



**TECHNICAL CELL, EPC MISSION,
PLANNING DEPARTMENT, LUCKNOW**

**As Executing Agency of
Department of Medical and Education
Government of Uttar Pradesh
E-Tender For
“Design, Engineering and Procurement Construction of
Autonomous State Medical College Ballia, India on EPC
Mode”**

**Tender No.: 117 (1) (SE)/General/Technical Cell/2026 dt
14.05.2026**

**Volume-5
TECHNICAL SPECIFICATIONS
(June, 2026)**

E-mail ID: technicalcellepcmission@gmail.com

**Design, Engineering and Procurement Construction of Autonomous State
Medical College Ballia, India on EPC Mode**

INDEX

Sl. No.	Heading	Page no.
1	Technical Specification -CIVIL WORKS	03-101
2	Technical Specification -PLUMBING WORKS	102-159
3	Technical Specification -ELECTRICAL SERVICES/FIRE-FIGHTING/SPECIALISED E&M WORKS	160-393
4	Formats for guarantees	
i	Guarantee to be executed by the contractor for removal of defects after completion in respect of water supply and sanitary installation.	394
ii	Guarantee bond to be executed by the contractor for anti termite treatment	395
iii	Guarantee bond to be executed by the contractor for water proofing treatment for basements.	397
iv	Guarantee bond to be executed by the contractor for water proofing treatment for roof	398
v	Guarantee bond to be executed by the contractor for water proofing treatment (under floors).	399
vi	Guarantee Bond To Be Executed By the Contractor In respect of aluminium works.	400
vii	Guarantee bond to be executed by the contractor in respect of structural glazing/ curtain wall system/works.	401
viii	Guarantee bond to be executed by the contractor in respect of seismic/mechanical joint works.	402

Technical Specifications

Civil works of Buildings

DETAILED SPECIFICATIONS

EARTH WORK

Earthwork excavation in foundation/trenches/over areas in all kind of soil/rock for desired level as per Structural/Architectural drawing for all kinds of soil and ordinary rock shall be as per CPWD Specifications- 2019 - Vol. I & Vol. II and relevant IS codes of latest edition with upto date correction slips. Any deviation in earthwork in excavation as per site condition will be ignored and nothing shall be paid extra. Top soil up to 300mm shall be preserved at site premises (protected against erosion during rain) and reused in landscaping development as per GFC drawing and CPWD specifications or as decided by Engineer-in-Charge

Excavation shall be undertaken to the width of the Basement / Retaining wall footing including necessary margins for construction operation as per drawing or directed otherwise. Where the nature of soil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer. Nothing shall be paid extra.

The contractor shall make at his own cost all necessary arrangements for maintaining water level in the area where works under execution are low enough so as not to cause any harm to the works or problems in carrying out with the execution and the rates shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains, subsoil water table being high or due to any other cause whatsoever. The contractor shall make necessary provision of pumping, dredging, and bailing out water coming from all above sources and excavation and other works shall be kept free of water by providing suitable system approved by the Engineer-in-charge.

In order to avoid construction of underground structure like UGS, WTP, STP, or any basement portion of building being getting uplifted/damaged due to water pressure, the contractor shall make arrangement for lowering the ground water table below the proposed foundation level as approved by Engineer-in-charge. Sub soil water table shall be maintained at least 50 cm below the P.C.C. level during laying of P.C.C., water proofing treatment, laying of basement raft and beams including filling of earth/sand under the basement floor. The water table shall not be allowed to rise above base of raft level until

completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls up to ground level and until the structure attains such height to counter balance the uplift pressure. However, the contractor should inspect the site and make his own assessment about sub-soil water level likely to be encountered at the time of execution and quote his rates accordingly. Scope of work are inclusive of pumping out or bailing out water, if required. Nothing extra on this account whatsoever shall be paid to him unless otherwise specified. The sequence of construction shall be got approved by the Engineer-in-charge.

All the major excavation shall be carried out by mechanical excavator. No extra payment shall be made for that.

The rates are inclusive for all depths & nothing extra shall be paid for additional lift etc.

Disposal and Shifting of Earth

Disposal of surplus excavated earth/cutting and shifting of earth to maintain required finished levels as per landscaping drawing from one area to another within the campus by mechanical transport including loading/unloading and stacking/spreading at designated location as directed by E.I.C is included in the scope of contractor and nothing will be paid extra even if contractor have to do double handling of earth.

Filling: -

The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish. Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top must layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metre vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

Under Floor and Building Outer area filling: -

Filling with available excavated earth in sides of foundations & under floors shall be done only if earth found suitable, otherwise filling shall be done by bringing Moorum of approved quality and quantity from outside and nothing extra shall be paid towards the same.

Moorum of approved quality and quantity shall be filled from Natural ground level to Proposed Made up ground level as per GFC drawing outside allround the building along the perimeter to an extent of 2.4 m from building outer face. Outer area murrom filling is included in scope of contractor for every building.

All the filling (**Exacavated Earth/Moorum**) work should be done in the layers not exceeding 20cm as per CPWD specification. Each layer shall be watered, rammed and consolidated.

Landscape area

All Cutting and Filling of Earth coming to maintain the required finished level of complete Landscape area as mentioned in the landscaping/building drawing is in the scope of

contractor. All filling should be done with available excavated earth and as per CPWD specifications and if the earth is not available, the same of approved quality to be brought from outside as decided by Engineer in Charge and Contractor is strictly advised to assess the required quantity beforehand and to quote his rate accordingly and nothing extra will be paid later.

Sand filling:

Supplying and filling with local sand including watering, ramming, consolidating and dressing complete as per CPWD specifications shall be provided as mentioned in GFC drawing.

Anti-Termite Chemical Treatment:

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

Supplying, Diluting and Injecting chemical emulsion chloropriphos/lindane E.C 20% with 1% concentration for anti-termite treatment and creating a chemical barrier for termite as per cpwd specification and as per direction of EIC.

- Treatment of soil under floors above sand filling using chemical emulsion by flooding @ 15 litre per sqm.
- Along external wall for 3m width using chemical emulsion @ 7.5 litres / sqm of the vertical surface of the substructure to a depth of 300 mm including excavation channel along the wall & rodding etc. complete.
- Along the expansion joints, surrounding of pipes & fittings and conduits @ 20litre per building.

The Contractor shall have to furnish 10 years Guarantee to maintain the anti-termite treated area / structures free from termite.

Treatment of column pits, wall trenches and basement excavations

The bottom surface and sides (up to a height of 30 cm from the bottom) of the excavations made for column pits and trenches shall be treated with the chemical emulsion mentioned above at 5 liters / sqm of surface area.

