant oil flow system. The compressor shall be provided with multiple pressure lubricated rolling element bearing group shall support the rotating assembly. Suitable overload protection shall be provided & necessary isolating valves shall be provided at suction & discharge . The compressor shall be fitted with electrically operated oil heaters with built in thermostats. The heaters shall be shall be automatically actuated when the compressor is stopped. Necessary time delay shall be provided for restart of compressor. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

c. Condenser

Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.

d. Condenser Fan

Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.

Indoor Unit

The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.

- a. Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities. Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.

The ceiling mounted cassette type indoor units shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.

The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.

Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.

b. Cooling coil

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.

c. Fan Section

The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.

Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.

d. Filters

Filters shall be cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM and pressure drop across filters shall not exceed 5 mm of WG.

e. Insulation

All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.

Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.

Refrigerant Piping

The copper refrigerant piping shall be carried out neatly to connect outdoor and indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & ready made copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure

tested using nitrogen at pressure of 21Kg/ Sqcm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polyshield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

Electrical Installation

Factory fabricated local control panel shall be provided with each three phase ductable unit. The armoured conductor power cabling along with earthing shall be carried out as required and the cables shall be as per the "Approved Makes".

FILTERS

Viscous Metallic Filters

Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.

Synthetic Fibre Filters

Synthetic fibre filter shall be non combustible, cleanable in light weight aluminium framed with non-woven synthetic fibre replaceable media. The filter shall have an efficiency of 90% down to 10 microns when tested as per BS: 2831 standard. It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop across the filter shall not exceed 2.5mm WG for 25mm thick filter. The filter frame shall be of aluminium and shall be suitable for mounting in air handling unit as required at site.

Microvee Filters :

Fine filters shall be designed to remove particles down to 5 microns as per I.S standard.

Filter shall comprise of a large aluminium sheet frame provided with neoprene gasket for housing the plated filter element. Filter element shall be made from multilayers of micro-fiberglass media specially treated with antifungal and bacterial reagent to prevent growth of micro-organisms shall be screwed into the frame by means of an aluminium clamp patti and brass screws. The filter media shall be reinforced by two layers of HDPE woven cloth 120 mesh size and anodized aluminium mesh and filters shall be cleanable type using water/detergent. Fine filter shall be housed in banks/arrays. They shall comprise of housing made from MS angles/flats epoxy coated of size suitable to receive the required number of filters to handle specified cfm for each AHU. All filters shall be installed in same plane. No zigzagging shall be allowed by means of threaded bolts. Housing shall be of 2" greater thickness than that of filters (i.e. 8" thick for 6" deep filters).

5. "SPECIFICATIONS - VENTILATION FANS"

1. CENTRIFUGAL FANS

Centrifugal fans shall be of approved make DIDW/SISW of specified Class and arrangement complete with access door, squirrel-cage induction motor, V belt drive, belt guard and vibration isolators. Type, direction of discharge / rotation, and motor position shall be as per the Approved for Construction shop drawings.

Housing :

Housing shall be constructed out of 14 gauge sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided through out split joints to make it air tight.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan Wheel :

Fan Wheel shall be backward curved non-overloading type. Fan wheel and housing shall be statically and dynamically balanced. Necessary documents establishing Dynamic balancing carried out at factory shall be provided with the consignment. Fan outlet velocity shall not exceed 2000 FPM (610 MPM) and maximum fan speed shall be 1000 RPM.

Shaft :

Shaft shall be constructed of steel, turned, ground and polished.

Bearings :

Bearings shall be of the sleeve/ball-bearings type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil grease pack pillow block type.

2. **Propeller Type Fans :**

The propeller type fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features :

- a. Fans shall be of ring mounted type having steel hub and MS blade, mounted directly on the shaft of a totally enclosed motor Bearings shall be maintenance free permanently lubricated type.
- b. The fan blades shall be constructed out of pressed steel in aero foil design to achieve high efficiency. The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame with the fan/motor assembly.
- c. Rubber mounts shall be provided between the mounting frame and the mounting brackets. The fan shall be direct driven type and motor shall either be capacitor start –run or three phase squirrel cage induction type totally enclosed.
- d. The fan shall be fitted with gravity type louvers. The speed of fan shall be as mentioned in “Bill of Quantities” and drawings.
- e. All the fans shall be tested for performance and the following test results shall be furnished :
 - i. Air flow rate in C.F.M.

- ii. Static pressure at the fan supply end.

Inline Fans :

The inline fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features :

- a. The casing shall be constructed out of hot rolled heavy gauge GSS metal epoxy coated embodied with required inspection doors.
- b. Fan shall be direct driven SISW forward or backward curved centrifugal type. Material of construction for impeller shall GSS. Fan wheel shall be statically and dynamically balanced.
- c. The bearing shall be completely maintenance free and can be used in any mounting position, at maximum indicated temperature.
- d. Motor shall be total enclosed external rotor type and suitable for operation on $415 \pm 10\%$ volts, 3 phase or $220 \pm 6\%$ volts, 1 phase, 50Hz AC power supply.
- e. Single phase inline fans shall be provided with factory fitted speed regulators and three phase inline fans shall be provided with GI dampers.
- f. All the fans shall be tested for performance and the following test results shall be furnished :
 - i. Air flow rate in C.F.M.
 - ii. Static pressure at the fan supply end.

“SPECIFICATIONS - PIPING”

General :

- a. The scope under this section covers supply, laying, erection, testing and commissioning of pipes, pipe fittings and associated valves conforming to these specifications and the general arrangements shown on the drawings.
- b. All piping including pipe fittings and valves shall follow the relevant Indian standards.

6. Chilled/Condenser Water Piping :

- a. All chilled water pipes and all fittings shall be MS heavy class (MS Class 'C') conforming to latest relevant BIS Codes including IS 1239-1990 & 1992. All pipe joints shall generally be welded type, unless & until mentioned otherwise. Entire welding work shall be carried out by qualified welders forming proper V-grooves prior to doing welding work and shall strictly conform to latest relevant BIS Codes of practice for manual metal arc, welding of Mild Steel.
- b. All pipes as well as steel supports shall be thoroughly cleaned and given one primary coat of red-oxide paint (non insulated pipes only) before being installed. All welded piping shall be subject to the approval at site by Engineer-in-Charge/Consultants. Pipes shall be sloping towards drain points.
- c. Fitting shall be malleable casting of pressure rating suitable for the piping system. fittings used on welded piping shall be of the weldable type. Fittings shall be new and from reputed manufacturers. Flanges shall be new and from standard manufacturers. Supply of flanges shall include bolts, washers gaskets, etc., as required.
- d. Tee-off connections shall be through equal or reducing tees wherever possible, otherwise ferrules welded to the main pipe shall be used. Drilling & tapping of the wall of the main pipe shall not be resorted to.

- e. All equipment and valve connections shall be through flanges (welded or screwed for galvanized steel). Sufficient number of flanges and unions shall be provided.

7. Valves and Strainers :

i. Gate & Butterfly Valves :

Gate Valves and Wafer type Butterfly Valves as per system requirement and as reflected on approved for construction shop drawings, conforming to the following specifications shall be provided .

S.No	Size	Construction	Ends	Type
01.	Upto 40mm	Gun Metal	Screwed	Gate
02.	50mm and above	Body: Cast Iron conforming to 10 Gr. FG 260/CG -25 : ASTM A217 GR. CA-15 (SS-410) Coating : Integral n : SS –410 Body Liner (Seal) : EPDM (Temp. Range 40C to 120C) Pressure Rating PN 10/PN 16	Wafer	Butterfly

Type and requirements shall be as indicated in schedule of Quantities. Valves shall have non-rising spindles unless specified otherwise and shall be suitable for not less than 10 Kg/Sqcm working pressure and 21 Kg./Sq.cm test pressure. Tail piece shall be used where required.

Butterfly valves shall perform as isolation valves. Butterfly valves shall conform to BS : 5155, IS 13095, MSS SP 67 & API 609 and designed to fit without gaskets between mating flanges. The valves shall be suitable for flow in either direction and seal in both directions. The valve shall be of integral molded design. Butterfly valves upto 200mm shall be hand lever operated and above 200mm gear operated.

ii. Balancing Valves :

Balancing valves shall be provided at Chiller, Condenser and each AHU outlet line as indicated in Schedule of Quantities. These Valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. To measuring flow rate, differential pressure will be measured with calibrated instruments – Digital or Manometer. Balancing Tools shall have a program to provide the following functions :

- To balance the HVAC installation and calculate the necessary valve settings based on the systems data as observed prior to balancing exercise.
- To log measured values from a valve (differential pressure and flow rate)'

c. To store the results of balancing

d. To printout saved data in computerized measurement protocol (CMP) consisting of :

- i. Name and size of Balancing Valves
- ii. Presetting position of Balancing Valves
- iii. Design Flow for each Balancing Valves
- iv. Flow at Balancing Valves Flow ratio pre-balancing based on Actual Flow / Design Flow Ratio post-balancing and Actual Flow

The Balancing Valves of size 15mm to 80mm dia shall be of gun metal construction with screwed ends. Whereas valves of size 80mm to 300mm shall be of cast iron construction.

All Valves shall be tested for flow vs. pressure drop with $\pm 5\%$ accuracy and data be furnished as part of Test Certificates.

8. Balancing of the Water System :

The balancing of water system is to be done by a third party or the balancing valves supplier as approved by the consultants with the help of a Software-package, if specifically asked for in the BOQ, digital differential pressure measuring instrument or Manometer.

A balanced flow condition in a system is when the total flow is distributed amongst the terminal units (AHUs etc) in equal proportion to the design flow so that a single point regulation from the supply point (Pump etc) can correct the flow through all the terminal units still in balanced manner.

Non Return Valves :

Non return valves shall be dual plate check valve provided as shown on the approved shop drawings, conforming to relevant Codes and in accordance with the following Specifications:

S.No	Size	Construction	Ends
01.	50mm to 150mm	Body : Cast Iron Plates : Gun Metal	Flanged
02.	200mm and above	Body : Cast Iron Plates : Carbon steel with 13% chrome overlay	Flanged

The spring and hinge/ stop pin shall be in SS 304 construction and bearing PTFE material.

Wafer type spring loaded check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Air release and clean out plugs shall be provided and valves shall be suitable for not less than 10 Kg/Sqcm working pressure and 21 Kg./Sq.cm test pressure.

Strainers :

Strainers shall be 'Y' type, or pot type as shown on the Drawings and mentioned in schedule of quantities, with C I / fabricated MS bodies designed for the test pressure specified for the butterfly valves. Strainers shall have bronze/brass screen with 3 mm perforations and a permanent magnet. Screen shall be removable and replaceable without disconnection of the main pipes. Strainers shall be provided with flanges or threaded sockets as required. The strainers shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

All strainers shall be provided with equal size isolating gate valves with rising spindles so that the strainer may be cleaned without draining the system. Strainers shall be provided on the suction side of each pump; and inlet side of heat exchanger equipment wherever shown in the drawings. Generally for 50mm pipe size 300mm dia pot, for 80mm pipe size 350mm dia pot, for 100mm pipe size 450mm dia pot, for 125mm pipe size 500mm dia pot, for 150mm pipe size 550mm dia pot, for 200mm pipe size 600mm dia pot, for 250mm pipe size 800mm dia pot shall be used.

Stainless steel basket shall be supported on brass disc mounted on solid brass blocks. Each pot strainer shall be provided with manufacture's test certificate.

Drain Piping :

- a. All pipes to be used for drain, condensate drain and fittings shall be galvanized steel class 'B' (medium class) confirming to relevant IS & BIS Codes.
- b. All jointing in the pipe system shall be by screwed and / or by screwed flanges using 3mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.
- c. All pipes supports shall be mild steel , thoroughly cleaned and given one primary coat of red oxide paint before being installed.
- d. Fittings shall be galvanized steel "medium class" malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, and gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing Tees. All equipment and valve connections or connections to any other mating pipes shall be through flanges required for the mating connections.
- e. All condensate drain piping shall be insulated and painted as per the section "Insulation" indicated in schedule of Quantities.

Pressure Gauges :

- a. Pressure gauges shall be provided at the supply and return of condensers, discharge end of pumps as shown in the schematic drawing.
- b. Pressure gauge shall be of approved make in stainless steel (SS) construction and not less than 100mm dia dial, glycerin filled and of appropriate range and be complete with shut off gauge cocks, isolating valves etc. duly calibrated before installation.
- c. Care shall be taken to protect pressure gauges during pressure testing.

Thermometers :

Thermometers shall be industrial type V-form having range of scales as 30-120 degree F (0-50 degree Celsius) for cooling applications and 30-212 degree F (0-100 degree C) for heating applications duly calibrated. Body shall be of aluminium alloy, anodized gold coloured surface against aggressive vapours. The casing shall be adjustable type to take any reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Graduation of scale shall be 1 degree in both readings. Thermometer shall be suitable for 1/2 FPT connections. Thermometers for chilled water pipe line shall be provided with long brass stem to facilitate ease in removal without damaging the insulation. MS socket to be welded on pipes shall also be provided with the thermometer. Thermometers shall be provided at the supply & return of AHUs as indicated on the drawings.

Piping Installation :

- a. Design drawings indicate schematically the size and location of pipes. Pipes runs and sizes may however , be changed to meet the site conditions .The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, location of isolating and controlled valves, drain and air valves and all pipes supports. The contractors must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.
- a. Piping shall be properly supported on, or suspended from, stands, clamps, hangers etc. as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps, and hangers and be responsible for their structural sufficiency.
- c. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between supports
15mm to 30mm	1.8 M
40mm to 150 mm	2.0 M
over 150 mm	2.5 M

Pipe hangers shall be fixed on walls and ceiling by means of metallic raw plugs.

- d. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor slab by clamps or collars attached to pipe and with a 12 mm thick ribbed rubber pad or any other approved resilient material. Where pipes pass through the terrace floor ,suitable curbing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lower point and air vent at the highest point. Risers shall also have a suitable concrete pipe support at the lowest point.
- e. Pipe sleeves atleast 3 mm thick, 50mm larger in diameter than condenser water pipes shall be provided wherever pipes pass through wall and slabs. Annular spaces to be filled with felt and finished with retaining rings.
- f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gauge metal sheet shall be provided between insulation and the clamp saddle or roller extending at least 15cm on both sides of the clamp, saddle or roller.
- g. Entire piping work shall be carried out in a workman like manner. Piping work shall be carried out with minimum disturbance to the other works being done at the site by other agencies. A program of work shall be prepared in consultation with the engineer –in –charge well in advance.
- h. Piping layout shall take due care for expansion and contraction in pipes and provide expansion joints wherever required. The contractor shall ensure providing adequate clamps, brackets, clamp saddles, hangers etc.
- i. All MS pipes shall be accurately cut to the required size in accordance with the relevant IS & BIS standards, proper V- groove made and burrs removed prior to laying. Open ends of the piping shall be closed to avoid entrance of foreign material . Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely, at other locations, concentric reducers may be used.
- j. Similarly, all GI pipes using screwed fittings shall be accurately cut to the required sizes and threaded in accordance with IS: 554/1955/relevant BIS codes and burrs removed before laying. Open ends of the piping shall be blocked to avoid entrance of foreign matter.

- k. Automatic purge valves shall be provided at all high points in the piping system for venting. Purge valves shall be 10mm size with screwed joints as mentioned in the schedule of quantities. Discharge from the purge valves shall be piped through GI pipe of similar size to the nearest drain / khurrah. The pipes shall be pitched towards drain points.
- l. Drain points shall be provided at all low points in the piping system using gate valves with rising spindle. Generally, upto 300mm dia pipe size 25mm size and above 300mm pipe 40mm size gate valves shall be used.

Discharge from the purge valves shall be piped through GI pipe of similar size to the nearest drain / khurrah. The pipes shall be pitched towards drain points.
- m. All buried pipes shall be cleaned and coated with zinc chromate primer and bituminous paint, thereafter wrapped with two layers of RP tissue each layer laid in bitumen.

Insulation

Chilled Water and Drain Pipes shall be insulated as required or as shown on the approved drawings and in line with with specifications stipulated in section 'INSULATION' .

Vibration Elimination

Piping installation shall be carried out with vibration elimination fittings wherever required to ensure vibration and noise free installation.

Testing & Balancing

- a. All piping shall be tested to hydrostatic test pressure of at least two times the maximum operating pressure but not less than 10 Kg/ Sq.cm for a period of not less than 24 hours prior to commencement of application of insulation.. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer – in- charge.
- b. Piping repaired subsequent to the above pressure test shall be retested in the same manner.
- c. Systems may be tested in sections and such sections shall be securely capped.
- d. All concerned agencies including Consultants shall be notified well in advance by the contractor of his intention to test a section of piping and all testing shall be witnessed by the Purchasers/Consultants or their authorized representative.
- e. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectified the defective connections. He shall bear all the expenses for carrying out the above rectification including the tarring- up and re-finishing of floors, walls etc. as required.
- f. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spilled over water is removed.
- g. After completion of the installation and testing entire chilled water system shall be adjusted and balanced to allow flow of water as required to meet essential design parameters.
- h. Complete certified balancing report shall be submitted by the contractor for evaluation and approval.

- i. The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Consultants.

Painting

After the piping has been installed, tested and run for atleast three days of eight hours each, all bare un – insulated water piping shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

Refrigerant Piping for VRV System:

All refrigerant piping for the VRV air conditioning system shall be constructed out of hard drawn copper refrigerant pipes with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good engineering practice within the air-conditioning industry, and shall be inclusive of charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweet joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

The Refnet Joints (Y-joints) and Refnet Headers shall be made from copper and would be imported, factory fabricated and pre-insulated.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 35Kg/Sq. Cm and 10 Kg/Sq.Cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum of 700mm Hg and held for 24 hours.

The air-conditioning system supplier shall verify the refrigerant piping design conceived and brought to the notice of Consultants if any discrepancy is found.

The OD & wall thickness of copper refrigerant piping shall be as follows:

Outside Pipe Dia (mm)	Wall thickness (mm)
54.1	1.5
41.3	1.3
34.9	1.3
28.6	1.2
25.4	1.2
22.2	1.2
19.1	1.0
15.9	1.0
12.7	0.8
9.5	0.8
6.4	0.8

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed

thereon.

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick closed cell elastomeric insulation material.

The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

Drain Piping:

- a. All pipes to be used for drain, condensate drain and fittings shall be galvanized steel class 'B' (medium class) conforming to relevant IS & BIS Codes.
- b. All jointing in the pipe system shall be by screwed and / or by screwed flanges using 3mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.
- c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.
- d. Fittings shall be galvanized steel "medium class" malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, and gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing Tees. All equipment and valve connections or connections to any other mating pipes shall be through flanges required for the mating connections.
- c. All condensate drain piping shall be insulated with closed cell elastomeric insulation material of thickness as mentioned in "Schedule of Quantities".

Insulation

Drain Pipes shall be insulated as required or as shown on the approved drawings and in line with specifications stipulated in section 'INSULATION'.

K. ELECTRICAL WORKS

1. GENERAL

1.1 STATUTORY REGULATIONS AND APPROVALS

All electrical works shall be carried out only by those Contractors who are licensed by the concerned local authorities to execute this type of work and who have sufficient competent staff to undertake work of this magnitude.

It shall also be the responsibility of the Contractor to get the electrical connections from the concerned authorities. However, the Employer will bear all the statutory expenditures.

1.2 I.E. RULES COMPLIANCE

The installations and equipment supplied shall comply in all respects with the Indian Electricity Act and the Indian Electricity Rules (1956) amended as on date.

1.3 STANDARDS AND CODES OF PRACTICE

The work shall be carried out as per the enclosed Specifications of Work and the construction drawings to be supplied by Contractor and approved by the Consultants from time to time. These specifications shall be read in conjunction with CPWD general specifications of Electrical works Part I Internal 1972 and Part II External 1995, relevant Codes of Practice and Standards as issued by ISI (all with the latest amendments) and with 16 edition of wiring regulations of I.E.E.

Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

660/1100 V grade PVC /FRLS PVC insulated wires.	IS 694 : 1990
Rigid steel conduits for electrical wiring. :	IS 9537 : Part I 1980, IS 9537 : Part II 1981
PVC conduits for electrical wiring.	IS 9537 : Part III 1980
Accessories for rigid steel conduits	IS 3837 : 1990
Flexible steel conduits for electrical wiring	IS 3480 : 1990
Switch socket outlets	IS 4615 : 1990
3 pin plugs and socket outlets upto 250 volts	IS 1293 : 1988
Glossary of items for electrical cables and conductors	IS 1885 : 1971
Conductors for insulated electric cable	IS 8130 : 1984
General and safety requirements for fluorescent lamps luminaries	IS 1913 : 1978
Switches for domestic and similar purposes	IS 3854 : 1997
Boxes for the enclosure of electrical accessories	IS 5133 : Parts I & II 1969
Danger notice plates	IS 2551 : 1982
Code of practice for personal hazard fire safety of buildings	IS 1644: 1998
Code of practice for electrical installation fire safety of buildings	IS 1646 : 1997
Code of practice for electrical wiring installations	IS 732 : 1989
Code of practice of fire safety buildings (General- Electrical installations)	IS 1646 : 1982
Guide for safety procedure and practices in electrical works	IS 5216 : 1982

1.4 WORKMANSHIP

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

DRAWINGS AND DOCUMENTS

1. General

- i) The Drawings provided with the Specification shall be treated as confidential documents and must not be copied or loaned to any other party without the express permission of the Architects/Consultants.
- ii) The Drawings are intended as a guide to the firms tendering and give approximate positions of pipes, conduits, cable runs and/or equipment only and in measuring from these drawings, the Tenderer must make due and proper allowance for all necessary diversions from the straight line, rises or falls as may be required for the proper execution of the Works.

Detail drawings in all cases shall be worked to in preference to those of a more general nature and figured dimensions where indicated shall be followed in preference to scale. Where necessary, the exact positions of plant and/or equipment will be decided by the issue of further drawings, but no claim for extra payment due to insufficient information on this scope will be entertained.

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

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

inferred as necessary for the installation as a whole not be expressly specified, the Contractor shall provide and execute such work as part of the Contract and shall not be entitled to any extra payment of that account.

- iv) The Contract Drawings and such other drawings as may be furnished by the Contractor and approved by Consultant during the progress of the Works shall be considered as illustrating between the Drawings and approved by Consultant the Specification, the Contractor shall execute the work in accordance with the decision of the Architects/Consultants. If modifications are necessary, the Contractor shall submit modifications to the Architects/Consultants for approval before such modifications are executed.
- v) All Drawings and Specification are the property of the Architects/Consultants and Employer.
- vi) The Contractor will be required to give and obtain all necessary site and other particulars and to agree such details with the Architects/Consultants. The Contractor must also obtain details of any other Contractor's work affected by his work and shall work in close co-operation with all such firms or persons concerned.
- vii) The Contractor shall be responsible for any damage caused to buildings and contents and works by reason of, arising out of, or incidental to, or in connection with the execution of any work in the Contract Documents.
- viii) The Contractor shall permit nothing to be done which may injure the stability of the Works, or existing buildings and no cutting through floors or walls will be allowed other than where required by the Drawings, without the sanction of the Architects/Consultants.
- ix) Before the work is commenced, The Contractor shall submit to the Architects/Consultants for approval, required shop drawings and other relevant details pertaining to the materials / systems, the Contractor proposes to use / deploy for the project .
- x) The Contractor for all clearance, field conditions, and maintenance of architectural conditions and proper co-ordination shall carefully check the work described on any working drawings submitted with all trades on the job. To this end, the Contractor, during the construction drawing stage, shall ensure that the co-ordinates drawings of all other trades which might interfere with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between trades shall be referred to the Architects/Consultants.