Treatment to Backfill Earth

After the column foundations and wall foundations come up, the backfill in immediate contact with the foundation structure shall be treated with the chemical emulsion at the rate of 15 liters/ Sqm of the vertical surface of the sub-structure for each side. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

Treatment for R.C.C Framed Structures

The treatment described above applies essentially to masonry foundations where there are voids in the joints through which termites can seek entry into the superstructure. Hence the foundations require to be completely enveloped by a chemical barrier. In the case of RCC framed structures with columns and plinth beams, the concrete mix is rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom excavations for columns, plinth beams and basement walls. The treatment shall start at depth of 50cm below ground level. From this depth, the backfill around the columns, beams and RCC basement walls shall be treated at the rate of 15-liters/ Sqm. of the vertical surface. The other details of the treatment shall be as laid down above.

Treatment of Top Surface of Plinth Filling

After the earth filling is completed in the plinth area and before the dry rubble packing or sub grade is laid, the entire surface of the filled earth shall be treated with the chemical emulsion at the rate of the 5 liters per Sqm. Light rodding may be carried out in the soil surface to facilitate absorption of the emulsion.

Treatment at Junction of Walls and Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surface from the ground level up to the level of the filled earth surface. To achieve this, a small channel 3 x 3 cm shall be made at all the junctions of wall and columns with floor (before laying the sub grade) and rod holes made in the channel up to the ground level 15 cm apart and the rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 15 litre/ Sq.m of the area of the vertical surface of the wall surface of the sub-structure so as to soak the soil right to the bottom. The soil should be tamped back into place after this operation.

Treatment to Soil along External Perimeter of Building

Finally, the earth around the external perimeter of the building up to a depth of 30cm shall be treated at the rate of 4.5 litres per running meter of plinth wall. To facilitate this treatment, solid M.S. rods should be driven into the soil as close as possible to plinth wall at intervals of 15 cm and up to a depth of 30 cm and the rods moved backwards and forwards in a direction parallel to the wall to break up the earth so that the chemical emulsion mixes intimately with soil.

Treatment of Soil Surrounding Pipes, Wastes and Conduits

When pipes, wastes and conduits enter the soil inside the area of the foundation, the soil surrounding the point of entry must be loosened around each such pipe waste or conduit for a distance of 15 cm and up to a depth of 7.5 cm before the treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 7.5 cm for a distance of over 30 cm.

Termite Proof Course or DPC (PCC) in Plinth

Where there is the provision of a damp-proof course in the construction, it is located just below the level of the filled earth. Although this acts as an effective barrier impervious to termite entry the PCC surface should be treated at 5 litres per Sq.m immediately after the course is laid and the concrete is green. Where there is no provision for a DPC, the top surface of the masonry course just below the level of

plinth filling mentioned above should be soaked with the chemical emulsion at the rate of 5 litres per Sq.m. of the surface. The application should be carried out slowly to enable the masonry surface to absorb the emulsion.

Guarantee

The Contractor shall guarantee the anti-termite work for a period of 10 years from date of completion. The guarantee will cover the surfaces treated and will bind the Contractor to perform remedial measures, at his expense including but not limited to repeat of anti-termite work in the affected area/zone. The guarantee shall be in the form of irrevocable bank guarantee for an amount equivalent to 10% of the total sum paid to the Contractor for anti-termite treatment work valid for a period of 10 years complying.

Contractors must ensure that the work is done through a professional pest control operator who is a member of Indian Pest Control Association or other recognized professional body. A list of termite control jobs successfully undertaken for Government Departments, Statutory bodies or large private organizations are to be provided to prove that they are capable of handling anti-termite work.

Reinforced cement concrete/ PCC in substructure

Foundation shall be with RCC isolated/ stripped/ combined, Raft type footing as per structural drawing using Ready mixed grade concrete as mentioned in drawing. Columns are connected by grade (external) beams/plinth (Internal) beams below Ground level as per structural drawing and wherever necessary additional tie beams shall be provided in between grade beams/ plinth beams & top of footing based on the depth of footing. All Pedestals & columns above foundation, plinth beams, tie beams etc shall be as per structural drawing with Ready mixed grade concrete as mentioned in drawing. Reinforcement steel as per drawings to be provided and Slab on grade below floor finish with Ready mixed grade concrete slab include reinforcement steel as per drawings. Base concrete below the footing, plinth beam, grade slab, etc. shall be of grade 1:4:8 minimum thickness of 75 mm or as mentioned in GFC drawing. To maintain the cover to reinforcement in structural members only factory-made cover blocks of required size and grade not lesser than the grade of concrete have to be used.

Brick work in foundation and plinth

Non modular well burnt clay of class M-75/ Cement based flyash bricks in foundation in cement mortar 1:4 (1 Cement: 4 Coarse sand).

Damp Proof Course

Damp proof course shall be with 50 mm thick cement concrete 1:2:4 (1cement: 2 coarse sand: 4 graded stone aggregate 12.5mm nominal size) mixed with approved water proofing compound painted at top with a coat of residual petroleum bitumen of grade VG-10 of approved quality at 1.7 kg/sqm.

Plinth Protection

Plinth Protection shall be 40mm thick rough Bilha stone with machine cut edges (straight or raked as called for) or as specified in drawing to the pattern laid over a 20mm thick bed of cement mortar 1:4 (1cement :4 coarse sand) with fine joints filled with cement mortar 1:2 (1cement :2 coarse sand) pigmented to match the stone. Brick edging, PCC& hardcore all sections as shown in GFC drawing.

Light weight sunken floor filling:

Providing and laying machine mixed Autoclaved aerated cement (AAC) blocks concrete in volumetric proportion 1:4:8 (1 cement: 4 coarse sand : 8 AAC block aggregate 40 mm nominal size) for specified thickness, for sunk floor, in depressed portions of toilets, terraces etc. in super structure at all heights & levels, including centering and shuttering if required, laying spreading, ramming, consolidating as per requirement and curing etc. complete as directed.

Reinforced cement concrete/ PCC in superstructure:

All RCC Columns, walls, beams, slabs etc. shall be as per structural drawing with required grade designed RMC concrete. To maintain the Cover to reinforcement in structural member, only factory-made cover blocks of required size and grade not lesser than the grade of concrete in RCC works have to be used. As far as possible, no honeycombing is accepted, but if any minor rectification required it shall only be done with GP2/Epoxy grout and not by Cement mortar.

Curing of RCC & PCC

Curing of concrete is most important. There shall be no compromise on this activity and it is for the contractor to arrange for everything necessary to make sure that the concrete is cured to the complete satisfaction of the Engineer-in-Charge. Concrete shall be protected from quick drying with moist or damped hessian cloth or any other material approved by the Engineer-in-Charge. After 24 hours of laying of the concrete, the surface shall be cured by flooding with water or covering with damp hessian cloth for a period of 7 days to keep it moist and for the next 7 days the surface shall be kept wet all the time by sprinkling water continuously or as per CPWD specifications.

If required, for columns and other vertical surface curing compound of approved make can be used as per the direction of E.I.C.

SHUTTERING / FORM WORK: -

The work shall be done in accordance with CPWD Specifications - 2019 - Vol.I& Vol. II with upto date correction slips.

Steel shuttering and 12 mm thick BWP grade film faced plywood shuttering to be used in the work by contractor as per direction of engineer in charge. All shuttering brought at

site should be new/fresh when used for the first time and should not be allowed more than permissible repetition or quality of surface of shuttering become uneven which ever is earlier

- Minimum size of shuttering plates shall be 600mm x 900mm except for the case when closing pieces required to complete the shuttering panels. Dented, broken, cracked, twisted or rusted shuttering plates shall not be allowed to be used on the work and Props of steel shall be provided with adequate horizontal and cross - bracing. Steel props shall use steel pipes and steel couplers.
- Form work including centering, shuttering, propping, staging shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Form work shall be properly designed for self-weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages. It is important to note here that Designing of formwork/shuttering as per CPWD specifications/relevant IS codes for RCC work i.e column/wall/beam/slab at all heights and level as shown in GFC drawing is the responsibility of contractor and if any mishap happens during execution of RCC work due to design/workmanship fault etc, then it will be the sole responsibility of Contractor.

Workmanship:

Contractor shall account for all material and labour etc. to achieve the required finishes to the satisfaction of the E-I-C:

- The shuttering plates shall be cleaned properly with electrically driven sanders to remove any cement slurry or cement mortar or rust. Proper shuttering oil or debonding compound shall be applied on the surface of the shuttering plates in the requisite quantity before assembly of steel reinforcement.
- The joint filler shall be resilient closed cell expanded polyethene and non- tainting as manufactured by approved make.
- Providing joint filler of required thickness in position to substrate using either double sided foam adhesive tape or neoprene synthetic rubber adhesive. When forming expansion joint with the Board in in-situ concrete, joint sealing slots can be readily formed in the following matter-
 - a) Before installing, simply cut off a strip of the required depth. Then install the filler flush with the finished surface.
 - b) Prior to sealing, the top strip can then be pulled easily from the joint to provide an uncontaminated sealing slot ready for preparation and sealing.
- Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.
- Shuttering surface before concreting should be free from any defect/ deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface

should be therefore checked for any damage to its surface and excessive roughness before use.

- Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the E-I-C, so as to offset the subsequent deflection, for cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the E-I-C.
- Erection of form work may be from pre-moulded, pre-fabricated, pre-assembled plates or forms reasonable enough to transport and erect at site to correct line and level as set out at site. Supports shall be firm and maintained in position by nails, cross bracings, tie rods, locking bolts and nuts. It shall be rigid and stiff so as to retain its shape during and after concreting. The tie rods shall be terminated at least 40mm inside the finished surface.
- Joints shall be water-tight and no cement slurry shall be allowed to slip through. In joints foamed tapes shall be used.
- Pre-fabricated or site forms shall be assembled, so as to deshutter without any jerk to the green concrete. For this double wedge shall be used. Wedges shall be nailed, the heads reasonably left out, allowing easy removal while deshuttering.
- Pre-fabricated or on site fabricated forms shall be of sufficient thickness and with the required supporting runners in either direction. Supporting runners shall be standardised in size for easy replacement and universal use at site.
- In repeated use, panels shall be clearly marked for using at defined locations.
- Successive lift shall be tightened with previous lift by fixing foamed strips at joints to avoid grout leakage.
- In fill pieces and panels shall be well dressed, leveled and jointed with main formwork so as to achieve smooth, even natural finish.
- Provide and fix or fix only inserts pockets, to correct line and level and with sufficient rigidity to keep in position while concrete placing is in progress along with vibration.
- Sloping, brackets, chajjas etc shall be well secured and firmly restrained.
- Adequate access and working platform shall be arranged with required safety to avoid reinforcement displacement, damage to shuttering and easy movement of concrete gang.
- Props and scaffolds are to be erected to correct plumb, line, level and with required tie. Load carrying capacity of props shall be as per table of manufacturer.
- Props and scaffolds shall not be loaded more than allowed by manufacturer of Props /scaffolds.
- Heavy, medium and light duty props shall not be mixed up.
- All angles and corners shall be sharp and well defined. In places where concrete edges are permanently exposed and require no further treatment, they shall be chamfered in a triangle of 25x25mm.
- At the design and erection stage, the following additional points shall be considered and incorporated into the shutters.
- Openings for cleaning prior to start of concreting.
- Pouring points shall avoid high drops and provide easy access to vibrator needles. Surfaces shall be treated with mould releasing oil or emulsion prior to reinforcement laying.

- Joints of moulds shall be water-tight & should be checked from bottom to make sure that no light is visible.
- Props shall be on solid base, plumbed, in one straight line, and braced horizontally and cross.
- Tie bars in beams, walls and columns shall be at the correct place and fully tight.
- Wedges shall be fully secured and nailed with head left out for easy removal.
- All saw dust, dirt, shaving and any other unwanted materials shall be cleaned and hosed out.
- Provision shall be made for watching form work while concreting and any other platform needed for movement of workers without any disturbance to reinforcement.
- Opening/inserts: All required openings and pockets shall be provided as detailed in the drawing. The contractor shall provide for the required material, labour for fixing and supporting during concreting, in his quoted price. It is imperative that all openings and pockets shall be deshuttered with care and all corners of openings shall be preserved. All openings/pockets shall be in a correct line and level. After concreting, the openings shall be secured by proper covering against any accident and guard rail and warning notice, if any will be incorporated.
- In case of multistory building, the concreting of upper floor shall be done only after lower floors have attained the strength.
- In case of shear walls, lift walls, internal walls, the form work shall be done by removable type tie rods within PVC sleeves.

Note: - Tolerance in Finished concrete and class of surface finish should be as per CPWD Specification.