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

- xi) All general layout drawings shall be drawn 1/50 scale, unless agreed otherwise with the Architects/Consultants. Distribution boards, power and control panels, methods of fixing of all equipment, including electrical conduits, detailed cross sections of service ducts, etc., are to be drawn to 1/10 scale.
- xii) The Contractor shall provide a detailed program incorporating working drawing production which can be read in conjunction with the building construction program.
- xiii) The Contractor shall prepare schedules and drawings showing precise details of holes in concrete, block works etc., base frames or support required and the like. The schedules shall show in detail the builders work required to be performed by all other trades for the mechanical and electrical installations. These drawings and schedules, in an approved form, must be submitted and properly approved by the Architects/Consultants before any structural work requiring holes or other modifications is constructed.
- xiv) The contractor shall submit all shop drawings in triplicate to the Architects/Consultants for his approval.

After his approval/ comments, one copy will be returned to the contractor for incorporation and thereafter five (5) copies shall be submitted to the Architects/Consultants.

Signed and approved drawings will not be departed from unless a signed variation or omission certificate is issued in writing by the Architects/Consultants. Drawings returned to the Contractor for alteration or amendment shall be re-submitted to the Architects/Consultants for approval.

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

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

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

2. Manufacturers' Data

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

Manufacturer names, sizes, catalogue numbers and/or samples of all materials shall be submitted for approval. Submittals and working drawings should, as far as possible be complementary so that drawings and submittals can be crosschecked.

- ii) Order of equipment submitted for approval must be accompanied by relevant drawings, technical data, catalogues and samples, Where data, certified drawings or other required information is not available until after orders have been placed, the Architects/Consultants will give provisional approval until all requested drawings and information have been supplied to the Architects/Consultants and approved by him. It is the Contractor's responsibility to ensure that all necessary information is supplied to the Architects/Consultants in accordance with the progress of the work.

3. Operating and Maintenance Manual

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

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

4. "As Installed" Drawings

The Contractor shall arrange to keep on Site a full set of drawings showing the progress of the Works, which must be kept up to date. The Contractor shall keep a record as the work proceeds of any work installed not in accordance with the drawings. On completion of the Works the Contractor shall supply three clear blue prints of each applicable drawing, showing the exact position of all apparatus, cable lines, conduits, switchgear, etc., together with diagrams, schedules, etc. to the Architects/Consultant's requirements and in addition one complete set on reproducible tracing paper and on one complete set of

drawings and other documents in the digital format on the compact disk.

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

5. RATES

The rates quoted for any particular item by the tenderer shall be **INCLUSIVE** of the cost of material, erection, connection, testing, labour, supervision, tools, plant, transportation, contingencies, breakage, wastage and all other sundries for all levels.

The rate shall also be inclusive of cutting holes, making chases in RCC/brick work, inserting sleeves and making good the same. No claim for extra would be entertained on this account.

The quantities mentioned in BOQ may vary (increase or decrease) to any extent without any change in prices.

6. WORK AND TIME SCHEDULE

The Contractor shall prepare a work and time schedule in a format as approved by the Architects/Consultants. The schedule shall be submitted within **SEVEN** days of the award of the Contract. It shall indicate the expected date of commencement and completion of each item of work. The chart shall also indicate the Scheduling of Samples, shop drawings and approvals. In addition to this, the Contractor shall also furnish to the Architects/Consultants fortnightly progress reports indicating percentage completion of each item of work

7. ELECTRICAL DRAWINGS

The electrical drawings are diagrammatic but shall be followed as closely as actual construction and work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the services drawings as far as the civil and other trade works are concerned.

8. DISCREPANCIES IN THE DRAWINGS

Should there be any discrepancy due to incomplete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Architects/Consultants and his decision would be final and binding on the Contractor.

9. MATERIALS

All materials to be supplied by the Contractor shall be new. All packed items shall arrive at site in original packing only. Any items found defective or damaged shall be replaced by the Contractor, at his own expense.

10. INSTRUMENTS FOR MEASUREMENT AND TESTING

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

11. SITE ORDER BOOK

The Contractor shall maintain a site diary, in which daily progress of the work and number of workers engaged shall be recorded. The site diary shall also be used by the Architects/Consultants for writing his comments / instructions.

12. PROTECTION

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

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

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

13. UP-KEEP OF THE SITE

It shall be the responsibility of the Contractor to clear away, from time to time, all debris and excess material generated by the activities of his workers.

14. NOTICE OF COMPLETION AND TESTING FEES

The Contractor shall obtain and pay for all licenses, certificates of approval and testing fees as required by the local codes. After completion of works, the installation is to be tested by the Electrical Inspector. Testing fees for this inspection are to be paid by the Contractor who should inform the Inspector well in the time that the works are fit for the inspection. Prior to inspection by the Electrical Inspector, the Architects/Consultants are to be informed that the installation is complete and necessary tests are to be done in his presence. Only if these tests are satisfactory, can the Electrical Inspector be informed for his inspection. Should the Electrical Inspector feel that the tests are not satisfactory or that some or the whole part of the installation does not conform to the minimum requirements, these should be got rectified at the cost of the Contractor including retesting fees, if any. Defects, if any, pointed out shall be rectified by Contractor, free of cost.

3.0 CONDUIT WIRING SYSTEM

3.1 Steel Conduits

These shall be of mild steel 16-gauge upto 32mm and 14 gauge for sizes above 32mm, electric resistance welded (ERW), and electric threaded type having perfectly circular tubing. Two coats of primer and one coat of black enamel paint applied inside and outside in its manufactured form shall protect the conduits from rust. Conduits shall conform to IS 9537 and shall be IS embossed along the length as stipulated in the IS.

3.2 Steel Conduit Connections

Connections between steel conduits shall be with screwed couplers of approved quality and finish, ensuring screwed metal-to-metal contact. Length of threads in all cases of joints shall be between 13 mm to 19 mm and sufficient to accommodate pipes to full threaded portion of couplers or accessories. Threads and sockets shall be free from grease and oil. Connections between screwed conduits and sheet metal boxes shall be by means of M.S. hexagon check nut fixed both inside and outside the box. Joints in conduits and terminations shall be free of burrs and bushes shall be provided to avoid damage to insulation of conductors while pulling them through the conduits. Connections between M.S. and PVC conduits, if required, shall be through a junction box and direct connections shall not be accepted.

3.3 Bends

As far as possible, the conduit system shall be so laid out that it shall obviate use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two-quarter bends from inlet to outlet.

3.4 Standard Conduit Accessories.

Standard conduit accessories like bends, tees, junction boxes, pull boxes etc. Shall be heavy duty, black enamel painted. The accessories shall conform in all respects to the relevant IS Codes. CONSULTANT

shall be approving samples before use.

3.5 Sheet Metal Outlet/Draw/Inspection/Junction Boxes.

3.5.1 General

Wherever required, outlet boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling fan outlet boxes, which shall be fabricated from minimum 2 mm thick sheets. Outlet boxes shall be provided with minimum 16 mm projected threaded collars. The outlet boxes shall be of approved quality, finish and manufacture. All outlet boxes shall be provided with an earth stud. The boxes shall be protected from rust by zinc phosphate primer process. For concealed conduiting work, boxes with primer only could be embedded. For surface conduiting work, the boxes shall be finished with minimum one coat of enamel paint of approved colour. The outlet boxes shall be so protected at the time of fixing that no mortar finds its way inside during concrete filling or plastering. For concealed conduiting work, outlet boxes shall be completely embedded in walls/ceilings leaving edges flush with finished wall/ceiling surface.

3.5.2 Switch/Socket Outlets Boxes - Modular Type

Boxes suitable to house modular type switches/sockets of required ratings, and fan regulators as required shall be provided. In case the number of switches in one box is not tallying with that available in standard manufacture, the box accommodating the next higher number of switches shall be provided without any extra cost. In case fan regulator/regulators is /are to be provided at a later stage, suitable provision for accommodating such regulators shall be made in the switch boxes and blank off covers shall be provided without any extra cost. The outlet boxes shall be of MS having external and internal surface true to finish. All boxes shall have adequate number of knock out holes of required diameter and earth stud.

3.5.3 Outlet Boxes For Light Fittings.

These shall be minimum 75 mm x 75 mm x 50 mm deep and provided with threaded collars for conduit entry as required. For ceiling mounted florescent fittings, the boxes shall be provided 300 mm off centre for a 1200 mm fitting and 150 mm off centre for a 600 mm fitting so that the wiring is taken directly to the down rod. 3 mm thick perspex/hylam sheet cover of matching colour shall be provided.

3.5.4 Ceiling Fan Outlet Boxes

Outlet boxes for ceiling fans shall be fabricated from minimum 2 mm thick MS sheet steel. The boxes shall be hexagonal in shape of minimum 100 mm depth and 60 mm sides. Each box shall be provided with one 'U' shaped 15 mm dia rod inside securely tied to the top reinforcement of the concrete slab for a length of minimum 150 mm on either side. 3 mm thick Perspex/hylam sheet cover of matching colour shall be provided.

3.5.5 Draw Boxes

Draw boxes of minimum 75mm x 75mm x 50mm deep or larger as required shall be provided at convenient locations to facilitate drawing of long runs of conductors. These shall have screwed covers of 3 mm thick perspex/hylam sheet.

3.5.6 Inspection Boxes / Junction Boxes

Inspection boxes of minimum 75mm x 75mm x 50mm deep shall be provided at suitable location in conduit runs to permit inspection and maintenance. These shall have screwed covers of 3 mm thick perspex/hylam sheet.

3.5.7 Cross Section

The conduits shall be of ample sectional area to facilitate simultaneous drawing of wires and permit future provision also. Total cross section of wires measured overall shall not normally be more than half the area of the conduit. Maximum number of PVC insulated 650/1100 Volt grade copper conductor wires conforming to IS : 694 – 1990 shall be as per table given below.

Nominal Cross Sectional area of conductor in sq. mm	20 mm		25 mm		32 mm		38 mm		51 mm			
	S	B	S	B		B	S	B	S	B	S	B
1.5	5	4	10	8			-	-	-	-	-	-
2.5	5	3	8	6			-	-	-	-	-	-
4	3	2	6	5			-	-	-	-	-	-
6	2	-	5	3			7	-	-	-	-	-
10	2	-	4	3			8	6	-	-	-	-
16	-	-	2	2			6	5	0	7	2	8
25							5	3	8	6	9	7
35							3	2	6	5	8	6
50									5	3	6	5
70									4	3	5	4

Notes :

- ❖ The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- ❖ The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw 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.
- ❖ Conduits sizes are the nominal external diameters.

3.5.8 Laying Of Conduits

Conduits shall be laid either concealed in walls and ceilings or on surface on walls and ceilings or partly concealed and partly on surface, as required. Same rate shall apply for concealed and surface conduiting in this contract.

3.5.9 Concealed Conduiting

Concealed conduits in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embedded the entire run of conduits and ceiling outlet boxes with a cover of minimum 12mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building.

Concealed conduits in brickwork shall be laid in chases to be cut by electrical Contractor in brickwork before plastering. A chase cutting electric machine shall cut the chases. The chases shall be of

sufficient width to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster over conduits. The conduits shall be secured in the chase by means of suitable clamps at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering.

Entire concealed conduit work in concrete members and in brickwork shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brickwork shall be laid before plastering. Should it become necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from CONSULTANT. For embedding conduits in finished and plastered brickwork, the chase would have to be made in the finished brickwork. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.

Cutting chases in finished concrete or finished plastered brickwork for embedding conduits and the Contractors without any extra cost shall do outlet boxes etc.

3.5.10 Surface Conduiting

Wherever so desired, conduits shall be laid on surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600 mm. Holes in concrete or brickwork for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality heavy duty MS clamps screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface conduiting work is of particular importance. The entire conduit work shall be in absolute line and plumb.

3.6 Painting Of Conduits And Boxes

All draw/switch/junction/fan-hook boxes shall be painted with red oxide/galvanized/zinc passivated in their manufactured form. All ungalvanized/unplated boxes shall be again painted with red oxide paint as required before fixing. Boxes fixed on surface shall, in addition, be painted with finishing paint of approved colour and finish

Before laying, conduits shall be painted at such places where painted has been damaged due to vice or wrench grip or any other reason.

3.7 Protection Of Conduits

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs, which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

3.8 Cleaning Of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

3.9 Earthing

Continuous earth wire shall be provided for all points, outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

4.0 WIRING

4.1 STANDARDS AND CODES

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

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

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

650/1100 V grade PVC insulated wires.	IS 694 : 1977
Rigid steel conduits for electrical wiring.	IS 9537 : 1981
PVC conduits for electrical wiring.	IS 9537 : 1981
Accessories for rigid steel conduits	IS 3837 : 1976
Flexible steel conduits for electrical wiring	IS 3480 : 1966
Switch socket outlets	IS 4615 : 1968
Switches for domestic and similar purposes	IS 3854 : 1966
Boxes for the enclosure of electrical accessories	IS 5133 : 1969
Code of practice for personal hazard fire safety of buildings	IS 1644: 1960
Code of practice for electrical installation fire safety of buildings	IS 1646 : 1982
Code of practice for electrical wiring installations	IS 732 : 1989

5.2 POINT WIRING

4.2.1. Measurement and payment

Wiring for light, ceiling fan, exhaust fan, call bell and socket outlet points, carried out as per tender specification, shall be measured and paid on point basis only. No part of point wiring items shall be paid on linear basis. Rates quoted for point wiring items shall be based on parameters stipulated in para below. Average wiring length and average conduiting length forming the basis of point wiring rates, shall take the electrical layouts of the entire project into consideration. Tenderers are advised to seek clarifications, if they so desired, on this aspect before submitting tenders. No claim for extra payment on account of electrical layouts in parts of projects requiring larger average wiring and conduit length per point, whether specifically shown in tender drawings or not, shall be entertained after the award of contract. Only circuit wiring shall be paid on linear basis from PANEL/DB to the first point of a circuit

4.2.2 Parameters

Point wiring shall be carried out as per following parameters.

- a) In concealed/surface conduit system unless otherwise stipulated.
- b) Only looping system of wiring shall be adopted throughout.
- c) All accessories shall be flush type unless otherwise stated.
- d) For estimation of load, following loads per point shall be assumed.

Light points	60 Watts.
6 amps socket outlet points	100 Watts.
Fan points	80 Watts.
Exhaust fan points	150 Watts or as specified.
16-amp socket outlet points	1000 Watts.
25A / 32A Industrial sockets	2500 Watts
- e) Light points, fan points and 6 amp socket outlet points may be wired on a common final such circuit. Such circuit shall not normally have more than a total of 10 light, fan or socket outlets or a load of 800 watts unless otherwise is stipulated. Wiring from DB to the first switch in each sub circuit is defined as circuit wiring, which shall be wired with one size higher wire.
- f) Power circuits shall normally have maximum one 16 amps socket outlet unless otherwise stated. Separate circuit shall be run for each geyser, kitchen equipment, window air conditioners and similar appliances.
- g) Point wiring rates shall include painting of conduits and other accessories as required.
- h) Point wiring rates shall include cleaning of dust, splashes of colour wash or paint from all fixtures, fans, and fittings etc. at the time of taking over of the installation.
- i) Rates quoted for loop points shall be inclusive of the circuit wiring and the looping wiring from the first point controlled with switch / MCB.
- j) Wiring for DB controlled groups of lights shall be done through MCB directly from DB. Control

switches are not required and cost of MCB is also not included in the point-wiring rate since this cost is included in the item of DB. Rates quoted for the DB controlled groups of lights shall be on the same basis as for switch-controlled groups excepting that the cost of switches shall not be included.

- j) All circuits, light points, fan points, sockets, mains and sub mains shall be provided with numbering ferrules at both ends of the wires. The Consultant shall approve the numbering scheme.

4.2.3 Point wiring definitions

4.3.1 Light points

Point wiring for light points shall commence at the distribution board terminals and shall terminate at the ceiling rose/connector in ceiling box/fixture terminal via the control switch. Rates quoted shall be deemed to be inclusive of the cost of entire materials and labour required for completion of point wiring thus defined including : **a)** conduiting system complete with all accessories, junction, / draw/inspection boxes, bushes, check nuts etc. complete as required, **b)** Wiring with stranded copper PVC insulated 660/1100 volt grade wires for point wiring including circuit wiring (wiring from distribution board terminals to the first switch in the sub-circuit) and terminations etc. complete as required. **c)** Control switch with switch box and cover plate of specified type including fixing screws, earth terminal etc. complete as required **d)** Loop earthing with FRLS insulated stranded copper wires complete as required.

4.3.2 Ceiling/Wall mounted fan points

Point wiring for ceiling fan points shall be the same as for light points above excepting that the conduiting system shall also include providing a concealed type fan outlet box as specified above and that the control switch box shall have space provision for providing a fan regulator as required. Point wiring for wall mounted air circulator fans shall be the same as for ceiling fans excepting that the wiring shall terminate an outlet box with connector instead of a ceiling fan outlet box.

4.3.3 Call bell points

Point wiring for call bell points shall be the same as for light points above excepting that a bell push shall be provided in lieu of the control switch and the point wiring rate shall also include the cost of supplying and fixing call bell/buzzer of approved make and type.

4.3.4 5 pin 6 amps socket outlet point (lighting)

Point wiring for lighting convenience socket outlet points shall be same as for light points above and shall, in addition, include supply and fixing a 5 pin 6 amps universal socket outlet alongwith the 6 amps control switch mounted and earthing of the third pin earthed with PVC insulated stranded copper wire unless otherwise specified.

4.3.5 6 pin 6/16 amps outlet point (power)

Point wiring for power convenience socket outlet points shall be same as for light points above and shall in addition includes cost of supply and fixing a 6 pin 6/16 amps universal socket outlet along with 16 amps control switch in lieu of the light control switch and earthing of the third pin earthed with PVC insulated stranded copper wire unless otherwise specified.

4.3.6 Exhaust fan point

Wiring for exhaust fan points shall be same as for 5 pin 6 amp socket outlet point excepting that the socket outlet and the control switch shall not be in the same box. The socket outlet shall be located near the exhaust fan and the control switch shall be located near the light control switches of the room.

4.3.7 Geyser points

Wiring for geyser points shall be same as for 6 pin 6/16 amp socket outlet point excepting that the socket outlet and the control switch shall not be in the same box. The socket outlet shall be located near the geyser and the control switch shall be located near the room entrance as directed.

4.3. 8 Circuit Wiring

Minimum size of ZHFR/ FRLS insulated copper conductor wires for all circuit wiring for light, exhaust fan, ceiling fan and lighting convenience outlet points shall be 2.5 sq mm unless otherwise specified. Circuit wiring shall not be separately measured and paid for. Point wiring rates shall include the cost of providing circuit wiring as required.

4.4 SUB-MAIN WIRING

Sub-main wiring shall comprise of **stranded** copper conductor ZHFR/FRLS insulated 1100volt grade wires in MS conduits as specified including loop earthing, terminations etc. complete as required.

Sizes of conduits, number/ type/size of wires and loop earthing shall be as stipulated in the schedule of quantities and/or drawings.

Wires shall be drawn in the concealed or surface conduits as required, without being damaged. For this purpose, draw boxes shall be located at convenient locations.

Every sub-main shall run in an independent conduit with an independent earth wire of ZHFR/FRLS insulated stranded copper wire as specified running along the entire run of conduit. For single phase, one earth wire shall run and for three phase two earth wires shall run.

Necessary provision of wire lengths entering and emerging from the conduit shall be made for connections.

Measurement shall be taken of the actual conduit run containing the wires from one point to the other.

4.5 ROUTINE AND COMPLETION TESTS

4.5.1 Installation Completion Tests

At the completion of the work, the entire installation shall be subject to the following tests:

1. Wiring continuity test
2. Insulation resistance test
3. Earth continuity test
4. Earth resistivity test

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor at his own cost.

4.5.2 Wiring Continuity Test

All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energised.

4.5.3 Insulation Resistance Test

The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all protection in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 1100 volts for LT circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 megaohms divided by the number of points provided on the circuit the whole installation shall not have an insulation resistance lower than one megaohm. The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and shall be carried out after removing all metallic connections between the

two poles of the installation and in those circumstances the insulation shall not be less than that specified above.

The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant Standard specification or where there is no such specification, shall not be less than half a megaohm or when PVC insulated cables are used for wiring 12.5 megaohms divided by the number of outlets. Where a whole installation is being tested a lower value than that given by the above formula subject to a minimum of 1 Megaohms is acceptable.

4.5.4 Testing Of Earth Continuity Path

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same alongwith the earthing lead but excluding any added resistance of 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.

4.5.5 Testing Of Polarity Of Non-Linked Single Pole Switches

In a two wire installation a test shall be made to verify that all non-linked single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-in-Charge as well as the local authorities.

4.5.6 Earth Resistivity Test

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

4.5.7 Performance

Should the above tests not comply with the limits and requirements as above the contractor shall rectify the faults until the required results are obtained. The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The above tests are to be carried out by the contractor without any extra charge.

4.5.8 Tests And Test Reports

The Contractor shall furnish test reports and preliminary drawings for the equipment to the Engineer-in-Charge for approval before commencing supply of the equipment. The Contractor should intimate with the tender the equipment intended to be supplied with its technical particulars. Any test certificates etc., required by the local Inspectors or any other Authorities would be supplied by the Contractor without any extra charge. All test reports shall be approved by the Engineer-in-Charge prior to energizing of installation.

5.0 MINIATURE CIRCUIT BREAKERS DISTRIBUTION BOARDS (MCB DB)

5.1 GENERAL

This section covers specification of Distribution Boards (DBs) suitable for operation on 415 V 3 Phase 4 wire 50 Hz supply feeding final lighting and power sub circuits.