Formwork for exposed concrete surfaces: -

- Where it is specifically shown on the GFC drawings to have Expose concrete finish or original fair face finish of concrete surface without any rendering of plastering, 12 mm thick BWP grade type 3 film faced plywood of CSFF designation confirming to IS: 4990 for form finished/ fair faced concrete surface as per acceptance criteria where ever required as per the Architectural GFC drawing. The BWP type 3 ply to be used can have maximum 3 repetition only.
- The forms shall be constructed so as to produce a uniform and consistent texture and pattern on the face of the concrete. The formwork shall be placed so that all horizontals are constructed of lumber and are not paneled and the formwork joints shall be staggered.
- To achieve a finish which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Whenever possible, joints between sheets shall be arranged to coincide with architectural feature, sills, window heads or change in direction of surface. All joints between panels shall be vertical or horizontal unless otherwise directed. Suitable joints shall be approved between sheets. The joints shall be arranged and fitted so that no blemish or mark is imparted to the finished surfaces.
- Forms for exposed concrete surfaces shall be constructed with grade strips (the underside of which indicate top of pour) at horizontal constructions joints, unless the use of groove strips is specified on the drawings. The reset forms shall be tightened against the concrete so that the forms will not be spread and permit abrupt

irregularities or loss of mortar. Supplementary form ties shall be used as necessary to hold the reset forms tight against the concrete.

- For fair faced concrete, the position of through bolts will be restricted and generally as indicated on the drawings.
- Plywood used in the formwork for obtaining exposed surfaces shall be got approved from Engineer-in-Charge on each use. However, no forms will be allowed for reuse if it is doubtful to produce desired texture of exposed concrete.
- Cement of only approved shade shall be used preferably of single lot to achieve integrity of texture.

REINFORCEMENT: -

Reinforcement bars shall be Thermo-Mechanically Treated (TMT) bars of min grade Fe-500D. Conforming to IS 1786. Steel shall be fresh and new. It shall be free of defects and free of rust, oil, paints, grease, loose mill scale or any other deleterious material undesirable for RCC or prevent adhesion of concrete with reinforcement. The contractor shall procure TMT bars from primary steel producers conforming to related IS Code and standards. All reinforcement bars brought at site shall be tested prior to use for respective specification / physical properties. Only material acceptable as per IS shall be allowed into the works. Workshop shall be installed at site for fabrication of steel.

Binding wires: Binding wire shall be 16 or 18 gauge annealed wire conforming to IS 280. It shall be free from rust, oil, paint, grease, loose mill scale or any other deleterious material undesirable for the reinforcement and concrete or which may prevent adhesion of concrete with reinforcement.

Workmanship

- Fabrication of reinforcement: Reinforcement shall be fabricated as per the structural drawing and approved bar bending schedule. Bending of material shall be cold bending only. Anchoring of bars and stirrups shall be provided exactly as detailed in the GFC structural drawing or as directed by the E-I-C.
- Laps shall be strictly as per the GFC drawing or as per CPWD Specification. For general guidance, the following principles shall be followed as given in IS 456.
- Mechanical Reinforcement coupler of adequate strength, length and internal thread and conforming to performance requirements as per IS code 16172:2014 can be used by contractor for diameter 25mm and above in place of Lapping but nothing extra will be paid for the same.
- The reinforcement shall be done as per CPWD Specifications - 2019 - Vol.I& Vol. II with upto date correction slips.
- The item of reinforcement of RCC work includes all operations including straightening, cutting, bending, binding and placing in position at all the floors with all leads and lift complete as per CPWD Specification - 2009 - Vol.I& Vol. II with upto date correction slips.
- To avoid displacement of bars in any direction and to ensure proper cover, only factory-made round type/rectangular cover blocks of same block of parent concrete shall be used by the contractor. Nothing extra shall be payable on this account.

MASONRY WORK

All external walls as per GFC drawings shall be Well burnt clay Bricks/Red Brick of Class M-150 or cement based Fly Ash brick walls of thickness 400 mm (consisting of 230 mm external wall in cement mortar 1:6 (1 cement: 6 coarse sand) & 115 mm internal wall in cement mortar 1:4 (1 cement: 4 coarse sand)) / 300 mm (consisting of two no. 115 mm wall in cement mortar 1:4 (1 cement: 4 coarse sand)) / 230 mm thick single wall in cement mortar 1:6 (1 cement: 6 coarse sand)

All Internal walls as shown in the drawing shall be autoclaved aerated cement blocks masonry of given thickness / 115mm thick brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) with Well burnt clay Bricks/Red Brick of Class M-150 or cement-based fly ash bricks / 230mm thick bricks masonry in cement mortar 1:6 (1 cement: 6 coarse sand) with Well burnt clay Bricks/Red Brick of Class M-150 or cement-based fly ash bricks.

Brick Masonry

Unless otherwise specified Well burnt clay Bricks/Red Brick of Class M-150 shall be used in all items of brick work. The classification of bricks brought by the contractor shall strictly conform to CPWD Specifications – 2019 Vol-1 & II with upto date correction slips or as specified.

Note: - Half masonry with cement mortar (1:4) shall be provided with RCC bands of required thickness as shown in GFC drawing at the Sill and Lintel level or as directed by E.I.C.

Autoclaved Aerated Cement Blocks Masonry

AAC Block shall confirm to IS:2185(Part-III) and shall be of grade-I with minimum compressive strength 4.0 N/sqmm.

Providing and laying autoclaved aerated cement blocks masonry with 100 mm thick AAC blocks in super structure above plinth level up to all level in block laying polymer modified adhesive mortar, with required thickness of RCC bands as shown in GFC drawing at sill level and lintel level or every 1.2m as directed by Engineer-in-charge.

Providing and laying autoclaved aerated cement blocks masonry with 200mm/300 mm thick or as specified in GFC drawing. AAC blocks in super structure above plinth level up to all level with required thickness RCC band as per GFC Drawing at sill level and lintel level or every 1.2m as directed by Engineer-in-charge with approved block laying polymer modified adhesive mortar all complete as per direction of Engineer-in-Charge.

CAVITY WALL: -

It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material as given in drawing.

The cavity between the walls shall be filled with cement concrete 1:2:4 (1 cement: 2 coarse sand :4 graded stone aggregate 20 mm nominal size) up to plinth level & filled with 50 mm thick extruded polystyrene rigid insulation board in super structure as per architectural drawings.

The item shall include use of device for keeping cavity clear and forming the requisite weep and vent holes as shown in architectural drawings.

Bonding units for Cavity wall

These shall be preferably precast R.C.C. units having cross-section based on the width of cavity wall. Length of the Bonding units will be sum of thickness of both leaves plus width of cavity. Width & Thickness are same as bricks used in the construction of cavity wall. Cement concrete used in the bonding units shall not be leaner than 1:2:4 (1 cement: 2 coarse sand :4 graded stone aggregate 20 mm nominal size).

Spacing: -Bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings. Precast R.C.C. bonding units provided in cavity wall shall not be less than 3 blocks per sqm.

Restrictions: -Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

SWG Aluminium sheet in cavity walls

28 SWG Aluminium sheet of required profile, size & shape shall be fixed in cavity walls as indicated in drawing or as per the directions of the Engineer-in-charge, with 75mm laps at the joints in the sheet including providing and laying cement concrete fillet in mix 1:3:6 (1 cement: 3 coarse sand: 6 coarse aggregate 12.5 mm nominal size) at the bottom of cavity.