5.2 STANDARDS AND CODES

Updated and current Indian Standard Specifications and Codes of Practice will apply to the equipment

and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 1910, Indian Electricity Rules 1956, National Building Code 1997, National Electric Code 1985, Code of Practice for Fire Safety of Building (general): General Principal and Fire Grading– IS 1641 - 1988 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

Miniature Air Circuit Breakers for AC circuits IS 8828 : 1996 and IEC 947

Residual current operated Circuit Breakers IS 12640 : 1988

Low voltage switchgear and controlgear Part II IS 13947 : 1993

Degrees of Protection provided by enclosures for low voltage switchgear IS 2147 : 1962

Code of Practice for installation and maintenance of switchgear not exceeding 1000 volts IS 10118 : 1982

General requirements for switchgear and controlgear for voltages not exceeding 1000 volts IS 4237 : 1982

5.3 MINIATURE CIRCUIT BREAKERS

The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system. The MCB's shall have a rupturing capacity of 10 KA lcs. The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with PVC cable characteristic. Watt loss per pole of MCB shall confirm to value specified in IS 8828 – 1996. Type test certificates from independent authorities shall be submitted with the tender. MCBs shall normally be provided with short circuit and overloaded releases. Wherever so specified, they shall also be provided with earth fault, under voltage and over voltage releases. Value of instantaneous tripping circuit shall be as per Type B for resistive or slightly inductive loads like heating and lighting, Type C for motor loads and transformers and Type D for UPS, VFD and high discharge lamps.

Every miniature circuit breaker shall incorporate a tripping mechanism having both a short-circuit release and an inverse time delay characteristic and shall be enclosed in a moulded all-insulated case. The switch action shall be trip free to inhibit closing under fault conditions. All brass parts shall be electroplated and all steel parts cadmium-plated and all contacts silver-plated. Miniature circuit breakers shall be SP, DP, TP or F.P. and of the current rating all as specified elsewhere or approved.

The instantaneous magnetic tripping of the miniature circuit breakers shall be in accordance with the latest edition of the I.E.E Wiring Regulations. The magnetic tripping of miniature circuit breakers shall be 7 to 10 times their rated current

5.4 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB)

RCCBs shall comply to IS 12640 – 1988 and shall be of the current operated type. The RCCB shall be designed to trip within 20 mili sec at a current sensitivity of 30 mA. The RCCB shall be of 2 pole construction for single phase and 4 pole construction for 3 phase. All RCCB shall be complete with test buttons. RCCB shall have a minimum life expectancy of 20,000 operations.

5.5 DISTRIBUTION BOARDS

- I) DBs shall be wall mounting, recessed/surfaced type, totally enclosed, dust and vermin proof and shall comprise of miniature circuit breakers, earth leakage circuit breakers, busbars, neutral link etc as required, of ratings detailed in the schedule of quantities.

- II) DBs shall be double door type. Access to the wiring shall be possible without removing the outer hinged door. The door shall be earthed with insulated copper braided flexible wires. Components forming a part of the DBs shall comply to the relevant Standards and Codes of the Bureau of Indian Standards.
- III) DBs shall be fabricated from minimum 16 gauge CRCA sheet steel and shall have a hinged lockable spring loaded cover. All cutouts and covers shall be provided with synthetic rubber gaskets. The entire construction shall give a IP 42 degree of protection unless otherwise stated.
- IV) The bus-bar shall be of electrical grade copper having a maximum current density of 1.6 ampere per square mm and PVC insulated throughout the length. The minimum spacing between phases shall be 25mm and between phase and earth 19mm
- V) Separate neutral link for each phase shall be provided. All the internal connections shall be with either solid copper PVC insulated or copper conductor PVC insulated wires of adequate rating. All the internal connections shall be concealed by providing a hinged protective panel to avoid accidental contact with live points. All outgoing equipment shall be connected direct to the bus bar on the live side. The equipment shall be mounted on a frame work for easy removal and maintenance.
- VI) The sheet steel work shall undergo a rigorous rust proofing process, two coats of filler oxide primer and final powder coated paint finish. All the circuits shall have an independent neutral insulated wire, one per circuit, and shall be numbered and marked as required by the Engineer-in-Charge.
- VII) A sample of the completed board is to be got approved by the Engineer-in-Charge before ASD of supply and erection. Before commissioning, the distribution boards shall be megger tested for insulation and earth continuity.
- VIII) Distribution board shall be surface or flush mounted as specified. The boxes shall be of rust proof sheet steel with external fixing lugs and detached gland plates.
- IX) An external rust proofed bolt or stud shall be provided for earthing purposes.
- X) The cover shall be flat, close fitting or gasketed and provided with locking facilities.
- XI) Ample wiring capacity shall be provided and the M.C.B banks shall be easily removed or tilted to give access to the terminals.
- XII) The neutral bar shall be provided with a separate neutral connection for every M.C.B way of each pole.
- XIII) Where boards are surface mounted, additional holes shall be drilled in the gland plates to provide wiring facilities for the spare ways on the boards. All such holes shall be plugged with iron, hexagon head stopping plugs.
- XIV) All MCB DBs shall be factory fabricated, of the type as specified in the **Schedule of Quantities** and shall be the same make as that of MCBs.
- XV) Identification of Circuits** : All outgoing circuits shall be identified with PVC numbering ferrules / Tags.
- XVI) Circuit Diagram** : Inside of the door of the MCB distribution board, a well prepared circuit diagram showing circuit numbers, the areas / rooms / utilities being served, conductor size etc. shall be pasted.

5.6 SHEET STEEL TREATMENT AND PAINTING

Sheet steel used in the fabrication of DBs shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint comp actively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

All sheet steel shall after metal treatment be given powder coated finish painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

5.7 NAME PLATES AND LABELS

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

6.0 EARTHING

6.1 GENERAL

All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits, trunking, cable armour, switchgear body, distribution fuse boards, lighting fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS:3043-1987.

6.2 STANDARDS

The earthing system shall be carried out in conformity with the updated and current edition of IS 3043 : 1987. In addition, relevant clauses of Indian Electricity Act 1910, India Electricity Rules 1956 and IEE Wiring Regulations (16th edition), as amended upto date, shall also be applicable.

6.3 EARTHING CONDUCTOR

Every earthing conductor shall be of high conductivity Copper / G.I. and shall be protected against mechanical injury and corrosion.

6.4 SIZING OF EARTHING CONDUCTOR

Earth conductor sizes shall be as shown on the drawings and specified in the BOQ.

6.5 CONNECTION OF EARTHING CONDUCTORS

Main earthing conductor shall be taken from the earth connections at the main distribution panel to the earth electrode with which the connection is to be made. For distribution boards, earthing conductors shall run from Main Distribution Boards. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed by means of an earthing conductor enclosed with the current carrying lighting fittings etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of earthing conductor for earthing purpose, even though the run of metallic conduit is earthed.

6.6 EARTHING STATION

6.6.1 Plate Electrode Earthing

Earthing electrode shall consist of a tinned copper plate of not less than 600 mm x 600 mm x 6 mm or GI pipe of not less than 600 mm x 600 mm x 12 mm thick as called for in the drawings. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible earth electrode shall be kept clear of the building foundations and in no case shall it be less than 2 meters from the outer surface of the wall.

The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe runs from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame.

6.6.2 Pipe Electrode Earthing

Earthing electrode shall consist of a 40mm dia GI pipe of 4500m lengths as per detailed drawings. The pipe electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 4.5 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible earth electrode shall be kept clear of the building foundations and in no case shall it be less than 2 meters from the outer surface of the wall.

The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. The top of the pipe shall be provided with reducer, funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame.

The pipe electrode is to be provided with a double C clamp at the top for onward connections.

6.6.3 Masonry inspection chamber

The watering funnel arrangement as also earth test links shall be accessible and shall be housed in a 400 mm x 400 mm x 400 mm deep masonry inspection chamber having a lockable 10 mm thick cast iron hinged cover plate attached to a galvanized steel frame work embedded in the chamber walls. The hinged cover shall be suitably marked on top so that it is conspicuously identifiable as an earth station.

6.6.4 Location of earth electrodes

Location of earth electrodes shall be based on following guidelines.

- i. Minimum distance between any electrode and building structure shall be 1.5 m.
- ii. Minimum distance between two adjacent electrodes shall be 2 m.
- iii. Electrodes shall be located in accessible locations. Entrances, pavements and roads shall not be used for locating earth electrodes.

6.7 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single-phase circuit shall be connected to earth by a single connection. All metal clad switches carrying 3 phases shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it

against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The overlapping in Copper/G.I. strips in joints shall be riveted / bolted / welded in approved manner. Lugs of adequate capacity and size shall be used for all termination of conductor wires above 5 sq.mm in size. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance.

6.8 INSTALALTION AND JOINTING OF CONDUCTORS

- i) Earthing conductors shall be provided in longest possible unbroken length to minimize jointing of the conductors in between terminations.
- ii) Strip conductors shall be secured to the building walls etc. with appropriate size of saddles at intervals not exceeding 900 mm. The saddle shall be gun metal for copper and GI for GI strips.
- iii) Copper earth strips shall be jointed by butt welding /brazing or the mating surfaces shall be tinned, riveted and soldered.
- iv) GI earth strips shall be jointed by GI bolts, nuts, checknuts and spring washers of appropriate size.
- v) All exposed joints shall be provided with 2 coats of anti corrosive paint.
- vi) Wires shall be jointed by means of lugs of appropriate size connected by bolts, nuts, checknuts and washers. If the connection is on a painted surface, the paint shall be thoroughly removed and the metal exposed for making effective electrical contact. Lugs and bolts shall be of brass for copper wires and GI for GI wires.

6.9 PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system.

6.10 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

6.11 CHEMICAL EARTHING

The maintenance free earthing should be done with the electrode manufacture from custom made GI pipe (3 meter length) with adequate galvanization i.e, more than (80-100m) to ensure maximum conductivity and prolonged service life. The concentrated GI pipe is earthed which is surrounded by the highly moisture absorbing channel mixture for the efficient and long lasting earthing value. Chemical earthing compound is a specially dropped chemical compound capable of absorbing and retaining the moisture for a long time. It can reduce soil resistivity to some extent which helps in faster dissipation of fault current, least fluctuation of ohms value. It eliminate the use of charcoal and salt.

Advantage of chemical earthing

- a) Corrosion free
- b) Constant ohm value
- c) Become part of the soil around the electric
- d) Requires less space and time to install the earthing electrode.

Bounding

To achieve a common earth base, equipotential bounding of the system is necessary. To achieve this, copper strip of 25 mm x3 mm dimensions is dug in an around the site in a 45 cm deep trench and all earth pits are connected together. The communication earth should be connected with the earth grid through

isolation space gap or directly as per advice of equipment provider.

6.12 RESISTANCE TO EARTH

No earth electrode shall have a greater ohmic resistance than 3 ohms as measured by an approved earth Testing apparatus. In rocky soil the resistance may be upto 5 ohms. The electrical resistance measured between earth connection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers, and shall not exceed 1 ohm.

6.13 TESTING AT SITE

6.13.1 Testing Of Earth Continuity Path

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same alongwith the earthing lead but excluding any added resistance of 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.

Earth Resistivity Test

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

7.0 L. T. PANELS

7.1 GENERAL

L.T. Panels are to be suitable for 3 phases 4-wire 415 Volts 50 Hz system with a fault level of 31MVA at 415 volts.

Panels are to be metal clad, cubicle type totally enclosed, floor mounted and air insulated. The total height of the switchboard is to be not more than 2100 mm. Panels are to be extensible on both sides and shall conform to IP - 54 as per IS: 2147 for indoor panels and IP-55 for outdoor panels/ feeder pillars

7.2 STANDARDS

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

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

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

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

7.3 CONSTRUCTION DETAILS

7.3.1 General

Cubicle shall be mounted on a base folded channel. All doors, sidewalls and interior separations shall be of CRCA MS sheet of specified thickness. Insulation barriers and protective screens shall be provided wherever required.

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

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

Creepage distances shall comply with those specified in relevant standard.

7.3.2 Electrical characteristics of Factory Built Assemblies:

The electrical characteristics of component parts of factory built assemblies shall be as indicated and shall apply when the components are mounted in their enclosures, appropriate derating factors having been allowed for effect of enclosures, other components and interconnections.

7.3.3 Enclosures of factory Built Assemblies:

Unless otherwise indicated enclosures shall provide a minimum degree of protection of IP 42 when located within buildings.

Door shall have adequate fastenings with provision for locking in the closed position. Covers requiring tools for their removal are excluded from this requirement. Fixing holes for equipment inside buildings may be inside or outside the enclosure.

Earthing terminals shall be fitted to each enclosure, suitable for internal and external connection, to enable the exposed conductive parts of the protective conductor. Where the enclosure has a painted finish, provision shall be made for earthing terminal to be electrically connected to the enclosure without need to remove any paint from ferrous metal.

Cable terminals shall be suitable for the number, size and type of cables as indicated. Adequate spacing shall be allowed for spreading of cable tails to avoid stress on the insulation or terminals; if necessary, extension boxes shall be fitted to standard enclosures. Terminals for neutral conductors for three phase and neutral circuits shall be the same size as for phase conductor, except where reduced section neutral cable cores are indicated.

Gland plates shall be provided for all multi-core cables of 35 Sq. mm and larger. For all sizes of single-core cable non ferrous gland plates shall be provided and there shall be a clearance of not less than 25 mm between cable glands and ferrous metal.

Metallic enclosures for location within buildings shall have a stove dried painted finish of the manufacturer's standard colour, unless otherwise indicated. Ferrous parts shall be degreased and adequately rust protected immediately prior to painting.

7.3.4 Construction:

All electrical panels will be fabricated from 14 SWG MS sheets properly supported with angles and channels.

The cubicle will be floor mounted type unless specified otherwise. The door will be provided with

internal hinges and panel locks of superior quality. The hinges will be union joint type to facilitate easy removal of the doors when necessary. The doors will be provided in a similar fashion as generally provided for the outdoor cabinet, where water cannot enter in the cabinet from the door. The door will be provided with strengthening arrangement to avoid wobbling and distortion.

Wherever the doors are opened on horizontal hinges, an arrangement will be provided to latch the doors in an open condition for inspection of the wiring.

Generally push buttons, signal lamps and control components will be provided on hinged door, hinged at the top, with suitable latching arrangement to hold the door in open position. These components i.e. push buttons, lamps etc. will be at approximately 1400 mm height. The cabinet will be welded construction and not of jointing construction. The channel frame of 300 mm height fabricated from minimum section of channel 75mm x 6 mm x 40mm will be provided at the bottom of each cabinet. This is required to make the cabinet stable and space for cable bends. The foundation holes with grouting bolts will be provided in the channel frame.

Sectionalized cable entry plates of 16 SWG MS sheets at the bottom complete with cable glands and cable lugs for both the end terminations of each cable should also be supplied in sizes as specified in the panel details.

The circuit components will be mounted on sectionalized 16 SWG MS sheet with suitable threading in the sheets to facilitate easy maintenance, future addition etc. The circuit components will be mounted on sectionalized 16 S.W.G. M S sheet with suitable threading in the sheets to facilitate easy maintenance, future addition etc.

7.3.5 Lockout / Tag out features

Lockout or tag out of energy isolating devices shall be used to ensure that the machines or equipment are isolated from all potentially hazardous energy, and are locked out or tagged out before employees perform any servicing or maintenance activities where the unexpected energization, start-up or release of stored energy could cause injury. Servicing and/or maintenance which takes place during normal operations is covered only if an employee is required to:

- remove or bypass a guard or other safety device;
- place any part of the body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during a machine operating cycle.

Capable of Being Locked Out - An energy isolating device will be considered to be capable of being locked out either if it is designed with other attachment or integral part to which, or through which, a lock can be affixed, or if it has a locking mechanism built into it. Other energy isolating devices will also be considered to be capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

Energy Isolating Device - a mechanical device that physically prevents the transmission or release of energy including but not limited to the following: A manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors and, in addition, no pole can be operated independently; a slide gate; a slip blind; a line valve; a block; and any similar device used to block or isolate energy. The term does not include a push button, selector switches, and other control circuit type devices.

Lockout - the placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and equipment being controlled cannot be operated until the lockout device is removed.

Lockout Device - a device that utilizes a positive means such as a lock, either key or combination

type, to hold an energy isolating device in the safe position and to prevent the energizing of a machine or equipment.

Tagout - the placement of a tag out device on an energy-isolating device, in accordance with an established procedure, to indicate that the energy isolating device and equipment being controlled may not be operated until the tagout device is removed.

Tagout Device - a prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

7.3.6 Dimensions:

The height of the panel will be as per the drawing but not be more than 2200 mm. Depth of the panel will not be more than 1400 mm and width of the panel will be given in the particulars of panel specifications. Width of the door will be restricted to 600 mm. Shop drawings shall have to be approved by the Engineer-in-charge before fabrication is taken up by hand.

7.3.7 Adaptor Chambers for all cable entries:

Wherever necessary, sheet metal adaptor chambers with angle frame and minimum depth of 300 mm will be supplied with panel. All the covers of adaptor box will be removable type. The box can be mounted horizontally or vertically. The pattern of cable entry, wherever not specified will have to be confirmed by the manufacturer in writing after placement of order.

7.3.8 Insulation:

The insulation between phases and between phases and ground of the power conductors will be made of synthetic resin board/molding, resistant to dust and dampness. All insulating material will be non-hygroscopic, fungus-proof and treated with suitable synthetic varnishes.

7.3.9 Terminals:

Upto 35 sq. mm cables, the terminal will be provided of clip-on type generally manufactured by M/s Elmex or M/s Technoplast and above 35 sq. mm, cable end terminals will provide of brass stud type designed of rugged construction.

7.3.10 Wire ways:

PVC extruded wire ways of required size will be provided for wiring in the control panel.

7.3.11 Ferruling and colour code:

Cabling for power circuit should be red, Yellow and blue or otherwise proper coloured sleeving will be provided at both ends of cables. For control cables every conductor will be provided with the identification ferrule matching with the one in the drawing.

7.3.12 Cable Termination:

Every cable, either for control or power duty will be provided with crimped type of lugs of suitable size as specified.

7.3.13 Cables (Internal Wiring)

All the cables will be FRLS PVC insulated of ISI approved and reputed make. The cables will be copper conductor only and will be stranded and minimum number of strands will be three. The ratings will confirm to IEE regulations. PVC flexible conductor, if used, will have minimum size of 24/35.

7.3.14 Earthing:

The earth Bus-bars should be of tinned copper/Aluminium as specified, G.I. bolts and nuts. Bolts to be of cadmium plated with washer. Earth Bus-bars will be provided all around the cubicle at the bottom and it

will be of the same size as neutral Bus-bar but the maximum size will be 75 x 6 mm with duplex external earth connection arrangement.

7.3.15 Cable Glands and Lugs:

The cable glands will be of brass cone grip type. These glands will be provided for all the outgoing connections at both the ends for power as well as control circuits provided in the panel and also for the incoming cable or cables. Lugs will be crimped for termination of outgoing cable at both ends (i.e. load end and panel end) with each outgoing feeder.

7.4 Feeder Units:

The feeder units shall be of compartmental design comprising of cubicles assembled together and shall incorporate cubicle ACB / MCCB and MCB having rupturing capacity of 65/50/35/25 KA and 10 KA at 440 volts respectively.

The MCCB shall be quick break and trip free type with magnetic thermal release and under voltage release protection against overload and short circuit and under voltage.

Individual ACB / MCCB (with ammeter, selector switch, CTs) small wiring where provided should be easily removable from the front of the switchboard for servicing and maintenance.

The connections to ACB / MCCBs from the Bus-bars and cables should be terminated in pressure bolted joints inside the switch contacts.

Bus bar should have sufficient mechanical strength to withstand the effects of short circuit until it can be cleared by appropriate protecting device. All Bus-bars should be clearly marked with appropriate colour code to enable immediate identification of the phase and neutral.

The vertical bus bar should have a number of laminations to give appropriate current rating and can be graded to suit the current rating required at each point by omitting laminations at the points of current decrease. All Bus-bar connections should be clamped and no drilling should be necessary.

Arrangements should be provided to receive PVC cables either from the topside or from the bottom (as specified). End plates should be mounted inside the Bus-bar at unit level for cables from above or below.

All sheet-steel parts used in the construction of a cubicle board should have undergone rigorous rust proofing process which must comprise of alkaline degreasing descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall be finished with powder coating paint.

The equipment when assembled shall form a neat and compact unit and shall be complete with supporting framework, mounting channels, and foundation bolts etc. and shall be designed so as to ensure complete interchangeability of components.

7.5 Capacitor Bank & Panel:

This specification covers requirements of Medium Voltage Capacitors and Control Panel to be used for power factor improvement of the electrical system and shall be connected to Main L.T. Panels. Automatic Power Factor Correction Panel shall function to improve power factor of the system in which it is connected. It shall improve power factor upto minimum 0.95 from initial power factor of 0.70.

The design, manufacture and performance of power capacitors and accessories shall comply with all currently applicable statutes, regulations and safety codes for power installation as prescribed in relevant IS codes and to requirement of Local Electricity Supply Authority to which the equipment shall be installed.

Unless otherwise specified the capacitor and control panel shall conform to following:

- a. IS : 2834 - Shunt capacitors for power systems.
- b. IS : 2147 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
- c. IS : 4237 - General requirements for switchgear and control gear for voltages not exceeding 1000V.
- d. IS : 8623 - Specification for factory built assemblies of switchgear and control gear (Upto 1000 volts).
- e. IS : 2208 - HRC cartridge fuse links upto 650 volts.
- f. IS : 4064 - Specification for Fuse Switch and Switch Fuse switchgear and control gear.
- g. IS : 2959 - AC contactors for voltage not exceeding 1000 volts.

Capacitor bank shall be suitable for operation on 415 volts 3 phase, 4 wire, 50 c/s, solidly earthed AC supply system. The capacitor shall be connected to the 415 V Switchgear bus and shall be manually as well as automatically switched in and out in steps so as to correct the power factor to be required value depending on the actual KVAR requirement of bus.

The capacitor bank shall be complete with the required capacitor units with the supporting post insulators, sheet steel cubicles, bus-bars, connecting strips, foundation channels, fuses, corrosion proof rating plate etc.

Each basic unit is to be built up with a number of elements. These elements should be wound with high-grade metallized polypropylene film. These metallised film capacitors should be self healing, having very low loss factor. Capacitor element to be completely sealed with epoxy resins to provide maximum humidity protection and highest insulation. The capacitor elements are to be given adequate outside insulation and should be put in all welded surface treated MS containers. These capacitors shall be impregnated with special grade of capacitor oil under high vacuum. The metal case shall be equipped with porcelain bushings to permit connection between power lines and active capacitors.

Externally each capacitor unit shall have two separate earthing points, name plate conforming to the requirements of IS:2834 (amended upto date), discharge resistance etc.

The capacitor bank may comprise suitable number of single phase self cooled hermetically sealed units in series parallel combination to achieve required KVAR rating. However, failure of one unit shall not create an over voltage on other units connected in parallel to avoid failure of parallel units.

Each capacitor unit/bank shall be provided with directly connected continuously rated, low loss discharge device built into the unit to reduce the residual voltage to a safe value within the specified time as recommended in the relevant standard after the capacitor has been disconnected from the supply.

All capacitors shall be suitably protected against over current by means of suitable over current protection (other than fuses) which are adjusted to interrupt the circuit when the current exceeds the safe permissible limit.