Installation: - Cement concrete fillet in mix 1:3:6 provided at the bottom of cavity in the profile as shown in drawings. Over the cement concrete fillet 28 SWG Aluminium sheet provided as profiled to the required shape as indicated in drawing. Minimum overlap shall be 75 mm provided at the joints of sheet.

19 mm dia PVC pipe in cavity walls

19 mm dia (OD), 150mm long, 2 mm wall thickness PVC pipes of approved make shall be fixed in cavity walls with galvanized mosquito netting over mouth of pipe, pipes placed at the required spacing and aligning the same vertically and horizontally etc. complete as per drawing.

Installation: - The pipe shall be cut to size as per drawing or as required, galvanized mosquito netting fixed over mouth of pipe with the help of galvanized steel wire and the pipe placed at location and required spacing as shown in drawing.

50 mm thick extruded polystyrene in between cavity wall

50 mm thick extruded polystyrene rigid insulation board of required size shall be fixed inside cavity wall, complying with ISO 4898:2008 & ASTM C 578-08b - type VI, having thermal conductivity of 0.0289 W/m K as per ASTM C 578 (measured as per IS 3346), compressive strength of > 350 kPa listed as per ASTM D 1621, density of 34-36 kg/cum as per ASTM D 1622, water absorption < 1% by volume as per ASTM D 2842, oxygen index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4 mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN 4102, Part 1 of class B2 and as per ASTM E84 class A, fixed with suitable water based adhesive or fastener, complete in all respect as shown in Architectural drawings or as per the directions of Engineer-in-Charge.

Expansion Joint System and Filler Board

Expansion joint filler Board of 25mm, 100 mm & 150 mm thickness.

Expansion joint filler Board is alkali resistant, closed cell, polymer based for RCC columns, Beams, Walls and slabs. It is non-staining and non-deteriorating expansion joint filler for buildings.

Features required: -

- Closed cell- Negligible water / moisture absorption.
- Bitumen free -Non impregnated, non-staining and Non bleeding. Does not disintegrate.
- Easy to use - no crumbs, dust or fibers, easy cutting by knife
- Chemical resistance – unaffected by acids, Alkalis, detergents, petrochemical products
- Excellent recovery hence can accommodate joint movement
- Will not discolor sealants or architectural substrates
- Thickness is built up using minimum 10 mm thick layer of specifically Extruded high performance Sheet.

Providing & Fixing Expansion joint filler Board of Dawn Color of approved make, thickness built up using minimum 10mm specifically extruded high performance sheet of minimum density 28 kg / Cum including using adhesive or double-sided adhesive tape to the casted surface to form the expansion joint of required width. Filler board will become one side of the shuttering while the expansion joint is being created. This item shall have included preparation of surfaces by cleaning of dust, oil, loose aggregate etc.,

Installation: - The Expansion joint board shall be cut to size as per the depth of expansion joints required. The Expansion joint board shall be shorter than the face of the expansion joints to allow installation of Seal / backer rod as per manufacturer's specification. The sheet shall be put in to place inside the expansion joints using suitable adhesive material with low VOC as per GRIHA norms. Care should be taken during installation to prevent any adhesive from sticking outside the expansion joints. Gaps of various sizes over or below 25mm/100 mm / 150mm shall have to be filled using the same Expansion joint board cut at site to give a tight fit.

EXPANSION JOINT SYSTEM

Expansion joint system (floor/wall (internal and external)/ceiling) of approved make and for required gap to be provided wherever joint is coming as shown in drawing or as decided by Engineer-in-Charge.

Floor Joint

Providing and fixing of heavy-duty expansion joint system related with floor location as per drawings and direction of Engineer-In-Charge. The joints system will be of extruded aluminum base members, self-aligning / self-centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor /floor to wall expansion control system for various locations that accommodates multi directional seismic movement without stress to it's components. System shall consist of metal profiles with a universal aluminum base member designed to accommodate various project conditions and finish floor treatments. The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self-centering arrangement that freely rotates / moves in all directions. The Exp. Joint Cover should have an Articulated Telescope Design so as to accommodate the movements in 3 directions. Provision of Moisture/water Barrier Membrane in the Joint System to have watertight joint is mandatory requirement all as per the manufacturers design and as approved by Engineer -in-Charge including cost of all materials and fixtures, preparation of surface for receiving the joints and system to be installed by company authorized vendor or as approved by Engineer in charge including all leads and lifts etc. (Material shall conform to ASTM 6063).

Wall / Ceiling Joint

Expansion joint system related with wall / ceiling joint (internal / external) location as per drawings and direction of Engineer-In- Charge. The joints shall be of extruded aluminum base members, self aligning / centering arrangement and support plates as per ASTM B221- 02. The material shall be such that it provides an Expansion Joints System suitable for vertical wall to wall/ wall to corner application/ Ceiling to Ceiling / Ceiling to wall corner, both new and existing construction with no slipping down tendency amongst the components of the Joint System. The Joint System shall utilize light weight aluminum profiles exhibiting minimal exposed aluminum surfaces mechanically snap locking the

multicellular to facilitate movement. Preparation of surface for receiving the joints and system to be installed by company authorized/trained vendors as per the manufacturers design and as approved by Engineer -in-Charge (Material shall conform to ASTM 6063)

Performance Requirement: Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

Approval of expansion joint system: Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

Installation of expansion joint system: In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

Note: - For all external wall joint the expansion joint system shall be used with Moisture / Water Barrier Membrane.

FLUSH DOOR

35 mm thick Flush doors with 1 mm lamination both side : All flush doors as shown in GFC Drawing shall be 37 mm(35mm+1mm+1mm) thick factory made Flush Door shutters conforming to IS : 2202 (part-1) non-decorative type, core of block board construction with frame of 1st class hard wood and well matched commercial 3ply veneering with vertical grains or cross bands and face veneers on both faces of shutters. Edges of the shutter should be provided with lipping with 2nd class teak wood battens 12 mm minimum depth on all edges of shutters. 1mm thick decorative high pressure laminated sheet of plain / wood grain in gloss / matt / suede finish with high density protective surface layer and reverse side of adhesive bonding quality confirming to IS : 2046 Type S to be provide on both side of shutter.

All flush door shutters shall be fixed with ISI marked stainless steel grade 304 butt hinges of size as mentioned in the architectural drawing. Vision Panels shall be provided as per details & size mentioned in GFC drawing.

NOTE: - The high pressure pasting of laminate over flush door shutter shall be done at factory itself and vision panel to be provided as per drawing.