Capacitor units shall also be protected against internal faults and the effected units/banks shall be automatically and immediately isolated in the event of such fault.

Each capacitor unit shall continuously operate at the following overload conditions separately.

- a. Over voltage upto 10% of the rated RMS voltage.
- b. Over current upto 15% of the rated current.
- c. Maximum reactive output upto 30% over the rated reactive output.

Each capacitor unit shall be individually protected by HRC fuses with visual indication for operation. The control panel shall be indoor, cubicle type, floor mounted, dust and vermin proof conforming to degree of protection IP54 excepting the enclosure enclosing capacitor bank which shall be of protection class IP-41.

Cubicle shall comprise rigid structural frame enclosed by 3mm thick cold rolled sheet steel, doors and covers shall be from 2mm thick cold rolled sheet steel. Structural frame-work with foundation bolts etc. shall be provided at the bottom to mount control panel directly on concrete/floor/steel channel base.

All doors, removable covers shall be gasketed all around preferably with neoprene gaskets.

The capacitors control panel shall, in general, comprise of the following and shall be housed in well-ventilated panels. Capacitors and their control elements may be installed in different compartments of the same panel to minimize space requirement.

- a. Power factor correction relay.
- b. Step controller with reversing motor.
- c. Time delay and No-volt relays.
- d. Protection fuses.
- e. Contactors for individual capacitors banks.
- f. Change-over switch for either automatic operation or manual operation with push button control.
- g. Visual indication for capacitor IN-OUT.
- h. Incoming fuse switch unit.
- i. 4 pole auxiliary switch for power supply to APFC relay.
- j. Ammeter with selector switch & CT's.
- k. Voltmeter with selector switch, protection fuse, indicating lamps.

Switches shall be triple pole, air break AC-23 duty. The switch shall have a quick make, quick break mechanism operated by a suitable external handle complete with position indicator.

The compartment door shall be interlocked mechanically with the switch so that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the listed short circuit current. Fuses shall be complete with fuse base and fitting of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

The Contactors shall be three pole, air break type designed for duty class III category AC3 with non bouncing silver/silver alloy contacts. Each Contactor shall be provided with 2 NC and 2 Nos. auxiliary lamps contacts rated at 10 amp. Indicating lamps shall be low watt filament type with series register. Lamp and lens shall be replaceable from front.

The main buses and connection shall be of high conductivity aluminium/aluminium alloy, sized for specified current rating shall be limited to 105OC and 100OC for silver plated copper joints and aluminium joints respectively.

For all bus connections adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts. Bus-bars and connections shall be fully insulated for working voltage with adequate phase/ground clearance. Insulating sleeves for bus-bars and shrouds for joints shall be provided. Shrouds for Bus-bar joints and tapping points shall be of two part epoxy resin cast/fibre glass moulded. Minimum clearance of 25mm is required between phases and between phase and earth irrespective of sleeve/shrouds provided for Bus-bar. Insulating shrouds shall be of moulded type.

Bus supports shall be non-hygroscopic type epoxy/SMC/DMC with high creepage surface. All buses and connections shall be supported and braced to withstand the stresses due to maximum short-circuit current and also to take care of any thermal expansion. Bus bars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the front to panel assembly. The horizontal Bus-bar chamber shall be separate and totally enclosed. Gland plate shall be minimum 3mm thick & shall be removable. Screws of

corrosion resistant material shall be furnished on all ventilating louvers to prevent the entry of insects. All internal wiring inside the cubicle shall be carried out with 650 V grade, PVC insulated copper wires duly ferruled at either end. The power wiring above 100A shall be carried out with PVC insulated aluminium links.

Separate labels shall be provided for relay, instruments, switch, indicating lamp etc. Approval for the type of label shall be taken from the Engineer-in-Charge.

Painting shall include emulsion cleaning, pickling with dilute acid, washing and rinsing by water, phosphating and oven drying. One (1) coat of stoving type zinc chromate primer and two (2) coats of synthetics enamel.

Automatic control relay with necessary taps shall be provided.

7.6 AIR CIRCUIT BREAKERS

Air circuit breakers shall be metal clad, flush mounted, horizontal draw out isolation, air break type complying with IS 13947 Part III. Air circuit breakers shall have a rupturing capacity of not less than short circuit current as indicated on the drawings for 3 seconds certified by CPRI or other recognized testing authorities. The air circuit breakers shall have a minimum mechanical life of 10,000 operations, with minimal maintenance.

The closing mechanism shall be of the manual spring charged type through a cranking or operating handle. The speed of operation shall be dependent on the stored spring energy and not on the speed of the operating or cranking handle.

A shunt trip coil shall accomplish normal opening of the circuit breaker. A latching mechanism, capable of opening the circuit breaker, shall also be incorporated. All operating circuits for opening and closing the circuit breakers shall be wired such that the operating circuits shall be automatically cut-off once the circuit breaker has attained its 'fully close' position.

Sufficient auxiliary contacts attached to the circuit breaker shall be provided for interlocking and signaling purposes.

The tripping mechanism shall be stable and shock or vibration shall not influence its operation. The design of the trip plunger shall be such that its action is instantaneous once the trip circuit is operated.

The main contacts shall be of high-pressure butt type. The contact surfaces being coated with a silver alloy material. Arcing contacts shall also be incorporated and these arcing contacts shall be capable of diverting the arc from the main contacts. All contacts shall be of the renewable type.

Individual arc chutes shall be provided on each pole of the breaker. They shall be so designed that any arc caused by the opening of the breaker under maximum fault condition shall be contained in the arc chute. There shall be no possibility of a 'flashover' between phases or between phases and neutral or phases and neutral or phases and earth.

Auxiliary switches, relays and contactors where deemed necessary for the proper operation of the circuit breaker, shall be provided. Auxiliary switches shall be of robust and double break type, easily accessible for maintenance and having adequate current ratings to carry the connected loads.

The circuit breaker shall be capable of the following operation positions :

- a) 'Service Position' : The breaker is ready for operation
- b) 'Test Position' : The breaker can be operated and tested without engaging the live contacts
- c) 'Isolation Position' : The breaker cannot be engaged at all.

Interlocking facilities shall be incorporated such that the breaker cannot be withdrawn when the breaker contacts are engaged in the 'Closed' position and the breaker cannot be pushed into the 'Service' position when the breaker contacts are engaged in the 'Closed' position.

Where two breakers are required to be interlocked with each other such that no two breakers can be engaged at the same time, Castell key interlocks shall be used.

Integral direct acting short circuit and over current protection relays shall be fitted. These relays when activated shall energize the shunt trip. The shunt trip operation shall be independent of variations or failure of the mains supply voltage.

Padlocking facilities, safety shutters to busbar plugs, number of operation counter, auxiliary switches, relays, contactors, electrical and mechanical interlocks, alarm indication and operation status indication shall be provided to ensure the proper operation of the air circuit breaker. In addition to those required for the functions covered in the Specification, a reasonable number of auxiliary switches shall be provided to cover possibility of future alarm or signaling circuit requirements. All auxiliary switches shall be robust, double break design, easily accessible for maintenance and replaceable.

7.7 MOULDED CASE CIRCUIT BREAKERS

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

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

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

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

7.8 SWITCH FUSE UNITS / FUSE SWITCH UNITS

Fuse switch units shall be of the load break heavy-duty type suitable for cubicle mounting with front operation. The switches shall conform to the requirements of IS : 13947 and shall be suitable for being fitted with HRC fuse links conforming to IS : 13703. The operating handles shall be interlocked with the opening of the door. The switches shall however be provided with defeat interlock.

7.9 CURRENT TRANSFORMERS

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

7.10 INSTRUMENTS

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

7.11 BUS BARS

The bus bar shall be of Aluminium strip designed for a continuous current of specified rating and fabricated from bars conforming to grade E - 91 of IS : 5082. Each bar shall be provided with flexible

expansion links as approved.

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

7.12 CONTROL WIRING

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

7.13 LABELS

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

7.14 TESTS

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

- a) Verification of temperature rises limits.
- b) Verification of dielectric properties.
- c) Verification of short circuit strength.

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

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

7.15 METAL TREATMENT AND FINISH

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

- i) Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii) Pickling in dilute sulphuric acid to remove oxide scales and rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- iii) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and

also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

- iv) Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v) Drying with compressed air in a dust-free atmosphere.
- vi) Powder coated to the specified shade of IS : 5. The total thickness of paint should not be less than 25 microns.

8.0 INTELLIGENT ADDRESSABLE FIRE ALARM AND DETECTION SYSTEM

8.1 GENERAL

The Fire Alarm System supplier shall furnish and install a fully integrated Fire Detection system. All the sensors, modules, devices are to be installed in entire premises.

This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, analog addressable, intelligent fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

The Fire Alarm System shall confirm to EN54, BS: 5839 or NFPA 71/72. The System shall give Audio/Visual Alarm Signals when there is rise in temperature in case of Heat Detector or while measuring Smoke Density in case of Smoke Detector, while it exceeds the pre-set limit. The system shall give pinpoint location of fire with warning system and voice communication for commands and instruction if required. It shall be possible to program each loop with up to a minimum of 99 Detectors & 99 Modules in a circuit.

8.2 SCOPE

The scope of work is designing supplying and installing of Analogue Addressable Fire Detection and Alarm System.

The work under this system shall consist of furnishing all materials, equipment and labor necessary to install the Fire Detection and Alarm System, complete with Main Fire Alarm Control Panel, Sensors, Sounders, Strobes, Manual Call Stations, Relays etc. for interfacing with other systems if required.

It shall include laying of cabling duct, conduits and power supply etc., necessary for installation of the system with supply of sensors and devices as per the Specification and Bill of Quantities.

The Building should be designated as multiple fire zones with each area forming one or more software programmed zones. All wiring shall be done using 2C1.5 mm² FS cable screened FRLS insulated armored copper cable while exposed, and in MS Conduits while concealed in concrete.

The sensors shall have located in all the three voids viz. ceiling void, room void and floor void. The reflective type Beam Detectors to be installed in as depicted in drawing.

8.3 STANDARDS

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

- A. EN54, BS: 5839 or NFPA 71/72
- B. TUV SIL 2
- C. LPCB

- D. FM (Factory Mutual)
- E. Certified compliance to European Norms (EN 54)
- F. Local Authorities certificate

8.4 APPORVALS

The system shall have proper listing and/or approval from the following nationally recognized agencies:
EN 54 Part I & Part II

8.5 SYSTEM REQUIREMENTS

8.5.1 General Requirements

The proposed FDAS shall cover specific areas in different facilities as defined in, The detectors shall be Analogue Addressable Intelligent detectors.

The coverage shall include the false flooring and false ceiling wherever coverage is mentioned to the room.

The number of detectors and location shall conform to relevant standards but not less than one detector per 12-sq. Meter area. Addressable intelligent detectors shall be used. The detectors shall give the visual and audible alarm at the respective control room. All the panels shall be located in the respective control rooms.

The fire alarm panel shall operate 240V \pm 10%, 50Hz. The FDAS shall also be provided with a dedicated standby power supply system (battery and charger) capable of maintaining the system for a period of not less than 48 hours after failure of ac power supply after which sufficient battery shall remain to provide full load operation for at least 30 minutes in line with IS 2189. Battery shall be sealed maintenance free type.

The system should be able to detect any type of smoke, fire and heat in the respective site area.

An intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

Basic Performance of FDAS shall be based on following guidelines:

9 BASIS OF DESIGN

An Intelligent Modular/ Expandable Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The system shall be provided with addressable fire alarm initiating, annunciating and control devices. Multiple stand-alone panels should be able to network with each other to take care of multiple sites. The addressable and intelligent system shall be such that smoke/heat, manual call points, etc., can be identified with point address.

The FDAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a alarm condition or the need of maintenance.

Read-out or address an actual detector location. The operator shall also be able to adjust alarm and alarm thresholds and other parameters for the Detectors.

Provide a maintenance/pre-alert alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.

Provide alarm verification of individual Detectors. Provide local numeric point address and LED display of device and current condition of the point.

Each detector shall use state-of-the-art Microprocessor Circuitry with error, detector self- diagnostics and supervision programs.

The detection of the fire shall be taken at the detector level.

Provide outputs that are addressable, i.e. Outputs shall have point address. The operator shall be able to

command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

1. The System Alarm LED on the main fire alarm control panel shall flash.
2. A local sounder shall be sounded.
3. The LCD display (touch screen type) on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.
4. Printing and history storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.
5. All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

10. FIRE ALARM CONTROL PANEL (FACPL)

The Addressable Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as in networking mode such as many such panels will be in a network. FACP shall have its own microprocessor, software and memory. FACP design to meet IEC 61508, SIL2/3, EN 54-4 and EN-54-13 regulations. FACP should have 16x40 character display and dedicated loop circuit for zone 0, 1 and 2 devices.

FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition. FACPs shall provide general purpose outputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commendable outputs, which can operate relays or logic level devices.

Detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall have facility for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring. It shall be possible for the panel to have a loop length with different modules offering up to 3km of length of loop from the panel.

Zones/loops shall be protected by inbuilt fault isolator modules in all addressable detectors & devices such that in the event of open or a short circuit the integrity of the system is maintained.

Intelligent smoke and thermal sensors shall be located as shown and shall report alarm.

The FACP shall have Drift Compensation facility to compensate for environment. The FACP should be EN 54 / FM listed approved to provide the sensitivity measurement and documentation required.

FACP shall be backed up with its built in battery & Battery and Battery change. Battery shall have capacity of complete operation for 48 hrs.

The display on FACP shall provide indication for AC Power, System Alarm, System Trouble/Security Alarm, Display Trouble and Signal Silence.

This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the LCD touch pad & alpha-numeric keyson the FACP panel to reconfigure the above parameters.

Power supply unit of FACP shall have following characters:

1. The main power supply shall be 230V AC \pm 10%, 50Hz \pm 1% and shall in turn provide all necessary Power of the FACP.

2. It shall provide a separate battery control module with charger.
3. For ease of service, all wiring terminal blocks shall be plug-in type.

11. DETECTORS AND DEVICES

General features common to all detectors:

Built-in-response indicator

Each detector shall incorporate indicator "LED" at the detector which shall light up/blink on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

Construction

The components of the detectors must not be damaged by static over voltage.

A) Multi Sensor Smoke Detectors

- 1 The multi-sensor (Optical/Heat) smoke detectors shall be of the intelligent type with inbuilt DFYI+ Filtering and self-verify and learning features.
- 2 The multi sensor smoke detectors shall have been tested to meet the requirements of EN54 Pt. 7 (EN54 Pt. 15 in future)
- 3 The detector shall be capable of having its function changed during periods when contamination may be present in the area.
- 4 The multi-sensor smoke detectors shall be capable of being locked into the base to prevent unauthorized removal.
- 5 The manufacturer shall have available the following versions of the multi-sensor smoke detector to meet different applications:
 - i. Analogue addressable
 - ii. Analogue addressable with Self Verify
 - iii. Analogue addressable - intrinsically safe
- 6 The detector shall incorporate and LED, clearly visible from the outside, to provide indication of alarm activation, have an output for a remote LED and be fitted with short circuit isolators.

B) Thermal Detector with Isolator Base

Heat detector to detect fires with rapid rises in temperature and/or a maximum temperature value. Alarm LED can be seen from all angles.

Maximum triggering temperature is programmable for 58°C or 73°C. Differential unit 1°C/min - 30°C/min.

Detector and transmission electronics in the detector head for easy exchange in the event of a malfunction. Therefore, no electronics are permitted in the base.

High level of immunity to electromagnetic influences.

Detector scanning routines with evaluation and multi-transmission of the following criteria: Life-zero monitoring, Recognition of sensor damage, Alarm signal when limit temperature is reached

Alarm signal when the temperature rate-of-rise is exceeded (rapid temperature development), Pre-alarm before alarm is issued.

Automatic addressing during initial setup or exchange of the detector, without making adjustments to the detector.

It must be possible to freely program the detector number according to local circumstances and to display it on all user interfaces and display interfaces that are in the fire detection system (individual identification) Wide sensor check (remote diagnosis).

Active self-monitoring of sensors with corresponding evaluation electronics.

Adjustment of the maximum temperature value in combination with or without the temperature differential value.

Theft protection to protect against unauthorized removal of the detector from the socket, included in the standard version and can be activated as desired.

C) Detector Base

Suitable for surface and flush mounting and should have built-in isolator circuit.

Anti-removal protection can be activated on-site without tools

Sufficient connection room also for cable while maintaining function Direction of mounting can be selected as desired because the detector display can be read from all sides Cable in and out feed separated into different directions, yet can be jointly routed in one direction Terminal technology for the connection technology for mounting that is easy on the cable Connection for parallel detector display (Response indicator)

12. Manual call points

Intended for Indoor/ Outdoor mounting,

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Press/break stations with resettable capability are also acceptable.

Manual stations shall be constructed of high impact LEXAN sheet with clearly visible operating.

Instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush

Mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

Individual detector identification with display of the detector address to quickly locate the detector triggered.

Acknowledgement LED displays-red, for trigger and alarm indication(flashing) and/or maintenance evaluation.

Protective category the same as the requirements of IP 54 for indoors & IP 65 for outdoors.

a. Output Module

The output modules shall be used to control zone of normally open dry-contact for Door Holders, Air

Handling Unit Shut Down, etc., This should also be addressed through Direct Code Wheel Rotary Switch with built-in Magnetic Alarm Test Switch. This should be wired directly in the loop. The system shall also be able to handle separate modules to interface the speakers of the Public Address System and Conventional Sounder Circuits.

b. Input Module

The input modules shall be used to monitor zone of normally open dry-contact alarm activation devices. This should also be addressed through Direct Code Wheel Rotary Switch with built-in Magnetic Alarm Test Switch. This should be wired directly in the loop.

c. Signalling Devices - Addressable Sounder- Loop Powered

Sounder for sounding a local alarm, designed for and can also be used as ceiling mount or wall mount for integrated tone generator and sound converter Monitored control and voltage supply via the loop system and external supply. Designed for surface and flush mounting cable feed Individual control of base sounders via assignment to any desired detector in the fire detector system.

6 tones programmable from the fire detector control panel; at least one of these tones can be selected to comply with at least 110 dB (A) Frequency range of 440 Hz to 2 850 Hz Volume can be adjusted from the fire detector control panel Various signals for pre-alarm and alarm.

d. Response Indicator

In addition to built-in response indicator in each detector. Secondary response indicator of LED type shall be provided outside the rooms.

Installation shall be in accordance with the IS 2189, NEC, NFPA 72 / EN 54 local and as per NBC.

e. Beam Detectors

1. Features

- a. Modular design
- b. Easeful First Fix system
- c. Integral LASER
- d. Auto-Align automatic beam alignment
- e. Auto-Optimizes building movement and
- a. Contamination compensation
- f. Low level system controller
- g. worldwide approvals including EN 54-12 and UL268

Descriptions

The Beam Detector combines an infrared transmitter and receiver in the same discrete unit and operates by projecting a well-defined beam to a reflective prism, which returns the beam to the receiver for analysis. Smoke in the beam path causes a drop in power, which, if below a pre-determined level, results in an alarm signal. A full range of installation accessories is available including the universal bracket, which allows a greater degree of flexibility during installation.

Once the detector head is connected, using an integral LASER can be activated. This allows the reflective prism to be sighted quickly and with confidence. Once the LASER has been used to coarsely align the beam, Auto-Align takes over and automatically steers the beam into the optimum position. The system can be fully customized, according to local conditions; alarm thresholds (sensitivity) and time to Alarm/Fault can be set from the low level system controller.

The system is fully compliant with the requirements of RoHS& WEEE.

f. Technical specification

Parameter	Min.	Typ.	Max.	
Operating voltage (to system controller)		14VDC		28 VDC
Operating current - low current mode		8mA	10	12 mA
Operating current - high current mode		48	50	52 mA
Response threshold/ Sensitivity (Default 35%)		0.45dB/10%	3.98dB/60%	
Delay to Alarm – user settable (Default 10 sec)		2		30 sec
Delay to Fault – user settable (Default 10 sec)		2		30 sec
Operating distance (separation)*	20			100 m
Maximum angular misalignment of detector from optical axis				±0.3 deg
Maximum angular misalignment of reflector from optical axis				±5 deg
Optical wavelength		850 nm		
Fault level/ Rapid obscuration ($\Delta \leq 2$ sec)				87 %
Operating temperature		-10 deg C		+55 deg C
Storage temperature		- 40 deg C		+85 deg C
Relative humidity (non condensing)				93 %
IP rating (degree of protection)			54	
Contact voltage - Fire & Fault relays (DPCO)		0.1 VDC		36 VDC
Contact current - Fire & Fault relays (DPCO)		0.1 mA		100 mA
Cable length – system controller to detector (2 core screened fire resistant)				100 m
Cable gauge	24 awg/0.5mm	14awg/1.5mm		
Housing flammability rating		UL94V0		
CPD reference			0832-CPD-0565	
UL file		S3417		

Installation

State codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

g. Typical Operation

Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

Activate all programmed speaker circuits.

Actuate all strobe units until the panel is reset.

Light the associated indicators corresponding to active speaker circuits.

Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.

Return all elevators to the primary or alternate floor of egress.

A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.

Smoke detectors in the elevator machine room or top of hoist way shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.

Correct installation, combined with the use of high quality equipment, components and cabling, ensures that the fire detection and alarm system shall operate as designed and provide many years of trouble-free service.

The Fire Alarm contractor shall install the alarm system in accordance with the documented installation instructions.

The Fire Alarm contractor shall provide all relevant installation documentation required for each component of the system.

Installation of the system shall be in accordance with the recommendations set out in NFPA-72

The Fire Alarm contractor shall be responsible for the correct setting of all equipment and components of the system in accordance with previously agreed plans and drawings.

All cabling and wiring shall be tested before they are connected to the fire controller and its associated devices.

WARNING If the tests are carried out after the cables and wires have been connected to the controller and its devices, components within the controller and the devices will be damaged by high voltages used during testing.

h. Materials

All cabling and wiring to be used in the system shall be copper Armoured with conductor not less than area 1.5mm² in cross section.

Wiring used for driving devices requiring high currents (e.g. bells, etc.) shall limit the voltage drop to less than 10% of the nominal operating voltage.

Cables used for the transmission of system data and alarm signals shall be in accordance with the types recommended by the manufacturer of the fire alarm system.

The ends of all cables shall be sealed by means of proprietary seals and associated glands. No heat shall be applied to any seal or termination. Cable tails shall be insulated by means of blank PVC sleeving anchored and sealed into the seal.

Where protection of the cable glands is required or terminations are on display, the glands shall be enclosed in red coloured shrouds of the appropriate British Standard colour.

All cables to brick/concrete shall be securely fixed by means of copper saddles sheathed with red PVC. These saddles shall be provided near bends and on straight runs at intervals no greater than recommended in the British Standards or by the manufacturer.