HINGED TYPE SLIDING FOLDING SYSTEM

Providing & Fixing hinged type sliding folding system (ceiling mounted) of approved make as per manufactureres specification for 37 mm thick factory made Pre-laminated Flush Door shutters conforming to IS : 2202 (Phenol formaldehyde resin bonded & shall be a green rated product) of size 3000 mm wide & upto 2400 mm height. Out of four shutter panels, two Panels each of width approximately 750 / 800 mm Sliding and Folding towards left & Two Panels towards right manually.

Note:- The above work shall be done by manufacturers authorized applicator/trained/recommeneded or as directed by engineer in charge.

ALUMINIUM WORK

Aluminium work for doors, windows, ventilators and partitions shall be with powder coated as per approved shade (minimum thickness of powder coating 60 micron) extruded built up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, necessary filling up the gaps at junctions, i.e. at top, bottom and sides shall be with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per GFC architectural drawings and the directions of E-I-C.

Sub frame : Aluminium (minimum thickness of powder coating 60 micron) sub frame work to be provided prior to finishing work, as per architectural drawing for all external & internal doors, windows and ventilators with extruded built-up standard tubular sections of approved make conforming to IS: 733 and IS: 1285, fixed with rawl plugs and stainless steel screws etc.

Aluminium doors : All Aluminium doors shall be powder coated aluminium glazed doors (minimum thickness of powder coating 50 micron) as per GFC architectural drawings . All aluminium doors shall be fixed with stainless steel grade 304 hinges of size as mentioned in the architectural drawing. Stainless steel grade 304 hardwares shall be fixed as per schedule of hardware or as shown in architectural drawing.

Windows / Ventilators: All aluminium windows, ventilators & internal partitions shall be powder coated (minimum thickness of powder coating 50 micron) as per GFC architectural drawings. All openable window shutters shall be fixed with 300mm length adjustable heavy-duty friction stays & have single point locking handles without key of approved make powder coated to required colour or shade as per drawing. Toilet ventilators shall be powder coated aluminium shutter with fixed /top hung / aluminium louvers as per drawing.

Glazing: Glazing to be provided and fixed With float glass panes of 5 mm thickness (weight not less than 12.50 kg/sqm) in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge.

Fly proof mosquito mesh: Fly proof mesh shall be stainless steel grade 304 wire gauge, to windows and clerestory windows using wire gauge with average width of aperture 1.4 mm in both directions with wire of dia. 0.50 mm all complete with aluminium beading.

Silicone Sealant and Neoprene Gasket

Neoprene/EPDM Gaskets

The contractor shall provide and install the gaskets of approved size and profile at all locations as shown and as called for to render the doors, windows etc. absolutely air tight and weather tight. The contractors shall produce samples of the gaskets for approval and procure after approval only.

Silicone Sealant

The gaps between frames and supports and also any gaps in the windows section shall be raked out as directed and filled with sealant of approved colour and make to ensure complete water tightness.

Application of sealant and gasket

- Sealant and gasket shall be provided wherever shown in the drawings or required for a permanently weather tight installation.
- All adjoining surfaces shall be protected to receive sealant against staining by masking and/ or other methods.
- Joints and joint surfaces shall be clean, dry, and free of any material that may have an adverse effect on the bonding and/ or seal of the sealant and gasket materials.
- Apply sealant and gasket under the conditions recommended by the manufacturer(s). Prime all surface to receive sealant and gasket unless recommended otherwise, use no sealant that has started to set in its container or a sealant that has exceeded the self life published by the manufacturer.
- Fill all joints continuously and completely with sealant, forming a neat, uniform, concave bead. Finish the material flush with adjoining surfaces unless shown on the drawings. All sealant surfaces shall be tooled smooth.

Hardware schedule:-All Doors and window to provided with necessary hardwares as shown in Hardware schedule/drawing i.e stainless steel grade 304 hardware & fittings (such as hinges, door closers, Dead Locks / Electromagnetic lock / mortise Locks / mortise bathroom lock, lever & pull handles, tower bolts, Floor & wall door stoppers ,vision panels etc., & windows / ventilators shall be provided with stainless steel grade 304 hinges, 300mm length adjustable heavy duty friction stays & Single point locking powder coated handles without Key.

Shop Drawings

The contractor shall submit the shop drawings of doors. Windows, louvers, cladding and other aluminum work, based on architectural drawings well in advance preferably 60 days before procurement to the Engineer-in-Charge for approval. The drawings shall show full size sections of doors, windows etc. thickness of metal (i.e wall thickness), details of construction, sub frame/ rough ground profile, anchoring details, hardware as well as connection of windows, doors and other metal work to adjacent work.

Samples

Samples of doors, windows, louvers etc. shall be fabricated, assembled and submitted to the Engineer-in-Charge for approval. They shall be of sizes types etc. as decided by Engineer-in-Charge. All samples shall be provided at the cost of the contractor and shall

be submitted to the Engineer-in-Charge for approval well in advance of commencing the work

Fabrication

Doors, windows, etc. shall be fabricated to sizes as shown and shall be of section, sizes combinations and details as shown in the Architectural Drawings. All doors, windows etc. shall have mechanical joints. All members shall be accurately machined and fitted to form hairline joints prior to assembly. The joint and accessories such as cleats, brackets, etc. shall be of such materials as not to cause any bimetallic action. The fabrication of doors, windows, etc. shall be done in suitable sections to facilitate easy transportation, handling and installation. Adequate provision shall be made in the door and window members for anchoring to support and fixing of hardware and other fixtures as approved by the Engineer-in-Charge.

Protection of Finish

Polythene tape/bubble sheet protection shall be applied on the powder coated section before they are brought to site. All care shall be taken to ensure surface protection during transportation, storage at site and installation. The tape protection shall be removed on installation. All aluminum members shall be wrapped with approved self adhesive non-staining PVC tapes/bubble sheet till completion / handing over of the building whichever is later. If any scratches and damages occurs shall be replaced or rectified at their own cost and noting extra shall be paid against the same.

Hardware for doors and window

All Doors and window to provided with necessary hardwares as shown in Hardware schedule/drawing. Hardware shall be of Stainless-steel grade AISI 304 / AISI 316 & as per European standard whenever applicable. All hardware should be of Satin finish or as decided by Engineer in charge.

Stainless steel Screw used for fitting shall be of same metal and finish as the fitting otherwise specified.

Samples & shop drawing: The Contractor shall prepare & submit shop drawings & samples of all hardwares used & got approved from the Architect & Engineering-in-Charge prior to the execution of work.

The detail list of hardware schedule is mentioned below. Although the tentative quantity of particular items is mentioned in hardware schedule attached.