Where multiple cables are to be attached to a wall or soffit, copper saddles shall enclose all cables and shall be secured by means of suitable masonry plugs and two round head plated woodscrews

Where multiple cables are to be attached to the top of horizontal trays they shall be neatly run and securely fixed at suitable intervals. Copper or plastic cable fixings shall be used.

At detector and sounder locations, cables shall be terminated in approved galvanized junction boxes. All other devices forming part of the system shall utilize dedicated /custom back boxes.

i. Installation of Detectors

All detectors (and bases) shall be installed in accordance with guidelines set out in BS5839/ NFPA -72 and the installation instructions provided by the manufacturer.

All detectors shall be installed in the exact locations specified in the design drawings; thus providing the best possible protection.

The type of detector installed in each particular location shall be the type specified in the design drawings.

All detector bases shall be securely fixed to approved boxes and allow for easy fitting and removal of detectors.

Cable and wire entries to detector bases shall be fitted with grommets to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at all entries to detector bases.

Cable entries of detector bases used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

j. Installation of Control Devices

All control devices (e.g. call points, sounders, interface modules, etc.) shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

All control devices and associated modules shall be installed in the exact locations specified in the design drawings.

The type of control device installed in each particular location shall be the type specified in the design drawings.

All control devices and associated modules shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to all control devices and associated modules shall be fitted with grommets or glands so as to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to control devices and associated modules as required.

Cable entries of control devices and associated modules used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

k. Installation of Fire Controller Equipment

The fire controller equipment shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

The fire controller and its associated component parts shall be installed in the location specified in the design drawings.

The type of fire controller and its associated component parts installed shall be the type specified in the design drawings.

The fire controller equipment shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to the fire controller and associated devices shall be fitted with grommets or glands to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to fire controller and associated devices as required.

The fire alarm system mains power connections to the fire controller equipment shall be accordance with the guidelines set out in the relevant British Standards and the installation instructions provided by the manufacturer.

The fire alarm system mains power isolating switch shall be coloured red and clearly labeled 'FIRE ALARM: DO NOT SWITCH OFF'.

Each circuit of the system shall be connected to the fire controller via associated fuse or circuit breaker devices located within the fire controller unit.

All cables from the fire controller equipment to the detection and alarm devices shall be clearly labeled as part of the fire detection and alarm system.

I. FACP

The FACP shall be checked for basic tests such as visually checking input voltage and amperage. All zones one by one shall be de wired to check for fault signal indication in the FACP.

1. The Power Source shall be cut off and checked for stand by Supply from the Batteries. After six hours the FACP Source shall be switched on to check for auto switch over to the Mains mode.
2. Tests shall be conducted for AC fail, charger fail, DC fail, Battery Disconnect or Battery fail. In all such cases the relevant L E D should glow and the piezo sound shall also give sound output.

m. Smoke Detector

1. The testing shall be carried out for each loop / zone, initially one detector in a zone and subsequently 2 or more disassociated detectors in each zone with time lapse between the detectors to test for Alarm Priority, Alarm Queuing and Call Logging.
2. An identified detector will be subjected to smoke aspiration from burning paper/cigarette puffs, rubber and other materials which give dense smoke held at 0.3 M distance from the detector. The FACP should indicate increased analogue output for that address and after the programmed delay time, a fire alarm signal shall be indicated. This delay shall be utilized for alarm verification.
3. The same test shall be carried out for two detectors in the same Loop but in different rooms. The FACP shall indicate Pre Alarm higher analogue levels for both detectors in its display with separate identification for both fires. One of the detectors in question is subjected to higher and longer levels of

smoke aspiration. The FACP should give priority alarm for this address. The printout shall indicate individual addresses of the detectors with achieved analogue values and the time of event.

4. This test shall be carried out for different Loops as well as for 2 Loops simultaneously.

n. Heat Detector

The same tests in the same sequence shall be carried out for this Detector but with the application of hot air from a hair dryer held at approximately 60-cm distance.

o. Combined Test

The next test shall be in combination of Photoelectric / Heat Detectors simultaneously with time lapse between application of smoke or heat or as required by the Purchaser.

p. Additional Test

1. One detector of each type will be disconnected and subjected to slow dust build - up by means as desired by the Purchaser and again connected in the circuit.
2. The FACP shall indicate the changed ambient levels and automatically adjust the analogue values for the same. These Detectors are to be replaced by new Detectors of identical type and the FACP shall then be programmed accordingly and checked. The Bidder will take custody of the removed detectors without additional cost to the Purchaser.
3. Any part of the Loop shall be short-circuited. The FACP shall indicate the communication failure of all the devices connected in the short-circuited segment. After the short circuit is corrected, the Fault Isolator shall return to its normal status automatically, this being reflected in the FACP. The Loop shall then be in normal operation again. Any part of the Loop shall be de wired and tested as given above.
4. All other tests as required by the Purchaser at the time of handing over.

Initial testing can be carried out as per following but not limiting to :-

Sr. No	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance etc.			√
2	Carry out visual checks on all panels, cables, interphase modules etc. to ensure they are clean and free from any mechanical damage	√		
3	Check for proper termination & feruling	√		
4	Check input A/C supply voltage		√	
5	Check location/spacing of Detectors as per standards	√		
6	All device are addressed as per drawing		√	
7	Check Distribution of Detector / Loops / Zones as per Drawing.		√	
8	Check all Modules / Detectors, for healthy blinking status.	√		

Sr. No	Description	Visual	Test Readings	Documentation
9	Apply Smoke / Aerosol to random detectors & check output of the same in panel, shall display proper address/Loop/zone..		√	
10	Check distribution of Amplification Zones as per approved shop drawings		√	
11	Check tripping of AHU / Fan / Access doors etc. on activation of detectors.		√	
12	Activation of Speaker circuits as programme, evacuation message/alert message/emergency message		√	
13	All the manual call point are working properly		√	
14	Hooter / Speaker are working as programmed		√	
15	If power fails, whether panel working on battery supply		√	
16	Panel display and all key working properly		√	
17	Check for seamless integration with BMS(optional)		√	

1. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
2. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
3. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
4. Verify activation of all flow switches.
5. Open initiating device circuits and verify that the trouble signal actuates.
6. Open signaling line circuits and verify that the trouble signal actuates.
7. Open and short notification appliance circuits and verify that trouble signal actuates.
8. Ground initiating device circuits and verify response of trouble signals.
9. Ground signaling line circuits and verify response of trouble signals.
10. Ground notification appliance circuits and verify response of trouble signals.
11. Check presence and audibility of tone at all alarm notification devices.
12. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.
13. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
14. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

13. Commissioning/Pre Commissioning

At final commissioning of each system, the Contractor shall confirm that:

All detection devices, including point detectors, beam smoke detectors, flame detectors, and aspirating smoke detectors and inputs are tested and operate correctly.

All manual controls, whether manual call points or centrally located controls, operate correctly. The correct indications are given at the control and indicating equipment, including the repeater panels, mimic panels and graphics PC central control and display terminal.

All outputs operate, in the required manner, including alarm sounders or voice alarm system loudspeakers, visual indicators and connections to ancillary services and other systems. In particular, the Contractor shall check that audibility levels of sounders and/or audibility and intelligibility of voice alarm broadcasts are correct.

The fire detection and fire alarm system complies with the operational sequence detailed in Section 5 of this Specification.

The standby batteries shall adequately sized. (Measurements of the quiescent and alarm loads shall be taken and compared to calculated values used at the design stage.) Calculations and measurements shall be submitted to the Engineer.

Commissioning shall be fully documented and the documentation submitted to the Engineer. The Contractor shall demonstrate each fire detection and fire alarm system to the satisfaction of the Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall take place after the above final commissioning and following receipt of the commissioning documentation by the Engineer. Acceptance testing shall include the actuation of all devices in the system, simulation of various faults and operation of all manual controls.

Following commissioning, a system soak period of not less than one week shall follow, unless the system incorporates fewer than 50 automatic fire detectors, in which case no soak test is necessary.

Both the installation and the commissioning activities shall be undertaken as a single continuous operation.

Upon completion of the installation activity, the Fire Alarm contractor shall Test, Start-up, Commission and Handover the system to the customer.

The Fire Alarm contractor shall make use of the following documents to record test results and details of commissioning tests:

1. Cable Test Sheets
2. Installation Check Report
3. System Layout Drawing(s)
4. System Schematic Diagram(s)

The Fire Alarm contractor shall be responsible for inspecting and testing the complete system, including:

1. Detectors
2. Call Points
3. Sounders
4. Ancillary Devices
5. Fire Controller Equipment and Associated Devices
6. Auxiliary Equipment
7. Operating and Control Software.

The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in NFPA-72 and the testing instructions provided by the manufacturer.

The Fire Alarm contractor shall start up and operate the system for a trial period to ensure that it operates correctly.

The Fire Alarm contractor shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.

The Fire Alarm contractor shall undertake audibility tests during which the sounders may be operated continuously over a period of two hours. (Should the customer require these tests to be carried out at a separate visit, or out of normal working hours, this can be arranged at additional cost.)

Commissioning of the system shall constitute practical completion

Following the satisfactory completion of installation, testing and start up, the Fire Alarm contractor shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.

The Fire Alarm contractor shall provide the customer with an agreed quantity of spare parts testing equipment and consumables which are to be used during routine maintenance and testing of the system.

The Fire Alarm contractor shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the Log Book. (also see Section 9).

The Fire Alarm contractor shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the tests and details of any specific Settings or adjustments made. Any outstanding tasks or activities which are to be completed at another time shall also be included in the report.

The Fire Alarm contractor shall present an Acceptance Certificate for signature by the customer.

14. Documentation

A) Pre Commissioning

Prior to handover, the Contractor shall furnish with 'as fitted' drawings / wiring diagrams.

As fitted' drawings shall indicate the layout of all equipment, layout of aspirating smoke detector pipe work, cable routes and cable sizes/types used. Wiring schematics, including cable termination details, shall also be provided by the Contractor.

'As fitted' CAD drawings shall be prepared using a software package capable of providing dwg format and two electronic copies shall be made available in that format. Also, four sets of A0 prints shall be provided to the Engineer.

Prior to handover, the Contractor shall also furnish with O&M manuals. In addition to the manufacturer's technical data sheets on all components of the system and standard operating and maintenance instructions, the O&M manuals shall include specially written sections covering the specific operation of the system and any special maintenance requirements.

Three printed copies of the O&M manuals shall be supplied along with a copy in electronic form in a format that is computer readable, e.g. the Microsoft Office™ range of software i.e. Word™, Excel™, etc.

The following documentation shall also be provided at handover:

1. The site-specific software as loaded into each control panel, to be supplied in both electronic format and printed listing for secure storage on site by Purchaser.
2. Alarm audibility and/or intelligibility information. (This can be recorded on the 'as fitted' drawings.)
3. Test results for all system wiring.
4. Commissioning testing results/listings.

5. Standby battery calculations.

B) Contract Documentation

The Fire Alarm contractor shall provide a complete set of documents describing the system and its design concepts, installation, final testing, commissioning, and required operating and maintenance procedures. As a minimum, the following documentation shall be provided for the system:

1. System description.
2. Checklist of equipment and components.
3. Installation instructions.
4. Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses.
5. Standby battery calculations showing system power requirements and formulas used
6. To calculate specified power.
7. Final testing instructions.
8. Commissioning instructions.
9. Certification documents.
10. Log book.
11. System operating instructions.
12. Routine maintenance instructions and schedules.
13. Remote monitoring link description and operating instructions (if this option is being provided).

As a minimum, the following drawings shall be provided for the system:

1. System schematic diagram.
2. Cabling and wiring diagram.
3. Detailed equipment connection diagrams.
4. Building plan showing zoning and location of fire controller, detectors, call points, Sounders and ancillary devices.
5. The Fire Alarm contractor shall provide a complete set of system operating and service manuals for the following:
6. Fire controller
7. Detectors
8. Call points
9. Sounders
10. Ancillary devices
11. Remote monitoring link (if this option is being provided).

The date for submission of all documentation shall be in accordance with the schedule provided by the Fire Alarm contractor and as agreed with the customer.

15. Final Inspection

At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

a. Instruction

Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

b. Handover

The Alarm contractor, upon completion of the commissioning activity, shall hand over the system to the customer.

At the time of hand over, the Fire Alarm contractor shall provide the customer with the following documentation:

1. Copy of detailed report
2. Component and equipment list
3. Product description sheets
4. System design specification
5. System design drawing(s)
6. System schematic diagram(s)
7. System operating and service manuals
8. Certificate of certification
9. Fire system users handbook, containing log book, routine maintenance instructions and schedules
10. Remote monitoring link description and operating instructions (if this option was provided).

c. Training General

The Fire Alarm contractor shall provide the customer with details of the training required by personnel to operate and maintain the fire detection and alarm system.

The Fire Alarm contractor shall provide two levels of training:

- * System Supervisor Training
- * Other Staff Training

The Fire Alarm contractor and the customer shall jointly agree the number of staff to attend the training courses.

d. System Supervisor Training

System supervisor training shall include technical training sessions provided at the Fire Alarm contractor's premises and on-site training given during installation and commissioning of the system.

System supervisor training shall be given by an experienced and competent engineer familiar with the fire system being installed.

The scope of training provided shall depend on the type, size and complexity of the system.

The Fire Alarm contractor shall initially provide technical training in all aspects of the system. The trainee shall then be given full instructions in the use, operation and maintenance of the system. This shall include instruction in the procedures to be followed in the event of fire and false alarms, routine maintenance and testing procedures, and how to keep the Log Book.

e. Other Staff Training

Other staff training shall include training sessions provided on-site after hand over of the system.

The training sessions shall be given by an experienced and competent engineer familiar with the fire system installed.

The scope of training provided shall include full operating instructions in the use of the fire system. This shall include instruction in the procedures to be followed in the event of fire and false alarms.

f. Maintenance

General

According to the recommendations in NFPA-72 fire systems should be regularly maintained under a maintenance agreement.

Fire and planning authorities, and in certain cases insurers, have powers to check that fire systems are maintained. Failure to maintain the fire detection and alarm system could contribute to death or injury in the event of fire.

The customer shall be responsible for ensuring that daily, weekly and monthly routine maintenance is carried out in accordance with the recommendations set out in NFPA 72 and the service and maintenance instructions provided by the Fire Alarm contractor or manufacturer.

The Fire Alarm contractor shall provide detailed information about the maintenance services which can be provided after hand over of the system.

If requested, the Fire Alarm contractor shall prepare and submit a draft maintenance contract for consideration by the customer.

The draft contract shall include complete details of all materials and labour required to maintain the system in correct working order. It shall also include details of the testing procedures which will be carried out and specify the proposed number of visits per year.

16. WIRING

Wiring for fire alarm system in general shall comply with IS 2189 - 76 and IS 732 - 63. The detectors shall be wired upto the main junction boxes by 2 core 1.5 sq.mm FRLS PVC insulated armoured FS (Fire Survival cable for 120minutes as per BS standard) cable with copper conductors of 1100 Volts grade.

LT CABLES

A) GENERAL

- i) The routes of all cables shall be approved by the Consultants or his representatives, before the installation is commenced.
- ii) The cables shall be so arranged that neither these nor their supports come into contact with the pipes of any other services. They shall be run in a neat orderly manner, with easy sets and bends.
- iii) All single core main and sub-main cables used on three phase circuits shall be clamped or bound in trefoil groups throughout their length.
- iv) All main, sub-main and multicore cables shall be marked with non-corrosive labels, bearing the cable reference given by the Consultants or his representative. The labels shall be provided at each cable joint, at each end of ducts, at each termination and at intervals of 30 meters on straight runs. All labels shall be approved, a sample being submitted to the Consultants prior to installation.
- v) Cables and flexible cords other than those specially designed for high temperatures shall not be installed in conditions where the ambient temperatures attained are likely to exceed those set out in the latest editions of the Regulations for Electrical Installations.
- vi) The cables may be installed in a number of ways. These may include:
 - a) Direct in the ground

- b) In piped ducts
- c) Saddled to the building structure
- d) On Cable Trays

vii) The following Table shows, which cable, are permitted to be installed in which of the foregoing ways. On account shall cables be installed in any other way than shown in this Table without reference to the Consultants.

B) STANDARDS AND CODES

Updated and current Indian Standard Specifications and Codes of Practice as stipulated below shall apply to the equipments and the work covered in this section. In addition the relevant clauses of the Indian Electricity Act 1910, Indian Electricity Rules 1956, National Building Code 1994, National Electric Code 1985, Code of Practice for Fire Safety of Building (general) : General Principal and Fire Grading – IS 1641 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

PVC insulated heavy duty cables IS 1554 - 1988

Cross link polyethylene insulated PVC (sheathed XLPE cables) IS 7098 - 1985

Code of practice for installation and maintenance of power cables IS 1255 - 1983

Conductors for insulated electrical cables IS 8130 - 1984

Drums for electrical cable IS 10418 - 1982

Methods of test for cables IS 10810 - 1988

Recommended current rating IS 3961 - 1987

Recommended short circuit rating of high voltage PVC cables IS 5891 – 1970

C) LAYING METHODS

Cables shall be laid direct in ground, in pipes/closed ducts, in open ducts or on surface depending on environmental conditions or as directed.

During the preliminary stages of laying the cable, consideration should be given to proper location of the joint position so that when the cable is actually laid the joints are made in the most suitable places. As far as possible water logged locations, carriageways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for joint position.

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for LT cables and 15 times the overall diameter for HT cables. Cables shall be laid in masonry trenches, directly on walls/cable trays, directly buried in ground or in pipes/ducts as elaborated below.

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

TABLE SHOWING METHODS OF INSTALLING CABLES

Type of Cable	Direct in ground	In earthen ware ducts	In concrete trenches	On hangers	On racks with cleats	On cable trays	In trunking	In conduit
PVC/PVC Unarmoured cables	No	No	Yes	No	No	Yes	No	No
PVC/PVC Armoured cable	Yes	Yes	Yes	Yes	Yes	Yes	No	No
PVC/PVC Telephone Cable	No	No	No	No	Yes	Yes	Yes	Yes
PVC Insulated Single Core	No	No	No	No	No	No	Yes	Yes
Co-Axial Cable	No	No	No	No	No	No	No	Yes

17. LAYING DIRECT IN GROUND

General

This method shall be adopted where the cable route is through open country, along roads/lanes etc. and where no frequent excavations are encountered and where re-excavation is easily possible without affecting other services

18. Trenching

i) Width of trench :

The width of trench shall first be determined on the following basis :

The minimum width of trench for laying single cable shall be 35cm.

Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified shall be at least equal to diameter of higher size cable.

There shall be a clearance of at least 15cm between axis of the end cables and the sides of the trench.

ii) Depth of Trench :

The depth of trench shall be determined on the following basis:

Where cables are laid in single tier formation, the total depth of trench shall not be less than 100cm for cables upto 1.1 KV and 1.20 m for cables above 1.1 KV.

When more than one tier of cables is un-avoidable and vertical formation of lying is adopted, depth of trench in B (i) above shall be increased by 30cm. For each additional tier to be formed.

iii) Excavation of trenches :

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction,

suitable curvature shall be provided complying with the requirements of permissible bending radius of various types of cables.

Where gradients and changes in depth are unavoidable, these shall be gradual.

Excavation should be done by any suitable means—manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.

Adequate precautions should be taken not to damage any existing cable(s), pipes or other such installations in the proposed route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Consultant.

Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the Consultant. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled.

If there is any danger of a trench collapsing or endangering adjacent structures, the sides should be well shored up with timbering and/or sheeting as the excavation proceeds. Where necessary, these may even be left in places when back filling the trench.

Excavation through lawns shall be done in consultation with the staff of the department/Purchaser concerned.

The bottom of the trench shall be level and free from stone, brickbats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8cm in depth.

iv) Laying of Cables in Trench

At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance

The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be laid off in one stretch. However, where this is not possible the remainder of the cable may be removed by 'Flaking' i.e. by making one long loop in the reverse direction.

- i. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 m apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.
- ii. For short runs and sizes upto 50 sq.mm of cables upto 1.1 KV grade, any other suitable method of direct handling and laying can be adopted with the prior approval of the Consultant.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable is then measured. The ends of all lead-sheathed cables shall be sealed with solder immediately. In case of PVC cables, suitable moisture seal tape shall be used for this purpose.

- i. Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 17 cms. Above the base cushion of sand before the protective cover is laid.
- ii.) In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30

cms. Shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cms. as stated above. The top most cable shall have final sand covering not less than 17 cms. before the protective cover is laid.

At the time of original installation, approximately 3m of surplus cable shall be left on each end of the cable and on each side of underground joints (straight through/Tee Termination) and at entries and places as may be decided by the Consultant. The surplus cable shall be left in the form of a loop. Where there are long runs of cable length, loose cable may be left at suitable intervals as specified by the Consultant.

A final protection to cables shall be laid in as directed to provide warning to future excavators of the presence of the cable and to protect the cable against accidental mechanical damage by pickaxe blows etc.

Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20cmx10cmx10cm (nominal size) or protection covers placed on top of the sand (bricks to be laid breadthwise) for the full length of the cable to the satisfaction of the Consultant. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm. Over the sides of the end cables.

V) Back Filling of Trench

The trenches shall be then back-filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm. Unless otherwise specified, a crown of earth not less than 50 mm. In the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth however should not exceed 10 cms. so as not to be a hazard to vehicular traffic. The temporary re-instatements of roadways should be inspected at regular intervals, particularly during the wet weather, any settlement should be made good by further filling as may be required. After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and material as the surrounding area and repave to the satisfaction of the Consultant.

Where road berms or lawns have been cut or kerbstones displaced, the same shall be repaired and made good except turfing/asphalting to the satisfaction of the Consultant and all surplus earth or rock removed to places as specified.

19. On Trays/Walls

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

Type of cable	size	Clamping by	Fixing Interval
LT	Up to and including 25	Saddle 1 mm thick	450mm
LT & HT	35 to 120	Clamp 3mm thick and 25mm wide	600mm
LT & HT	150 and above	Clamp 3mm thick and 40mm wide	600mm

Note : The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 300mm from the center of the bend on both sides.

Cable trays

Cable Tray & Ladder Specification

General Requirement:-

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/Instrumentation/Communication systems.

Design and Fabrication of Cable Trays / Ladders:-

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 3 meters						
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)			
			1.5m	2m	2.5m	3m
			Permitted Load (in kg/meter)			
Perforated Cable Tray	35	50 - 300	125	90	50	-
	60	50 - 600	150	100	50	-
	85	100 - 600	175	110	50	-
	110	100 - 550	185	130	75	60
Cable Ladder	45	200 - 600	180	140	100	55
	60	200 - 600	-	225	150	100
	110	200 - 600	-	310	200	140

Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						
Perforated Cable Tray for long span distance	110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
Cable Ladder for long span distance	110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, If any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be

applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

Cables shall run in cable tray/ladder mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures using mounting accessories

a) Cable Tray:-

The cable tray and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications & should have a Base Perforation Class B according to IEC 61537. The cable trays shall be supplied in standard lengths of 3000mm and the width of the tray shall be as follows.

Width: 50, 100, 150, 200, 300, 400, 500, 600 & 750 mm.

All the cable tray accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories.etc are shown in the enclosed drawings.

For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non tested tray, thickness should be 2 mm up to span length of 1.5 meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

b) Cable ladder:-

The cable Ladder and all accessories shall be fabricated from sheet steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications & should have a Free Base Area classification Y according to IEC61537. The cable ladders shall be supplied in standard lengths of 3000/6000 mm and the width of the tray shall be as follows.

Width: 200 to 1200 mm in multiples of 100 mm

Maximum rung spacing in the ladder shall be 300mm. The rungs should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's , TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated . The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories .etc are shown in the enclosed drawing.

For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue. For locally fabricated and non tested Ladder, thickness should be 2.5 mm up to span length of 1.5 to 2 meter, 3 mm for span length between 2.5 to 4 meter and 3 to 4 mm for span length between 5 and 10 meter

c) Cover for Cable Trays / Ladders:-

Cover for trays/ladders to protect the cable insulation from falling objects, water droplets, harmful effects of ultraviolet rays and accumulation of dust. The cover shall be made either from Hot Dip Galvanized sheet steel or superior quality Double Dip Galvanized Sheets. For Outdoor application, Double dip Galvanized material shall be used. The covers should be fitted properly to the Ladder / Tray by using pre fixed and tested locks which ensure that covers are fitted rigidly to Tray / Ladder. For outdoor application

in high wind areas, additional cross over beading to be used for fixing the cover on tray / ladder of width more than 500 mm.

Mounting Accessories (supports and Brackets):-

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hard ware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

d) Corrosion Protection:-

The cable tray / ladder/accessories shall be of HOT DIP Galvanized (ISO 1461-1999) for installations in corrosive atmospheres both indoor and outdoor application. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 for > 500 hours. (*550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

e) Testing and Certification:-

Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than $1/100^{\text{th}}$ of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed $1/20^{\text{th}}$ of the length. The cable tray / cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

Marking, Documentation, Compliance and Inspection:-

Each system component shall be durably and legibly marked with:

- the manufacturer's or responsible vendor's name or trade mark or identification mark;
- a product identification mark which may be, for example, a catalogue number, a symbol, or the like.

When system components other than cable tray lengths and cable ladder lengths are supplied in a package, the product identification mark may be, as an alternative, marked on the smallest package unit.

Marking shall be applied, by moulding, pressing, engraving, printing, adhesive labels, or water slide transfers. Compliance is checked by inspection and, for marking on the product, by rubbing by hand for 15 s with a piece of cotton cloth soaked with water and again for 15 s with a piece of cotton cloth soaked with petroleum spirit. Marking made by moulding, pressing, or engraving is not subjected to the rubbing test. After the test, the marking shall be legible.

If a system component is stored and transported at a temperature outside the declared minimum and maximum temperatures, the manufacturer or responsible vendor shall declare the precautions and the alternative temperature limits. Compliance is checked by inspection.

The manufacturer or responsible vendor shall provide in his literature all information necessary for the proper and safe installation and use of the cable tray system and cable ladder system. The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include

- a. Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.
- b. Thermal Expansion properties and precautions to be taken, if necessary,
- c. Material, Surface Treatment and Salt Spray Test certificate
- d. Relative humidity if it affects the material and Surface Treatment
- e. Information on holes or devices provided for equipotential bonding or to run Earth Bonding Bar
- f. Precautions for transport and storage outside the declared temperature classification, where applicable
- g. Product dimensions
- h. Torque setting in Nm for screwed connections and internal fixing Devices. These devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections. To test the screwed connections, it shall be tightened and removed.
- i. End Span Distance
- j. Position and type of coupling along the span
- k. SWL in kg/m for the fittings when not directly supported
- l. Fixing method for installing cable tray or cable ladder to the supports
- m. SWL in kg/m for the cable tray lengths or the cable ladder lengths including joints for various Span Distances. SWL information can be given in the form of a diagram, table or similar. Compliance is checked by inspection
- n. SWL in kg for cantilever brackets
- o. SWL for pendants as a bending moment in kg and /or as a force in N
- p. The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable

f) SPECIFICATION FOR WIRE MESH CABLE TRAY

GENERAL:-

Wire Mesh Cable Tray System intended for the support and accommodation of power, Instrumentation, data network, voice, video and other low-voltage cables and possibly other Electrical equipment in Electrical / Communication systems. The SYSTEM shall support commercial, industrial, and utility applications and should be designed, constructed and tested according to IEC 61537.

Design and Fabrication of Mesh trays:-

The wire mesh cable tray shall be manufactured according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 2 meters					
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)		
			1m	1.5m	2m
			Permitted Load (in Kg/meter.)		
Mesh cable tray	35	50 -			
		150	25	11	10
		200	30	14	10
	55	300	75	22	15
		50 -			
		150	25	12	8
		200 -			
		400	60	28	25
	105	500 -			
		600	75	38	25
		100 –			
		200	80	55	37

		300 – 400	110	75	53
		500 – 600	125	85	60

Each section of mesh tray shall have a length of 3 meter of continuous, rigid, welded steel wire mesh. Consecutive straight length of 3 meter mesh trays shall be connected without couplers or connecting tools

Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections
Cables shall run in cable tray mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles or other building structures using mounting accessories

SURFACE TREATMENT:-

- Electro Galvanized confirming to DIN E 12329 with minimum 10 microns zinc coating for indoor closed and dry atmospheric application
- Hot Dipped Galvanized confirming to ISO 1461 – 1999 with minimum 60 microns zinc coating for outdoor or open area applications
- Stainless steel 304 for Food/Beverage/Pharmaceutical and clean room application
- Stainless steel 316 for highly corrosive atmospheric areas like chemical plant & Offshore platforms

According to area of application, Surface treatment of material can be selected. Eg. Electro Galvanised cable tray and accessories should never be used in outdoor or open areas.

CONSTRUCTION:-

The Tray shall be constructed using 50 mm x 100 mm grid except for 50mm wide tray to ensure maximum ventilation of cables and dissipation of heat. For 50 mm wide tray, the grid size should be 20 mm x 100 mm. All exposed fabricated edges shall be tapered to ensure safe handling and installation of the product. One end of each straight section of formed wire mesh cable tray shall be of integrated interlocking ends. The diameter of the steel wire shall be minimum 3.5 mm for trays up to 150 mm width and minimum 4.5 mm for trays up to 600 mm width.

Screw less straight connection of mesh cable tray shall be made without couplers and special tools for straight consecutive lengths.

All tray fittings (eg., change in direction) shall be constructed at site by using bolt cutters and fastened using joint connectors, clamps & corner connectors with M6x20 bolt and combination nut. The connectors and clamps should be same or higher corrosion resistance class of the tray.

Mounting Accessories (supports and Brackets):-

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc to form various arrangements required to support the mesh trays. Welding of the components shall not be allowed.

Corrosion Protection Testing:-

Sample tray / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 as below

#	Corrosion resistance class	Material Surface Treatment	Salt spray test duration
1	1	Electro Galvanised	24 Hours
2	6	Hot Galvanised Dip	550 hours
3	6	Double Galvanised Dip	550 Hours
4	9 A to 9 D	Stainless Steel	Not applicable

Testing and Certification:-

Mesh tray and all mounting supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray should not deflect more than $1/100^{\text{th}}$ of the span length at SWL in Mid span for mesh trays and the transverse deflection of all mounting accessories at SWL shall not exceed $1/20^{\text{th}}$ of the length. The mesh tray should be tested up to 1.7 times SWL at minimum and maximum Temperature. The temperature classification of mesh tray system should be - 5 to + 150°C.

Marking, Documentation, Compliance and Inspection:-

The manufacturer or responsible vendor shall provide in his literature all information necessary for the proper and safe installation and use of the mesh tray system. The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include

- Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.
- Thermal Expansion properties and precautions to be taken, if necessary,
- Material, Surface Treatment and Salt Spray Test certificate
- Relative humidity if it affects the material and Surface Treatment
- Information on devices provided for equipotential bonding or to run Earth Bonding Bar if necessary for routing power cables
- Product dimensions
- Torque setting in Nm for screwed connections and internal fixing Devices. These devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections. To test the screwed connections, it shall be tightened and removed.
- End Span Distance
- Position and type of coupling along the span
- SWL in Kg/m for the fittings when not directly supported
- Fixing method for installing mesh tray or to the supports
- SWL in Kg/m for the mesh tray lengths or the lengths including joints for various Span Distances. SWL information can be given in the form of a diagram, table or similar. Compliance is checked by inspection
- SWL in KG for cantilever brackets
- SWL for pendants as a bending moment in Kg and /or as a force in N
- The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable

INSTALLATION

Prior to and during installation, refer to SYSTEM layout drawing containing all elements of the SYSTEM. Installer shall comply with manufacturer's installation procedures. Support and cable loading shall be done in accordance with manufacturer's load diagram.

20. Laying In Pipes/Closed Ducts

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

pipes or closed ducts. Spun reinforced concrete pipes shall be used for such purposes and the pipe shall not be less than 100 mm in diameter for a single cable and not less than 150 mm for more than one cable. These pipes shall be laid directly in ground without any special bed. Sand cushioning and/or brick tiles need not be used in such installations. Unless otherwise specified the top surface of pipes shall be at a minimum depth of 1000 mm from the ground level when laid under roads, pavements etc. The pipes for road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing. Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing. No deduction shall be made for sand and bricks not used for cables passing through RCC Hume pipes or for parts of vertical cables at the lighting poles.

Wherever so required, cables shall be laid at the bed of the lake through existing PVC pipe as itemized in schedule of quantities.

a) Laying Of Cables In Floors

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

b) Cable Entry Into Buildings

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

c) Cable Identification Tags

Wherever more than one cable is laid/run side by side, marker tags as approved by the Engineer-in-Charge, inscribed with cable identification details shall be permanently attached to all the cables in manholes/pull pits/ joint pits/ entry points in buildings/open ducts/trenches etc. These shall also be attached to cables laid directly in ground at specified intervals, before the trenches are back-filled.

d) Wall / Floor Crossing

Adequately sized sleeves shall be provided for all wall and floor crossings. The annular space around the cables at either ends shall be sealed with fire resistance packing material which shall be made available by Engineer-in-Charge. The sealing shall be done as per manufacturer's instructions

21. CABLE JOINTS AND TERMINATIONS

- i) The Contractor shall be responsible for terminating all cables and for checking that such terminations are in accordance with the diagrams provided. He shall provide all materials required for this work. No through joints will be allowed in any cable without the prior approval of the Consultants.
- ii) PVC insulated PVC sheathed cable terminations shall be made with an approved type of compression gland. The gland shall be complete with armour clamp where required and where the armour is PVC sheathed, a PVC shroud, which encloses the glands, shall be provided. The cores shall be terminated in compression lug.
- iii) PVC insulated PVC sheathed multicore cable terminations shall be made with compression glands as described for main cable. The cores shall be terminated in crimp lugs with spring washers. At junction of cables inside buildings, the cables shall be terminated with compression glands in junction boxes. The cable cores shall be connected to a fixed terminal block having stud connectors of not less than 6mm diameter. Not more than one core shall be terminated on each stud, interconnections between studs being made with copper links.

- iv) At junction of cables inside buildings, the cables shall be terminated with compression glands in purpose made junction boxes. The cable cores shall be terminated by the use of double washers and connected to a fixed terminal block. Not more than one core shall be terminated on each stud, interconnections between studs being made with copper links.
- v) For PVC insulated cables, no joints or connections shall be made in the cables other than at outlet positions where the wiring is connected to flexible lamp holders via a heat resisting flexible cable or cord. These connections shall be made in a ceiling rose or in a base fixed connector block with two brass pinching screws for each connection. The connector block shall be enclosed in a conduit box, due regard being given to the Regulations in respect of shrouding live terminals. Where the cable feeds equipment other than lighting fittings, the conduit box shall have a suitable outlet for flexible cable.

1. **CABLE ROUTE MARKER**

Route marker shall be provided along straight runs of cables, at each turning and shall be spaced not more than 100M. These shall also be provided for to identify the change in direction of the cable route and also for location of every under ground joint.

Route markers shall be made out of 100mm x 100mm x 5mm GI welded or bolted on to 35mmx 35mm x 6mm angle iron 600mm long. Such plate markers shall be mounted parallel to and 0.5M away from the edge of trench. No extra cost will be paid for providing the route markers.

2. **MEASUREMENT OF CABLE RUNS**

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

3. **CABLE LOOPS**

At the time of the installation approximately 3 meters of surplus cable shall be left at each end of the cable on each side of underground straight through/tee/termination joints at entries to buildings and such other places as may be decided by the Engineer-in-Charge. This cable shall be left in the form of a loop. Wherever long runs of cable length are installed cable loops shall be left at suitable intervals as specified by the Engineer-in-Charge.

4. **BONDING OF CABLES.**

Where a cable enters any piece of apparatus it shall be connected to the casting by means of an approved type of armoured clamp or gland. The clamps must grip the armouring firmly to the gland or casting, so that in the event of ground movement no undue stress is placed on to the cable conductors.

5. **DELIVERY, STORAGE AND HANDLING**

Cable drum shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in ground causing rot and damage to the cable drum. The cable drum shall conform to IS 10418. During storage, periodical rolling of drums, in the direction of arrow marked on the drum, shall be done once in 3 month through 90o C Both ends of cables shall be properly sealed to prevent moisture ingress Drums shall be stored in well ventilated area protected from sun and rain. Drums shall always be rested on the flanges and not on flat sides. Dropping of drum even from a small height or the drum falling from one side shall be avoided to prevent distortion and damage to the cable drum. Damaged battens of drums etc. shall be replaced. Movement of drums shall always be in direction of the arrow marked on the drum. +

For transportation over long distance, the drums shall either be mounted on drum wheels and pulled by ropes or they shall be mounted on trailers etc. drums shall be unloaded preferably by crane otherwise they shall be rolled down carefully on suitable ramps. While transferring cable form 1 drum to another, the barrel of the new drum shall have diameter not less than the original drum. Cables with kinks or similar visible defects like defective armouring etc shall be rejected.

6. **TYPES OF CABLES**

LT Cables

L.T. Cables shall be aluminium conductor armoured XLPE insulated cables conforming to IS :1554 and IS: 7098. Cables shall be of 1100V grade. The conductor of cables from 16 Sq. mm. to 50 Sq.mm. shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq. mm and above. Conductors shall be made of electrical purity aluminium 3/4 H or H temper. Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

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

Current ratings shall be based on the following conditions.

- a) Maximum conductor temperature 70degree C for PVC and 95degree C for XLPE
- b) Ambient air temperature 45 degree C
- c) Ground temperature 30degree C
- d) Depth of laying 1000 mm

Short circuit rating of cables shall be as specified in IS 1554 Part-I. Cables have been selected considering conditions of maximum connected loads, ambient temperature, grouping of cables and allowable voltage drop. However, the contractor shall recheck the sizes before cables are fixed and connected to service.

H.T. Cables

Cables for H.T. shall be with aluminium conductor XLPE insulated screened and PVC sheathed, armoured and overall sheathed with PVC and suitable for a 11KV three phase grounded system. Cables shall conform to IS : 7098(Part-II). Conductors shall be sector shaped, made from electrical purely aluminium of 3 x 4 H or H temper conforming to IS 8130 XLPE insulation of high purity shall be extruded on the conductors with screen a layer of semi-conducting material shall be applied over the XLPE insulation to prevent partial discharge at insulation surface. This shall be followed up by metallic aluminium tape screen the cores shall be discharged tested. Built up cores shall then be laid up and filler codes added. Combined core shall be provided with extruded PVC sheathing. Galvanized steel wire of strip armouring shall then be provided protected by an overall extruded black PVC sheet. The outer sheath shall bear the manufacturer's name and trade mark at every meter length.

6.1 TESTING

Tests At Manufacturer's Work

The cables shall be subjected to shop test in accordance with relevant standards to prove the design and general qualities to the cables as below (as per IS 10810) :

- g) Routine test on each drum of cables.
- h) Acceptance tests on drums chosen at random for acceptance of the lot.
- i) Type test on each type of cables, inclusive of measurement of armour DC resistance of power cables.

Site Testing

- a) All cables before laying shall be tested with a 500 V megger for 1.1 kV grade or with a 2,500/5,000 V megger for cables of higher voltages.
- b) The cables cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.
- c) All cables shall be subject to above mentioned test during laying, before covering the cables by protective covers and back filling and also before the jointing operations.
- d) After laying and jointing, the cable shall be subjected to a 15 minutes AC/DC pressure test.
- e) In the absence of facilities for pressure testing, it is sufficient to test for one minute with 1000 V megger for cables of 1.1 kV grade and with 2500/5000 V megger for cables of higher voltages.

Test Witness

Tests shall be performed in presence of representative of Engineer-in-Charge. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

Fire sealants

Fire sealants according to NEC – National Electrical Code 2011; SP 30 (by Bureau of Indian Standards) as per the following specification should be used to reduce the spread of fire through electrical installation.

All wiring system which passes through the building construction –viz- floor, walls, roof, ceilings, partitions etc., the openings (after the passage of wiring systems and pipes) shall be sealed to avoid spreading of fire and smoke. All wiring system viz- conduits, cable ducting, cable trunking shall be internally sealed to maintain the degree of fire resistance as well as externally sealed to maintain required fire resistance. All wires/bunch of wires running in vertical cable shafts should be wrapped with fire-protected bandage as below.

The manufacturers certificate as well as inspection report / label to be prepared during the installation and should be recorded. These papers are to be handed over to the appropriate authority to comply to the verification requirements according to National Electrical code – Bureau of Indian standards.

22. DATA NETWORKING SYSTEM WIRING**1. Intent of Specifications for Telecommunication**

These specifications are intended to cover the Cabling and installation for Telephone & Intercom System. It is not the intent to specify completely herein all aspects of design, constructional features of equipment and details of the work to be carried out, but nevertheless the intent of the specification is to ensure that the equipment and work shall conform in all respects to the relevant Bureau of Indian Standard Specifications, Codes of Practice, and other statutory regulations as may be applicable and to high standards of engineering, design and workmanship. The equipment and work shall perform in continuous operation in a manner acceptable to the Employer who will interpret the meaning of the specifications and drawings and shall have the right to reject or accept any equipment or work which in their assessment is not complete to meet the requirements of these specifications and/ or applicable Codes and Standards.

2. Scope Of Work

The scope of work under these specifications shall include the design and manufacture (wherever required), work's testing, supply, storage, erection, site testing and commissioning of the following:-

- a) All conduit work including Junction Boxes, outlet boxes and wiring & cabling of telephone & intercom system etc.
- b) Boxes & cover plates for telephone outlets.
- c) Supplying and laying/fixing of main Telephone cables and Tag Blocks as per the BOQ and line diagrams.
- d) To do the ferruling and identification of all multi core cables at both the ends of each cable as per requirements.

3. Information Outlets:

- (i) All Telephone Outlets shall be modular plate type accessories with CAT-6/6A Information Outlets. Cover plate shall match in shape & finish with other light and power accessories.
- (ii) Front Cover Plates shall match the Existing type and size of the gang box

4. Intent of Specifications for Computer system

These specifications are intended to cover the Conduiting & Cabling work for Computer System. It is not the intent to specify completely herein all aspects of design, constructional features of equipment and details of the work to be carried out, but nevertheless the intent of the specification is to ensure that the equipment and work shall conform in all respects to the relevant Bureau of Indian Standard Specifications, Codes of Practice, and other statutory regulations as may be applicable and to high standards of engineering, design and workmanship. The equipment and work shall perform in continuous operation in a manner acceptable to the employer who will interpret the meaning of the specifications and drawings and shall have the right to reject or accept any equipment or work which in their assessment is not complete to meet the requirements of these specifications and / or applicable Codes and Standards.

5. Scope Of Work

The scope of work under this specification shall include the design, manufacture (wherever required), work's testing, supply, storage, erection, site testing and commissioning of the following:-

All conduit work including Junction Boxes, outlet boxes and wiring and cabling for computer system.
Boxes and cover plates for computer outlets.
Laying of main computer wire Cat-6/6A as per line diagram and copper cable for point outlets.

To connect and help in commissioning of switches, back bone switch its peripheral main server and desktop etc., as and when received at the site through enhanced Cat 6 cables along with connector wherever required.

To do the ferruling and identification of all the Cat 6A cables.

6. As Built Drawings

After the completion of the work and before issuance of virtual completion, the Contractor shall submit completion drawings drawn at approved scale indicating the complete system as installed. These drawings shall give the following: -

Number and size of conductors in each conduit for computer wiring.
Location of outlets and patch panels.

Location of main switches and other particulars.

Complete schematic drawings as installed showing all connections in the complete computer system.

Layout and particulars of all cable runs size and type of cables, mode of installation, etc. as installed.

7. Copper Components

All the items/components used for the installation shall meet the requirement of TIA/EIA T568A, T568B, and ISO/IEC 11081 and it should be as per the specified make.

8. Category 6 Unshielded Twisted Pair Cable

The category 6A UTP LAN cable shall be four pair, 23 AWG copper cable suitable for 1000 Mbps speed, designed and constructed as per specifications listed in annexure.

9. Test Certificate

The test certificate and the EIA standards/ specifications for all above components used for the structured cabling shall be submitted along with the tender

10. Makes of Material

Approved List of makes of material is indicated in Specifications. Only such material shall be used. Alternative makes shall be used only with the specific written approval of the Employer/consultant.

11. Samples

A list of items of materials and equipment, together with a sample of each shall be submitted to the employer within 15 days of the award of the Contract.

Samples and drawings of equipment shall not be departed from without the written instructions of the employer. Approvals given by the employer to any samples or drawings submitted by the Contractor shall not in any way exonerate the Contractor from his liability to carry out the work in accordance with the terms of the contract.

12. Completion Certificate

On completion of the wiring & cabling, a certificate shall be furnished by the Contractor countersigned by the Licensed Supervisor, under whose direct supervision, the installation was carried out.

13. Technical data

Cat 6A UTP cable:

4 pair cat 6A , 23 AWG 100 ohms 250 Mhz UTP cable that should confirm or exceed component specifications TIA/EIA-568-A standards for physical & electrical Specifications, The cable should be unshielded type having flame retardant properties to Cat6 UTP standard , it should be Third Party certified and tested.

Storage and transport temperature -0 + 50 °C

Operating Temperature=- -20 + 60 °C

Cat 6A Information outlets:

The Cats 6 information outlets should confirm or exceed component specifications TIA/EIA-568-B.2-1 standards for physical & electrical Specifications, should be fully unshielded type and should have the tool less mechanism with inbuilt crimping tool and it should be Third Party certified and tested.

23. PUBLIC ADDRESS AND CCTV SYSTEMS

Scope:

The scope of this section covers supply and installation of Public Address System and CCTV systems.

System :

The equipment shall have to be designed to provide the following facilities:

To make the paging announcement from the central control desk either zone wise or on 'all call' basis.