1. Stainless steel grade 304 satin finish tower bolts 150mm
2. Stainless steel grade 304 satin finish tower bolts 300mm

3. Stainless steel grade 304 satin finish pull handle 19 mm dia x 150 mm long
4. Stainless steel grade 304 satin finish pull handle 19 mm dia x 200 mm long
5. Stainless steel grade 304 satin finish pull handle 22 mm dia x 300 mm long
6. Stainless steel grade 304 satin finish pull handle 38 mm dia x 1200 mm long
7. Satin stainless steel Foot operated Door Stopper with rubber buffer
8. Satin stainless steel wall mounted Door Stopper with rubber buffer
9. Single point locking handles without Key for window
10. Mortise lock with Euro Profile half Cylinder with one side Key & pairs of lever handle with rose & escutcheons.
11. Mortice bathroom lock, strike plate, bathroom escutcheons with indicator & spindle & pairs of lever handle with rose
12. Backset dead lock with Euro Profile Cylinder with both side Key operation including strike plate & escutcheons
13. External Trim with panic device with cylinder & Key.
14. Stainless Steel Ball bearing hinges & Spring hinges for double action swing doors
15. Surface mounted door closer
16. Electronic Deadbolt for double action swing doors
17. Single electromagnetic lock with 600 lbf (2668 N) holding force, surface-mounted, with lock status sensor and red/green LED indicator, anodized aluminium finish. Power supply: 12/24 V DC
18. Double electromagnetic lock with 600 lbf (2668 N) holding force per magnet, surface-mounted, with lock status sensor and red/green LED indicator, anodized aluminium finish. Power supply: 12/24 V DC
19. Single electromagnetic lock with 1200 lbf (5338 N) holding force, surface-mounted, with lock status sensor and red/green LED indicator, anodized aluminium finish. Power supply: 12/24 V DC
20. Double electromagnetic lock with 1200 lbf (5338 N) holding force per magnet, surface-mounted, with lock status sensor and red/green LED indicator, anodized aluminium finish. Power supply: 12/24 V DC.
21. 300mm length adjustable heavy duty friction stays for window
22. Hydraulic floor spring with double spring mechanism and door weight upto 125 kg

GLAZING WORK

Glazing in aluminium doors, windows, ventilators shutters and partitions, spider glazing, structural glazing & skylights etc. shall be with 5 mm thick single glass panel / 5 mm thick single high performance toughened glass / 24 mm thick double glazed dual sealed insulating toughened glass / 31.52 mm thick Double glazed dual sealed insulating toughened glass / 13.52 mm thick laminated toughened glass & 13.52 mm thick laminated heat strengthened glass with norton tape, silicon structural sealant and weather proofing sealant complete as shown in architectural GFC drawings/ as per approved shop drawings and the direction of Engineer- in-Charge.

Details of different type of glazing is as follow: -

a) 5 mm thick Single clear/float glass: - Providing and fixing 5 mm thick Single clear/float glass of approved make.

b) 5mm thick High performance toughened glass: Providing and fixing 5 mm thick High performance toughened glass of approved make (meeting the minimum glass specification mentioned below) with coating on face 2 in aluminium door, window, ventilator shutters etc. complete as per architectural drawings and the directions of engineer-in-charge. The glass shall be fixed with necessary EPDM rubber/neoprene gasket of the approved colour, make, size and shape with silicone sealant of neutral grade.
(1) Light Transmission - 44% to 56% (2) Reflection (Ext.) - 14 to 19% (3) Reflection (Int.) - 18 to 27% (4) Solar Factor - 0.46 to 0.50 (5) U value – 5.4 to 5.6 W/Sqm K.

c) 24 mm thick Double glazed insulating glass: Providing assembling supplying and fixing Double glazed insulating glass of size & shape as required & specified to aluminium door, window & structural glazing with approved make tape, silicon structural sealant and weather proofing using weather proofing sealant (approved make).The insulated glass comprising of an outer toughened (Heat strengthened) float/clear glass 6 mm thick of approved colour& shade with reflective coating on face 2 of approved colour& shade, an inner 6 mm thick clear float glass toughened separated by spacers to create 12 mm dehydrated air space and thermatically sealed by using double sealed organic sealant (priming sealant of thermoplastic), solvent free polyisobutylene which is applied on both sides of spacer, secondary sealant comprising of two component polysulphide in the right proportion for final outer seal including perforated channel for air spaces and complete processed with expertise of company authorized processor only or as directed by EIC,all complete for the minimum required performances given below, as per Architectural drawings, as per approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor.
(1) Light Transmission - 47% to 50% (2) Reflection (Ext.) - 12% to 14% (3) Reflection (Int.) - 11 to 17% (4) Solar Factor -0.27 to 0.28 (4) U value -1.5 to 1.7 W/Sqm K.

d) 13.52 mm thick laminated high-performance glass for skylight etc as per GFC: Providing and fixing fixed glazing into skylights etc., with Laminated glass of approved

quality of 13.52mm overall thickness with 1.52mm thick polyvinyl butyl sandwiched between heat strengthened glass of thickness 6 mm on both sides (one glass shall be 6 mm clear HS glass & one glass shall be 6 mm high performance HS glass). PVB Interlayer; colour shall be as per approved sample of the Architects. The glass shall be fixed with necessary EPDM rubber/neoprene gasket of approved colour, make, size and shape, with Norton tape, silicone structural / weather sealants of neutral grade. The Laminated glass shall be assembled in the factory/ workshop of the glass processor.etc. Complete as per architectural drawings and directions of engineer-in-charge

(1) Light Transmission - 42% to 45% (2) Reflection (Ext.) - 19% to 23% (3) Reflection (Int.) - 5 to 7% (4) Solar Factor -0.41 to 0.42 (4) U value -4.5 to 4.7 W/Sqm K.

e) 13.52 mm thick Laminated glass for spider glazing etc as per GFC: Providing and fixing in spider glazing item Laminated glass of approved quality of 13.52mm overall thickness with 1.52mm thick polyvinyl butyl sandwiched between toughened glass of thickness 6mm on both sides (one glass shall be 6 mm clear glass & one glass shall be 6 mm high performance glass) instead of 12 mm thick toughened glass as indicated in item. PVB Interlayer; colour shall be as per approved sample of the Architects. The glass shall be fixed with necessary EPDM rubber/neoprene gasket, PVC packing of approved colour, make, size and shape, with silicone sealant of neutral grade. The Laminated glass shall be assembled in the factory/ workshop of the glass processor.etc. Complete as per architectural drawings and directions of engineer-in-charge

(1) Light Transmission - 44% to 52% (2) Reflection (Ext.) - 14% to 19% (3) Reflection (Int.) - 18 to 22% (4) Solar Factor -0.42 to 0.45 (4) U value -5 to 5.4 W/Sqm K.