The system working is as follows:

Normally the music originating from the cassette desk or record player is relayed over the loud speakers. For making the paging announcement, the operator starts particular group selector and after pressing the speech switch, he makes the paging announcement. In the system, a provision has been made whereby prior the announcement, a melodious 'Ding Dong' tone is heard over the loudspeaker.

Speakers:

Following types of speakers shall be provided in different areas as follows and as shown on the drawings.

a) Metallic ceiling recessed type ring with speaker and line matching transformer.

6W Ceiling speaker with metal grille and 6/3W taps

Parameters	Values
Max power	9W
Rated power	6W
Power taps @ 100V	6W / 3W
Sound pressure level at 6W/1W (4kHz,1m)	98 dB / 90 dB
Frequency range (-10dB)	80 Hz -20 kHz
Dispersion angle (1kHz/-6dB)	160°
Rated input voltage	100 V / 70 V
Rated impedance	1.7 kΩ / 3.3 kΩ
Connection	Push terminal
Dimensions(Φ x H)	Φ180mm x 55 mm
Hole cut-out size	150 mm
Size of speaker	5"
Color	White (RAL 9010)

b) Wall mounted horn type speakers

Parameters	Values
Max power	15 W

Rated power	10 W
Power taps @ 100V	15 W / 7.5 W
Sensitivity	91.6 dB
Max sound pressure level (1 m)	101.1 dB

Frequency range (-10dB)	150 Hz - 20 KHz
Diameter of Speaker	6.5"
Dispersion angle (1kHz/-6dB)	170°
Rated input voltage	100 V / 70 V
Rated impedance	1 kΩ
Color	White
Material	ABS

c) Outdoor pole mounted loudspeaker type speakers

Parameters	Values
Max power	25 W
Rated power	15 W
Power taps @ 100V	15 W / 7.5 W
Sound pressure level at 6W/1W (1kHz,1m)	110.3 dB / 98.5 dB
Frequency range (-10dB)	500 Hz - 5 kHz
Dispersion angle (1kHz/-6dB)	140°
Rated input voltage	100 V / 70 V
Rated impedance	500 Ω / 1 kΩ
Connection	Cable
Color	White (RAL 9010)
Case material	ABS

Cable Specifications:

2 Core twisted shielded FRLS insulated cable core of specified size in BOQ ATC conductor with cores of different colour.

Music System Cables:

Single pair 40/0.20 or as specified in BOQ FRLS insulated, PVC sheathed, tinned, annealed copper shielded flexible cable shall be provided for music system controlled through volume controller outlet to speakers in Public areas.

The wires shall be conform to relevant Indian Standards and of approved make.

CCTV SYSTEM WIRING

Wiring for CCTV Camera System shall be carried out with Cat. 6A cables. Wires shall be drawn in Heavy gauge steel conduits as specified.

24. LUMINAIRES

Scope:

The scope of this section comprises the supply, erection, testing and commissioning of lighting fixtures for internal lighting of service areas wherever required of the specified models.

Without restricting to the generality of the foregoing, this section shall include luminaires, lamps and accessories necessary and required for the installation.

Whether specifically mentioned or not, the luminaires and lamps shall be provided with all fixing devices, terminal blocks, holders etc. as required.

General Requirements:

All the luminaries and lamps shall be of best quality and as per approved makes. Wherever alternative makes are specified the choice of selection shall remain with the Engineer-in -charge .

The luminaires and lamps shall be fixed in a neat workman like manner, true to level and in accordance with manufacturer's instructions.

The luminaire and lamps shall be provided with such accessories as are required to complete the item in working condition whether specifically mentioned in the specifications, drawings or not.

Luminaires:

Luminaires shall comply with relevant Indian Standards.

Unless otherwise indicated, enclosure of luminaires shall provide a minimum degree of protection of IP44 when located within buildings and IP 65 when located outside buildings, but luminaires mounted externally; and less than 2 M above finished ground or paved level shall be IP 65.

Unless otherwise indicated, luminaires, both with and without built-in ballast or transformers shall be suitable for direct mounting on normally flammable surface.

Where specific requirements related to flame propagation and flammability of translucent covers are indicated, certificates of tests shall be submitted to the Engineer-in -charge .The tests shall comply with relevant Indian Standards.

Terminal blocks for connection of the supply cables shall be of adequate size for the size of conductors forming the loop in wiring.

Ballasts for tubular fluorescent lamps shall have a maximum value of harmonics complying with the colour headed "without H Marking" in Table VII of BS 28116. Power factor correction shall be provided and this shall be not less than 0.85 lagging unless otherwise indicated.

Translucent covers and reflective surfaces shall be clean at the completion of the works.

25. Lamps:

Lamps shall be of the type and ratings as indicated.

All lamps shall be installed by the contractor.

Lamp caps shall be suitable for the lamp holders listed socket by means of a locking ring.

Support and Fixings:

Where Linear luminaires 1200 mm or more in length are supported directly by the conduit system, they shall be fixed to two circular conduit boxes both of which shall form an integral part of the conduit system.

Where the weight of a luminaire is supported by a conduit box or cable trunking, the fixing of the conduit box or trunking shall be adequate for the purpose and approved by Engineer-in -charge .

Luminaires fitted with tungsten filament lamps and having metal back plates shall not be fixed directly to conduit box in which thermoplastic material is the principal load bearing member.

Support of luminaires from cable trunking shall be by means of proprietary clamps or brackets.

Where luminaires are supported from the structure other than by the conduit system, the supports shall comply with

Luminaires mounted on or recessed into suspended ceilings shall not support luminaires unless specifically shown and approved.

For wall mounted luminaires, the mounting height shall be 1900 MM above finished floor level, measured to the centre of the conduit box, unless otherwise indicated.

Wiring Connections:

Where luminaires, other than those covered by clause 17.6.2 are fixed direct to circular conduit boxes or are supported by pedants or chains, the final circuit wiring shall terminate at a terminal block in the conduit box.

Where luminaires having fluorescent tubes are fixed direct to circular conduit boxes, the final circuit wiring may be terminated within the luminaire unless otherwise indicated. The wiring shall enter each luminaire at the conduit entry nearest to the terminal block and where a loop in wiring system is used, leave by the same entry; wiring shall not pass through a luminaire unless the approval of the Engineer-in -charge .

Where luminaires are mounted on or recessed into a suspended ceiling, connection shall be by flexible cord from a plug-in ceiling rose unless otherwise indicated. The plug-in ceiling rose shall be located not more than 500 mm from the access in the ceiling and shall be firmly supported, unless otherwise approved by the Engineer-in -charge .

Cables and flexible cords for final connections to luminaries shall be suitable for the operating temperature of the luminaire.

The size of final connection cables or flexible cords shall be as indicated.

Cables and cords passing close to a ballast within a luminaire shall be suitable for the operating temperature of the ballast.

A protective conductor shall connect the earthing terminal or earthing contact of each luminaire to an earthing terminal incorporated in the adjacent conduit box. Where the final connection is by flexible cord, the protective conductor shall form part of the cord.

24. TRANSIENT VOLTAGE SURGE ARRESTERS (TVSA)

SCOPE

Work required under this section shall include all material, labour and auxiliaries required to furnish and

install complete TVSA devices at main LT Panel incoming feeders (Stage I /Class B) & Distribution Boards (Stage II / Class C) for protection of Building electrical and Electronic system from effect of Lightning discharges. Line induced transient surge voltage or switching surges as per details mentioned in the BOQ.

CODE & STANDARDS

Following standards & publications as referred in various parts of these specifications shall apply.

- IEC – 61643-11, IEC – 61643-12
- IEC – 60 364 – 5 - 5. 53
- IEC – 62 305 – 4

Surge protector at stage I / Class B (LT Panel Protector)

The surge protection Device (SPD) manufacture shall offer a complete line of Surge protection devices to support requirement for main LT panel incoming feeder. Surge protector at this stage shall be provided to protect the downstream electrical and electronics against any lightning discharge surges that may enter into the system through main panel.

Unit status indicator shall be provided to indicate the status of complete protection unit.

Protection shall be manufactured for specific type and voltage of electrical services and shall provide clamping for both normal (L-N) and common (N-G) mode operation.

Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% of normal RMS line voltage of 240 V.

Protection shall be provided with safety MPCB’s to be connected in series between Line/s to neutral & neutral to earth as per TNS configuration of wiring. It shall be testable on line for routine maintenance, module failure and in order to prevent catastrophic failure modes.

Protection shall be a fail –safe type device that shall have a follow through current quenching capacity upto 25 KA rms shall have repeated surge capability state, shall be self restoring and be fully automatic in all modes of operation.

Protections shall comply with IEC 61643 and shall be approved for location in which they are listed. Protection shall have an operating temperature range from -20°C to 60°C.

Protection Criteria

Maximum continuous operating voltage (Rated Voltage) for SPD devices connected to phase neutral shall not be less than values shown in table.

Nominal voltage rating per phase (Vrms)	Maximum continuous operating voltage (Vrms)
240	320

Surge protective

device and associated hardware must comply with IEC 61643 – 11. Protection voltage of complete rail ,mount surge protective service shall be type tested to figure as indicated in table below, which must not exceed the values shown.

Service voltage / per phase	Protection voltage @In (Nominal discharge current) / Protection Level
240	<2.5 k V (between line to neutral) k V (between Neutral to Earth)

Surge protective device application at low voltage AC main LT Panel incoming feeder surge impulse current withstanding capacity as shown in table below.

Application Panel Location	Max. Single Withstand surge Current (of 10/350µs Impulse)
Service Entrance (Main LT Panel)	25 k V, 10/350µs (between line to neutral) 100 k V, 10/350µs (between Neutral to Earth)

Compliance to these specifications must be provided in form of a certificate from an independent testing laboratory.

Response time of stage – I class – B arrester should not be <100ns.

Surge protector at stage II / Class C (Final Distribution Board Protector)

- The surge protection manufacturer shall offer a complete line of surge protection product to support requirements for distribution Board. Surge protector at this stage shall be provided to protect downstream electrical and electronics against any induced switching surge that may be passed on to downstream electrical & electronic system.
- Protection unit shall be based on single High Capacity metal Oxide Varistors (MOV), capable of handling 8/20µs surges and shall be able to give an indication in the event of module failure and be pluggable to facilitate in-services replacement without distributing lines. One extra set of replacement module shall be furnished to job site.
- Protection network configuration. The work required under this section consists of furnishing. Installing and connecting SPD device as specified. SPD device shall be installed in a network configuration, consisting of one set of SPD panel device at service entrance of switch stand. All SPD devices in this network configuration shall be of same manufacture. All SPD devices shall be module, mountable on 35 mm DIN rail and be field replaceable without interruption of electrical distribution circuit.
- Unit status indicator shall be provided to indicate status of complete protection unit on product as well as provision for remote indication must be provided.
- Protection shall be manufactured for specified type and voltage of electrical service and shall provide clamping for both normal (L-N) and common (N-G) mode operation.
- Protection shall be manufactured to withstand a maximum continuous operating voltage of not less than 115% normal RMS line voltage of 240 VAC.

- Protection shall be provided with internal safety fusing if required to be connected in parallel between line/s to neutral & neutral to earth as per TNS configuration of wiring. It shall be testable on line for routine maintenance module failure and in order to prevent catastrophic failure modes.
- Protection shall be a failsafe type device with no follow through current, have repeated surge capability, be solid state, self restoring and totally automatic in all modes of operation. It shall have thermal disconnections and indications against overloading of device.

Protection shall comply with IEC 61643 standards.

Protection shall have operating temperature range from -20°C to +60°C.

Protection Criteria

Maximum continuous operating voltage (Rated Voltage) for SPD device connected to phase- neutral shall not be less than values shown in table below:

Nominal Voltage Rating per phase (Vrms)	Maximum continuous operating voltage (Vrms)
120	150
240	320
350	440
480	600

Listing

Surge protective device and associated hardware must comply with IEC 61643-11

Protection voltage of complete rail mounted surge protective device shall be type tested to figures as indicated in table below, which must not exceed the values shown.

Service voltage / per phase	Protection voltage @In (Nominal discharge current) / Protection Level
240 V	1500 V

Nominal Withstand surge current.

Surge protective device (including all fusing and over current protection) for application at sub-distribution panels shall have a nominal surge current withstand capacity as shown in table below. Failure or operation of any fuse / over – current device during test is not permissible.

Application Panel Location	Max. Single Withstand surge Current (of 8/20µs Impulse)
Service Distribution Panel Final Distribution Board	10 KV, 8/20µs (between line to neutral) 24 V, 10/350µs (between Neutral to Earth)

Compliance to these specifications must be provided in this form of a certificate from an Independent testing laboratory.

25 Response time of class C arrestor should not be <25 ns.

25. Intelligent Emergency Lighting System

GENERAL

The emergency lighting system will be a fully addressable, self-test system using self-contained luminaires and comply with the requirements of BS5266 and all other related standards. All luminaires and exit signs shall incorporate an LED light source and Lithium Polymer battery technology to improve operational efficiency, reduce costs and protect the environment. Luminaires incorporating fluorescent lamp technology, nickel cadmium or nickel metal hydride batteries will not be accepted.

The system shall be designed to meet the requirements of BS5266 pt1 and a certificate of compliance shall be issued on completion.

SYSTEM REQUIREMENTS

Each lighting final sub-circuit shall be individually monitored by use of a DIN rail mounted phase monitor. The phase monitor shall be microprocessor controlled and detect the presence or absence of the mains supply in accordance with the parameters laid down in BS EN 60598-2-22.

The emergency lighting control panel shall be capable of supporting up to two circuits of emergency lighting luminaires. Each of these circuits shall be capable of supporting up to 127 devices.

Where more than 254 luminaires are required it shall be possible to install a second ELCP and interface them via a graphics package and an IEEE802.3 Ethernet network. It shall be possible to connect up to 15 panels onto a single network.

The user interface shall consist of a keypad with a 2line by 40character LCD display. It shall be possible to connect up to eight user interfaces onto each ELCP.

LUMINAIRES

Each luminaire shall be self-contained and consist of a single LED light source - with a specially designed lens to provide optimum light distribution, electronics and battery, all contained within a single plug-in housing.

Each luminaire shall be of the self-contained type and be connected via a 2 core data communication cable to a control panel. The power to charge the batteries in each self-contained luminaire shall also be delivered through this cable. Luminaires requiring a local 230V ac mains supply to charge the batteries shall not be permitted.

Each luminaire shall be microprocessor controlled and allocated an individual address within the system. This address will be programmed into the microprocessor of the luminaire using a hand-held programming tool. Setting address by use of switches shall not be permitted.

Each luminaire and exit sign shall be capable of a minimum of 3hrs continuous operation in an active mode. Each luminaire shall be fitted with a bi-colour Red/Green LED to indicate its status. This LED shall provide the following information.

Green Steady – battery fully charged.

Green Flashing – battery charging.

Alternate Green/Red – LED fault.

Red Flashing, - battery fault.

Red Steady – LED and battery faults.

Each luminaire shall be site programmable for operation in a maintained or non-maintained mode and shall provide a minimum of 3 hours continuous operation in the event of a mains power supply failure.

When a luminaire is operating in the maintained mode, it shall be possible to set the light output to seven different levels of brightness. Should the main supply fail, the luminaire shall automatically switch to maximum brightness.

To assist in servicing and maintenance, each luminaire shall plug-in to a common base. This base shall be free of any electronic components, addressing devices or batteries.

To avoid unauthorised removal it shall be possible to lock the luminaire into the base with removal only possible by use of a special tool.

BATTERY

The standby batteries incorporated into each luminaire shall be Polymer Lithium Ion technology and incorporate over voltage, over current and deep discharge protection circuitry. Additional protection shall also be provided in case of a short circuit across the battery terminals.

End of Life Disposal

Luminaires shall be WEEE and RoHS compliant and suitable for recycling. Luminaires shall not contain any heavy metals which require special handling for disposal, such as mercury, lead or cadmium.

Range of Luminaires

A range of products shall be available covering all types of emergency lighting application. All of the luminaires shall use LED technology. The range shall include the following:

LED Down-light with specially designed lens for corridor area applications. Both surface and semi-flush mounting models shall be available.

LED Down-light with specially designed lens for open area applications. Both surface and semi-flush mounting models shall be available.

A weatherproof housing shall be for LED "step light" designed for flush mounting applications. LED "swing frame" exit signs which allows the same sign to be either ceiling or wall mounted. These signs shall utilise the same "plug-in" base as the luminaires. Two blade sizes shall be available for 20M and 40M viewing distances.

LED recessed mounting exit signs.

All of the above luminaires and exit signs shall be soft addressable via a handheld programming tool.

EMERGENCY LIGHTING CONTROL PANEL

The ELCP shall consist of a sheet steel enclosure with a white powder coat finish and contain an internal termination board for all incoming and outgoing cables. The housing shall measure 295w x 475h x 100d (mm) and incorporate a secure hinged front door.

The panel shall be designed for surface mounting

All external cabling connections are via plug-in screw terminals. Terminals are of the rising-clamp style suitable for cables sized up to 2.5mm²

Cable entry is through the top or rear of the panel.

The panel shall derive its power from an externally mounted 220V/35V a.c. transformer. The transformer shall have a protection rating of IP44.

The panel shall have space for one 12V 7.2 Ah Sealed Lead Acid batteries.

The ELCP shall not incorporate any user controls. User controls shall be provided via a separate combined keypad and display unit.

The panel shall support up to two circuits of addressable luminaires, exit signs and Input/output modules. Each circuit shall be able to support 127 addresses.

The ELCP shall have a transactions log of the last 512 events. Subsequent events should overwrite the log on a FIFO principle. The data shall be held in non-volatile memory. The ELCP shall have a reports log of at least the last 12months activity. Subsequent activity should overwrite the log on a FIFO principle. The data shall be held in non-volatile memory.

Serial Outputs

The ELCP shall include a minimum of two RS232 serial data ports, with an expansion card for an additional two RS232/485 ports. The ELCP shall include an RS485 port for communication with up to eight combined keypad and display units.

One serial port shall be dedicated for uploading and downloading the programmed data to and from a PC, or to provide data to a network interface module.

Panel Networking

The ELCP shall include a serial output which will allow up to 15 panels to be connected via an existing or dedicated TCPIP Ethernet network to a graphical interface.

Power Supply

Each ELCP shall be supplied via an external 220V/35Va.c. Transformer.

Each ELCP shall contain 1 x 7Ah Sealed Lead Acid batteries to support panel and keypad operation during a mains failure condition.

User Interface

The user interface shall consist of an illuminated alpha-numeric membrane keypad, with a group of “soft keys” to be used in conjunction with a graphic based 128x64 pixel backlit LCD display in a surface mounting enclosure measuring 147W x 144H x 29D.

It shall be possible to connect up to eight user interfaces on an RS485 bus to the ELCP. The LCD shall be menu driven and incorporate the following capabilities:

Initiation of light test with selectable duration settings

It shall be possible to initiate a manual test of the emergency lighting luminaires. The duration of which shall be selectable from 10 minutes in increments of 10 minutes up to a maximum of 180 minutes. Or alternatively, a “No Limit” test can be initiated, the duration of which will last until the battery voltage reaches its lower cut off limit.

It shall be possible to initiate a battery status check to allow the operator to view the capacity of the battery within each luminaire.

To extend battery life it shall be possible to initiate a battery refresh (discharge/recharge) cycle.

Initiation of service mode, by line

To prevent emergency mode operation of luminaires during routine maintenance operations.

Auto Learn Devices

Allows the system to identify and include in configuration all addressable line devices connected to the ELCP.

Auto Learn New Devices

Allows new devices to be added into the ELCP configuration.

Manual Learn New Devices

Allows new devices to be added into the system.

Service State

It shall be possible to set a line into a “service state”. In this state, the power will be removed from the line (to allow maintenance work on the line wiring to be carried out). When switched into this mode, the luminaires shall remain off so as to prevent discharge of the luminaire standby batteries.

WIRING

The cable that interconnects the luminaires, I/O units and the panel shall be a screened and twisted single pair 1.5mm² cable with a maximum length of up to 1000M

OUTPUT RELAY CARD

It shall be possible to connect up to four 8way relay cards on a single RS485 Port. These relays shall be used for interfacing to other systems within the building.

PANEL PROGRAMMING SOFTWARE

The Control Panel shall be fully site configurable and programmable using a PC-based programme and allow the data to be backed-up to a disc for archiving purposes.

This programme shall also include the facility to produce reports of all the system programming in a printable format.

MONITORING OF GENERAL LIGHTING MAINS SUPPLY

Each lighting final sub-circuit shall be monitored at the lighting distribution board by a DIN rail mounting phase monitor. The phase monitor shall be microprocessor controlled and detect the presence or absence of the mains supply in accordance with the parameters laid down in BS EN 60598-2-22. and incorporate a voltage free change of state relay.

Each phase monitor shall be connected via an addressable input module to the ELCP to signal the presence or absence of its monitored supply.

26. ERECTION, TESTING AND COMMISSIONING

GENERAL

This section shall cover erection, testing and commissioning of all electrical equipment such as L.T. Switchgear, Distribution Boards, wiring, cables, earthing, lighting fixtures etc. to the satisfaction of the Architect / Consultant, IS codes and authorities. Requisite number of copies of test reports shall be furnished to the Architect / Consultant.

All such tests shall be carried out by the Contractor with his own instruments in the presence of the Architect / Consultant. Necessary fees, if any to be paid to the authorities, shall be borne by the Contractor.

If special tests in addition to the standard given below are required by the Architect / Consultant the Contractor shall carry out the same at his own cost to the satisfaction of the Architect / Consultant. Three copies of test certificates showing readings and details of tests carried out as above, duly signed and dated by the Contractor and the Architect / Consultant Representative shall be bound in neat folder and submitted to the Architect / Consultant.

Upon completion of the installation or part thereof, the Contractor shall test the equipment installed under this contract in presence of the Architect / Consultant. Tests shall include those specified in the Indian Electricity Rules and relevant Indian Standards as detailed below in addition to a through visual inspection to check compliance with this specification and to ensure that no part of the installation is damaged or otherwise defective.

L.T. SWITCHGEARS

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

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

CABLE WORK

Meggar test of cores of cables before termination, after termination and before commissioning. And as specified in the relevant section of the specifications

EARTHING SYSTEM

- a) Earth continuity for all earthing circuits.
- b) Earth electrode resistance.

CAPACITOR BANKS

Insulation resistance with 500 VDC megger shall be carried out and test results recorded.

POLARITY TEST OF SWITCH

In a two wire installation a test shall be made to verify that all 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 conductor of the supply.

A verification of polarity shall be made and shall be ensured that all fuses and single pole control devices are connected in the live conductor only and for socket outlets that the wiring is correctly connected.

EARTH ELECTRODE RESISTANCE TEST.

The earth resistance of the earth electrode is to be measured by an earth testing "Megger" provided with a direct reading ohmmeter. Readings obtained in ohms shall not be more than 1 ohm. If necessary, with the approval of Architect / Consultant additional electrode shall be provided away from the resistance area and linked to the electrode and inter-connecting tape/wire will be paid on unit or linear basis.

INSULATION RESISTANCE TEST.

Insulation resistance test should be made before the installation is permanently connected to the electric

supply. The insulation resistance is to be measured by using an approved portable hand operated insulation resistance tester reading directly in ohms. The voltage of this tester shall be about 500 volts. The insulation resistance to earth shall not be less than 1 mega ohm when measured with all fuse links in place, all switches closed and all poles or phase of wires are electrically linked.

EARTH CONTINUITY TEST

The earth continuity conductor should be tested for continuity to ensure that there is no breakage or loose connections in the system.

TEST REPORTS

All tests and test records are to be done in the presence of the Architect / Consultant and duly recorded in a register under the combined signature of the Architect / Consultant and the Contractor's representative. All test reports are to be made available to the Electrical Inspector for his perusal and approval.

27. PREAMBLE TO BILL OF QUANTITIES

GENERAL

1. This section shall be applicable for item rate work and for variations.
2. This preamble covers installation of lighting system, distribution boards and telephone system.
3. This preamble shall be read in conjunction with the Specifications, Conditions of Contract and all other documents accompanying the tender papers.
4. For all times of work the rates shall be comprehensive and all inclusive. The rates shall include for all materials and things necessary for satisfactory completion and maintenance of the work in proper working order and to the satisfaction of the Consultant, including testing, making samples etc., and all that have been indicated in the Specifications or other Tender Documents either directly or indirectly and cover for all obligations of the Contractor under the Contract. No claim for additional payment shall be allowed for any error or misunderstanding by the Contractor of the work involved.
5. Unless otherwise mentioned in the description of the item, this Schedule shall be applicable for work in any height, position or condition.
6. Unless otherwise stated, method of 'measurement' as described in the latest 'Specifications' of CPWD shall be followed. In case of any dispute in this regard, the Consultant's decision shall be final, binding and conclusive.
7. The following notations have been used throughout the Schedule of Quantities and Rates :

m/M	Running Metre
Sqm/SQM	Square Metre
Cum/CUM	Cubic Metre
mm/MM	Mili Metre
No.	Number/Numbers
Dia.	Diameter
Kg.	Kilogram/s
T.	Tonne

L.S.	Lump Sum
Pt.	Point
Rs.	Indian Rupees
ND	Nominal internal Diameter of pipe(mm)
%	Percent.

8. The Contractor shall be deemed to have full knowledge of all his obligations under the Contract and shall be deemed to have made full allowance for complying with all such obligations in his offer

TRADE PREAMBLE

Point Wiring (for light, fan, exhaust fan, call bell, socket outlets etc.)	Point wiring for light, fan, exhaust fan and call bell shall be measured on unit basis by counting (enumerated)
	The rates for all point wiring items shall include all work necessary in complete wiring of a switch circuit of any length from tapping point on the distribution circuit to ceiling rose, connector, back plate, lamp holder, via the switch including circuit wiring from the subdistribution board upto the first switch board on the circuit.
	The following shall be deemed to be included in point wiring for light, fan, exhaust fan, socket outlets and call bell:
	Conduit with fitting and pull through boxes on surface or in recess, cutting chases and making good as necessary.
	Wires as required upto ceiling rose, connector, back plate, lamp holder etc.
	Accessories such as switch, socket, bell push, and ceiling rose etc.
	All boxes recessed or surface mounted for housing switches, bell push, ceiling rose etc. including those required for housing fan regulators.
	Specified covers for box housing.
	All fixing accessories such as saddles, clips, nails, screws, rawl plug etc. as required.
	Interconnecting wiring between point on the same distribution circuit, in the same

	switch box or from another switch box.
	Protective (loop earthing) conductor from one metallic switch box to another on the same distribution circuit.
Stages of Payment	i) Conduit work on ceiling - 20% ii) Conduit work on walls and fixing of switch boxes - 40%
	iii) Drawing of wires - 25%
	iv) Fixing of plates and switches - 25%
	v) Testing and commissioning - 10%
Submain Wiring	Submain wiring shall mean the wiring from one main distribution switchboard to another.
	Submain wiring shall be measured on linear basis along with the run of the wiring. The measurement shall include all lengths from end to end exclusive of interconnections inside the switch board.
	Protective (loop earthing) conductors which are run along sub main wiring shall be measured on linear basis and paid for separately.
Stages of Payment	i) Conduit work on ceiling - 20%
	ii) Conduit work on walls - 20%
	iii) Drawing of wires - 50%
	iv) Testing and commissioning - 10%
Sub Distribution Board	The rates shall include for fixing, connecting and testing of the following separately.
	i) SP, SPN, TP & TPN MCBs
	ii) ELCB / RCCB
	iii) Distribution Board
Earthing and Lightning Protection	The rates for the following items of work include :
	All necessary earth work for earth station and trenches for GI pipes or plates for earth stations.
	Laying of GI tapes and GI wires in trenches and or fixing on surface / recess as required.

	All fixing accessories such as screws, Saddles etc.
	Effective connecting by bolting or welding as required.
Fixing of Fittings	The rate shall include for providing necessary fixing arrangements and flexible wires in flexible conduits from the junction box on the rigid conduit work upto the light fixture terminal box, brackets, etc. as required.

All tests and test records are to be done in the presence of the Architect / Consultant and duly recorded in a register under the combined signature of the Architect / Consultant and the Contractor's representative. All test reports are to be made available to the Electrical Inspector for his perusal and approval.

28. SPECIAL GUIDELINE TO TENDERER

GENERAL

Rates quoted shall be for work to be carried out at all heights and levels as required at site. No extra payment on this account shall be admissible. The tender may access the site conditions for assessing the content of work and heights etc. before quoting the tender.

1. POINT AND SUBMAIN WIRING

POINT WIRING

- a) Rates quoted for Point Wiring items shall be based on average wiring and average conducting length in all areas of the project. irrespective of their being shown in tender drawings or not. No extra claim on this account shall be admissible.
- b) Cost of circuit wiring (wiring from DB terminal to the first switch in any sub circuit) is shall be paid separately as Circuit wiring in the circuit wiring item.
- c) Rate quoted for Point Wiring for ceiling fan points shall also include the cost of providing fan hook cum outlet box in the ceiling. The switchbox shall have space provision for electronic fan regulator. The cost of fan regulator shall also be part of the fan point wiring.
- d) Same rate shall be payable for wiring in surface conducting system or recessed conducting system.
- e) Recessed conducting work shall be carried out in close co-ordination with progress of civil works. Conducting system in slabs shall be laid on shuttering before concrete is poured. Chases in brick work shall be made prior to plastering. Cutting of concrete or plaster for conduit laying shall not be permitted.
- f) Wiring colour code – Red, Yellow, Blue for three Phases, Black for Neutral and Green for Earth –shall be maintained for entire wiring except on UPS
- g) UPS wiring colour code – Red/white, Yellow/white, Blue/white for three Phases, white for Neutral and Green/yellow for Earth shall be maintained for wiring on UPS system.
- h) All wiring accessories (switches, socket outlets, bell pushes etc..), shall be as per approved make, type and colour. Sample of each type shall be got approved by Engineer-in-Charge before use on work.
- i) Socket outlets on UPS and on normal supply shall be designated and labeled as “UPS” and “Raw Power” in a manner specifically got approved from Engineer-in-Charge
- j) Rates for wiring of IP 56/metalclad 20/32 amps single/three phase socket outlets shall include the cost of matching plugs also.

2. SUB-MAINS AND MAINS.

- a) Payment of submain wiring in conduit shall be as per the length of conduit measured between conduit terminations. Wires without conduits inside equipments for making terminal connections at either end shall not be payable extra.
- b) Payment of cables shall be based on length of cable laid between cable termination glands on either end. Length of cable leads inside the cable termination arrangement shall not be payable extra.
- c) Single core cables shall be armoured with non magnetic material. The core insulations shall be colour coded (Red/Yellow/Blue for phases and Black for neutral)
- d) Annular space around cables, conduits, busducts and rising mains shall be filled by fire resistant compound of approved make and type in accordance with the compound manufacturer's instructions.
- e) Annular space around cables/earth strips entering below ground level into the building shall be filled up with suitable mastic compound to prevent ingress of rodents and water into the building.

3. SWITCHBOARDS AND DISTRIBUTION BOARDS

Quoted rates shall be inclusive of the cost of the following:

- a) Details of sub-circuits being fed by DBs shall be affixed on the back of the DB door of each DB.
- b) Earth bonding of all hinged doors (of DBs and SWBD cubicles/panels) shall be effectively done by braided flexible copper wire.
- c) All doors and operable covers shall be gasketed with neoprene gaskets.
- d) 3 mm thick gland plate shall be provided at top/bottom of panels for cable entry.
- e) 1 no. sample DB shall be got approved from Engineer-in-Charge before undertaking bulk procurement/fabrication.
- f) All DBs and panels shall be designated by engraved name plates of approved material, finish and lettering fixed by countersunk nickel/cadmium plated screws.
- g) Danger plates shall be affixed on all three phase panels.
- h) An as-built schematic wiring diagram in stenciled permanent ink and housed in wooden frame with clear non- reflective acrylic cover shall be provided near main LT panel in substation/electrical room.
- i) Framed safety instructions complete with emergency telephone numbers shall also be provided inside each panel room and generator room.
- j) Contractor shall provide bus bar rating calculation for current carrying capacity, short circuit thermal and electro dynamic stresses to comply to the current and fault current withstand specified for each item of switchboard, rising main, bus ducts etc. for approval of engineer prior to fabrication. Changes if any required by contractor shall be incorporated without any additional cost.

4. INSTALATION OF LIGHTING FIXTURES

Quoted rates for light fixtures shall include the following:

- 1) All components that may be required to make the installation complete in all respects such as: ,
 - a) Suitable length of down rod, hanger and connecting wires where called for.
 - b) Internal wiring between accessories.
 - c) Wiring for connecting the fixtures to the point through connection blocks.
 - d) Metal blocks to serve as base of fixtures.
 - e) Bonding with earth.
 - f) Drilling holes in supports where required.
 - g) Fixing clamps, GI bolts and nuts, brass screws, saddles, rawl plugs and other fixing accessories as required.
- 2) Installation of light fittings shall be with the use of two junction boxes placed 600 mm apart for 36/40 watt fixtures and 300 mm apart for 20 watt fixtures. The junction boxes shall form a part of the conduiting and shall be placed in the slab at the time of concreting.
- 3) For any fixtures and fittings required to be fixed to the RCC slab, the Contractor shall drill the required holes with the use of an appropriate drilling machine with drill bits and no extra charges shall be payable on this account.

5. LT SYSTEM DISCRIMINATION

The Switchgear supplier shall furnish through the contractor.

Discrimination curves, Fault current calculations, relay settings ,cable withstand calculations for the entire electrical system. The releases shall be selected as per requirement of discrimination and no extra payments shall be payable on this account.

6. SUPERVISION BY THE PRIME VENDORS

The installation, testing and commissioning of Main LT panel, 11 kV Panels, Transformers, DG sets, Bus ducts, Rising mains, 11 kV cables termination, Lifts, Escalators, UPS, Dimming System, Lighting management, Fire detection and PA systems shall be supervised and certified by the respective manufacturers at site and final test certificates shall be submitted in this regard

7. WIRES AND CABLES TEST CERTIFICATES FROM THE RESPECTIVE MANUFACTURERS

All wires and cables used shall be of the stipulated make. The contractor shall provide a certificate from the manufacturer Confirming that all wires and cables supplied to site are of their Make, irrespective of whether the wires/cables are purchased from the manufacturer directly or through a dealer suitable test certificates from manufacturers, as required, shall be submitted to engineer-in-charge. Payment for wires/cables shall not be made without the manufacturer's certificate being furnished to the engineer-incharge.

We confirm that the Special Instructions to Tenderers have been understood and our tender complies to the above in its entirety.

8. CABLE AND PIPE SEALING SYSTEM

Cable & Pipe Sealing System is used in infrastructure applications to prevent entry & ensure foolproof protection against "Water, Dust, Humidity, Fire, Vibrations, Temperature Variations, Pull Tension, Noise, Rodents and EMI.

All the Cables & Pipes passing through the walls of MSC, NOC, Data Center, Power Room, Battery Room, Cable Trenches, Control Panels, Enclosures, Junction Boxes, SCADA, Out Door Cabinets, Shelter shall be sealed through Modular based Cable & Pipe Sealing System based on multi-diameter technology.

A standard solution will have a frame, modules, wedge / compression unit, stay plate, and lubricant gel.

9. Sealing Solution for Building Infrastructures (MSC /NOC /DC/Any Infra Facility): G Frame

The G frame is a flanged metal frame available with a single opening or combinations with several openings in and / or height. G frame can be bolted, casted or welded.

Bill Of Material (BOM) – G Frame			
S. no	Roxtec G Frame Type	Frame Opening Size (HXW) mm	Accessories
1	2 X 1	60 X 120	Modules, Stay plates & Wedge
2	4 X 1	120 X 120	
3	6 X 1	180 X 120	
4	8 X 1	240 X 120	

Note – Frame opening size and numbers, module type and quantity depend upon number & actual outer diameter of cable.

10. Cable & Pipe Sealing Solution for Cabinets / Panels:

The Com Seal is a light weight and area-efficient cable sealing solution for cabinets. The frames are made out cast aluminum and solutions are approved for IP 65/55 and UL/NEMA 12,12K.

Bill Of Material (BOM) – Com Seal Range					
S. no	Com Seal Range	Cable outer dia. range in mm	Can Accommodate Total no. of cables (Qty.)	Module type	No. of modules
1	Com seal 10/4	3.5 TO 16.5 mm	2 cables	CM 20W40	1
		9.5 TO 32.5 mm	2 cables	CM 40 10-32	2
2	Com seal 10/7	3.5 TO 16.5 mm	6 cables	CM 20W40	3
		9.5 TO 32.5 mm	1 cables	CM 40 10-32	1
3	Com seal 10/10	3.5 TO 16.5 mm	10 cables	CM 20W40	5
4	Com seal 12/3		3 Cables	CM 40 10-32	3
5	Com seal 12/6	3.5 TO 16.5 mm	4 cables	CM 20W40	2
		9.5 TO 32.5 mm	2 cables	CM 40 10-32	2
6	Com seal 12/9	3.5 TO 16.5 mm	8 cables	CM 20W40	4
		9.5 TO 32.5 mm	1 cables	CM 40 10-32	1
7	Com seal 12/12	3.5 TO 16.5 mm	12 cables	CM 20W40	6
8	Com seal 16/4	9.5 TO 32.5 mm	4 cables	CM 40 10-32	4
9	Com seal 16/7	3.5 TO 16.5 mm	4 cables	CM 20W40	2
		9.5 TO 32.5 mm	3 cables	CM 40 10-32	3
10	Com seal 16/10	3.5 TO 16.5 mm	8 cables	CM 20W40	4
		9.5 TO 32.5 mm	2 cables	CM 40 10-32	2
11	Com seal 16/16	3.5 TO 16.5 mm	16 cables	CM 20W40	8
12	Com seal 32/8	9.5 TO 32.5 mm	8 cables	CM 40 10-32	8
13	Com seal 32/14	3.5 TO 16.5 mm	8 cables	CM 20W40	4
		9.5 TO 32.5 mm	6 cables	CM 40 10-32	6
14	Com seal 32/20	3.5 TO 16.5 mm	16 cables	CM 20W40	8
		9.5 TO 32.5 mm	4 cables	CM 40 10-32	4
15	Com seal 32/32	3.5 TO 16.5 mm	32 cables	CM 20W40	16

LIST OF ELECTRICAL APPROVED MAKES/MANUFACTURES OF MATERIALS

S.NO.	MATERIAL	BRAND NAME / MANUFACTURER
-------	----------	---------------------------

I. CONDUITS, CABLE TRAYS, PIPE DUCTS ETC.

- | | | |
|----|--|---|
| 1. | FRLS PVC & MS/GI Conduits, junction boxes and Other accessories (ISI : marked) | a) BEC
b) Polycab
c) AKG |
| 2. | GI Pipes | a) Tata
b) Jindal Hisar |
| 3. | Cable trays, raceways and accessories | a) Sai Metal Craft
b) MEM
c) KME |
| 4. | GI conduit accessories | a) Sharma sales corp.
b) Super sales corp. |
| 5. | MS /GI/ SS flexible conduit accessories | a) Setia
b) Trinity Touch |
| 6. | Nylon Flexible Conduits & Accessories | a) Trinity Touch
b) Lapp
c) Hummel |

II. WIRES & CABLES

- | | | |
|----|--|---|
| 1. | FRLS/ZHFR Insulated Copper Wires for internal Wiring | a) RR Kabel
b) Havells
c) Polycab
d) KEI |
| 2. | XLPE Insulated Copper/Al power cables (Armoured) 1.1KV grade | a) RR Kabel
b) Polycab
c) KEI
d) Havells |
| 3. | Co-axial cables | a) Polycab
b) Finolex |
| 4. | Cat-6A cable | a) Avaya
b) AMP
c) D-Link |
| 5. | 1.1KV Double compression brass glands | a) Gripwell
b) Comet
c) Dowells |
| 6. | XLPE Insulated Copper/Al power cables (Armoured) 11KV grade | a) Polycab
b) Universal
e) Nicco
f) Fort Gloster |
| 7. | 1.1KV PVC glands | a) Hensel
b) LAPP
c) Trinity Touch |
| 8. | 1.1KV cable lugs | a) Gripwell |

- | | |
|--------------------------------------|--------------------|
| | b) Comet |
| | c) Dowells |
| 9. Fire survival wires and cables | a) KEI |
| | b) Polycab |
| | c) Agilon |
| 10. Heavy duty cable terminal blocks | a) Phoenix Contact |
| | b) Wago |
| 11. Music wires | a) Finolex |
| | b) Polycab |
| | c) Agilon |
| 12. Special cables – FS and others | a) Agilon |
| | b) KEI |
| | c) RR-Kabel |

III. SWITCHES, SOCKETS & OTHER WIRING ACCESSORIES

- | | |
|--|-------------------------|
| 1. Plate type switches & sockets and accessories | a) Legrand –Arteor |
| | b) Schneider |
| | c) Hager |
| 3. Plate type plates and boxes | a) Same as the switches |
| 4. Data outlet RJ-45 | a) Avaya |
| | b) D-Link |
| | c) AMP |
| 5. Industrial sockets | a) Neptune- Balls |
| | b) Legrand – Tepmra |
| | c) Scheme |
| 6. Telephone tag blocks | a) Krone |
| | b) Legrand |
| 7. Ceiling rose | a) Anchor |
| | b) SSK |
| 8. Pop up boxes and accessories | a) OBO |
| | b) Legrand |
| | c) Honeywell |

IV. SWITCHGEAR

- | | |
|----------------------------------|--------------|
| 1. ACB | a) Schneider |
| | b) ABB |
| | c) Havells |
| 2. Moulded Case Circuit Breakers | a) Schneider |

- | | | |
|-----|--|---|
| | | b) ABB
c) Havells
d) BCH |
| 3. | Change over switches | a) Socomec |
| 4. | Miniature Circuit Breakers and Isolators | a) Legrand
b) Schneider
c) Havells |
| 5. | ELCB / RCCB | a) Legrand
b) Schneider
c) Havells |
| 6. | MCB Distribution Boards | a) Same as that of MCBs |
| 7. | HRC Control fuses | a) Siemens
b) L&T
c) S&S |
| 8. | Digital Voltmeter & Ammeters | a) BCH
b) Schneider
c) Neptune |
| 9. | Selector switches | a) Kaycee
b) Salzar
c) BCH |
| 10. | Indicating lights and other accessories | a) BCH
b) TC
c) Siemens |
| 11. | Cast resin CT | a) Automatic electric
b) Kappa
c) Gilbert |
| 12. | Contactors and starters
b) | a) Siemens
ABB
c) Havells
d) BCH |
| 13. | Push buttons
b) | a) L&T
BCH
c) Siemens |
| 14. | Relays
b) | a) ABB
Schneider
c) BCH |
| 15. | LED Lamps
b) | a) L&T
Siemens
c) BCH |

- | | | | |
|-----|------------|----|--|
| 16. | Capacitors | b) | a) Ducaiti
Siemens |
| 17. | TVSA /SPD | | a) OBO-Betterman
b) DEHN
c) Cap electric |
| 18. | ATS | | a) ASCO
b) Socomec |
| 19. | MPCB | b) | a) Schneider
ABB
c) Siemens |

V. LIGHT FIXTURES

- | | | |
|----|----------------|------------------------------------|
| 1. | Light fixtures | a) Wipro
b) Legero
c) K Lite |
|----|----------------|------------------------------------|

VI MISCELLANEOUS ITEMS

- | | | |
|----|--|-------------------------|
| 1. | Telephone Tag Block | a) Krone
b) MDS |
| 2. | Fire sealant and Fire retardant paints | a) Birla 3M
b) Hilti |
| 3. | Fire pipe and wall seals | a) Roxtec |

VII PANELS

- | | | |
|----|----------------|--|
| 1. | Panel Builders | a) Neptune System
b) Adlec Systems
c) Shivalik Power
d) Elpower |
|----|----------------|--|

VIII FIRE ALARM SYSTEM

- | | | |
|----|-----------------|--|
| 1. | Smoke detectors | a) Notifier
b) Hochiki
c) Tyco
d) Honeywell |
| 2. | Heat detectors | a) Notifier
b) Hochiki
c) Tyco
d) Honeywell |
| 3. | Fire panel | a) Notifier
b) Hochiki |

4. MCP, RI and sounders
 - c) Tyco
 - d) Honeywell
 - a) Notifier
 - c) Hochiki
 - c) Tyco
 - d) Honeywell
5. Batteries
 - a) Chloride
 - b) Exide
 - c) Standard

IX **CCTV SYSTEM**

1. Cables
 - a) Belden
 - c) Agilon
 - d) Bhansali
2. Cat-6A cable
 - a) Avaya
 - b) AMP
 - c) D-link
3. Cameras
 - a) Hik Vision
 - b) CP-PLUS
 - c) Tyco

X **PA SYSTEM**

1. Speakers
 - a) Heinriech
 - b) Bosch
 - c) Bose
2. Amplifiers/Zone control/Mike etc
 - a) Heinriech
 - b) Bosch
 - c) Bose
3. Wires
 - a) RR-Kabel
 - b) Polycab
 - d) Agilon

XI **UPS SYSTEM**

1. UPS
 - a) APC
 - b) EATON
 - d) ALBITEK
2. Batteries
 - a) Exide
 - b) SF
 - c) Rocket

XII **EMERGENCY LIGHTING SYSTEM**

1. Control panel
 - a) Hochiki

b) Sure Fire

2. Luminaires

- a) Hochiki
- b) SureFire

XIII) Panel Pressurised fire suppression system

1. Panel suppression system
(UL Listed and FM Approved)

- a) Kanex
- b) Cease Fire
- c) Firetrace
- d) FireMech