f) 31.52 mm thick Double glazed insulating glass for structural glazing etc as per GFC: Providing assembling supplying and fixing Double glazed insulating glass of size & shape as required & specified to aluminium door, window & structural glazing with approved make tape, silicon structural sealant and weather proofing using weather proofing sealant (approved make).The insulated glass comprising of an outer toughened laminated glass 13.52 mm thick (6mm clear toughened+1.52 PVB+ 6mm toughened high performance glass of approved colour& shade with reflective coating on face 2 of approved colour& shade), an inner 6 mm thick clear float glass toughened separated by spacers to create 12 mm dehydrated air space and thermatically sealed by using double sealed organic sealant (priming sealant of thermoplastic), solvent free polyisobutylene which is applied on both sides of spacer, secondary sealant comprising of two component polysulphide in the right proportion for final outer seal including perforated channel for air spaces and complete processed with expertise of company authorized processor only or as directed by EIC, all complete for the minimum required performances given below, as per Architectural drawings, as per approved shop drawings, as specified and as directed by Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor.

(1) Light Transmission - 46% to 48% (2) Reflection (Ext.) - 12% to 13% (3) Reflection (Int.) - 11 to 16% (4) Solar Factor -0.25 to 0.27 (4) U value -1.5 to 1.6 W/Sqm K.

Installation: -

The glass shall be cut to exact size, toughened and brought to site for installation. The glass panes shall be so cut that it fits slightly loose in the frames. Glazing shall be provided on the outside of the frame unless otherwise specified. Before fixing the glass all joints and glazing pockets to be cleaned by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt or glazing compounds and protective coatings. Fixing of glass panes may be done with Aluminium beading / section as shown in structural glazing detail. Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms. Masking tape shall be removed immediately after tooling. Installation of backer rod of appropriate size and application of silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms. A tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. All the glass work shall be installed by a company Authorized/Trained/Reffered system integrator only or as decided by Engineer in Charge.

SAMPLES / SHOP DRAWINGS

The contractor shall organize to submit samples & shop drawings well in advance for approval.

SEMI UNITIZED STRUCTURAL CURTAIN GLAZING SYSTEM WITH PRESSURE PLATE & CAP:

Designing, fabricating, testing, installing and fixing in position structural glazing and its suitable glazing cleaning/maintenance system for all heights and all levels is included in scope of contractor.

Structural Glazing shall be designed as per BIS code IS-875 Part III / EN 12210 for required wind pressure. Structural analysis & design and preparation of shop drawings for the specified design loads conforming to IS 875 part III (the system must pass the proof test at 1.5 times design wind pressure without any failure), including functional design of the aluminum sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)-cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation & drainage and protection against fire hazard) The contractor must design the Structural Glazing as per the prevalent site conditions and building profiles and the Structural Glazing should be structurally safe. The system should have already been tested/accredited by an

international independent testing laboratory. The system should comply with an Air infiltration requirement of ± 600 Pa when tested in accordance with ASTM E283 / EN 12207 133, Static and Dynamic water penetration of 720 Pa in accordance with ASTM E331.

The work of Structural Glazing shall include the designing and fixing Mullions & Transoms to the structure through adequately designed galvanized MS brackets, providing and fixing glass of approved quality & spec. with Aluminum sections using structural silicon sealant of approved quality including all Aluminum sub frames wherever necessary. The transom should be shorter than mullion by 1mm at the back face of the mullion. Gap between the transom and mullion surface at intersection would not be acceptable. The system shall also include sealing the complete glazing and perimeter channel with weather sealant to prevent water penetration as per relevant specifications etc. Complete as per detailed drawings & approved shop drawings. A complete drainage system to be incorporated in the design in the unlikely event that water penetrates the pressure seal.

The contractor must provide detailed design & drawings of the system indicating individual profiles and also details of any other profiles that may be used including dimensions, wall thickness etc., for approval by the Engineer-in-Charge.

Specification for Materials used for Curtain Wall

- (1) Glazing: as specified in drawing.
- (2) Framing system: Extruded Aluminum sections shall be specially designed and shall be of 6063/6060 T6 alloy. All exposed profiles should be powder coated to a minimum of 60 microns. All anchor fasteners to be made of SS 304 grade. All shims to be capable of transferring the load evenly and made of a suitable material (Teflon etc.) capable of lasting the life span of the system including all miscellaneous items such as peripheral sealants, backer rods, flashing, fasteners, brackets etc. Aluminum extruded sections along with hardware & accessories should be supplied by Approved system companies for all types of articles like, mullions, transoms, gaskets, hardware etc.
- (3) Sealant: Silicon sealant structural grade and weather grade shall be of approved make as per the design requirement.
- (4) Non-corrosive galvanized brackets of approved design. Galvanizing to be done conforming to IS: 4759-1996 up to 610 gms. Per Sqm. i.e. 80-90-micron thickness. Shims of various thickness to adjust the beam level/ line variations fixed with SS 316 Grade dash fasteners of approved make-min. 12mm dia. 100 mm long.

Preliminary Requirements

- (i) The contractor shall design, fabricate, deliver, install, test and guarantee all construction necessary to provide a complete curtain wall system for the proposed building, all in conformity with the drawings as shown

(ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawing

(iii) The curtain wall system shall also include the following activities:

- Metal frames, glass glazing, spandrels, ventilators, finish hardware copings, metal closure, windows etc.
- All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
- All copings and closure and metal cladding to complete the system.
- All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system. Gaps up to 10 mm between the peripheral aluminum member and masonry / R.C.C. / Stone shall be sealed by inserting Backer Rod and weather silicon sealant: wherever the gaps are more than 10 mm the same shall be sealed by providing and fixing 1.5 mm thick Aluminum sheet flashings bent to required profile as per approved design and duly Anodized/Powder coated in approved color.

• Isolation of dissimilar metals and moving parts.

• Anticorrosive treatment on all metals used in the system.

Deflection Criteria: - For mullions: for Single height glazing, $\text{Span}/175$ or 19 mm, whichever is less. And for Double height glazing For spans up to 4110 mm, same as single height; and for spans above 4110 mm, the same shall be $(\text{span}/240)+6.35$ mm. For transoms: i. $\text{Span}/500$ or 3 mm, whichever is the least for dead load and $\text{Span}/175$ or 19 mm, whichever is the least for wind load. Deflection at the centre of the glass: Monolithic glass Shortest span/ 60 or 19 mm, whichever is the least and Double glazed unit Shortest span/ 90 or 19 mm, whichever is the least and Deflection at edge of the glass Shall be limited to 15mm.

- The transom should overlap the mullion with an EPDM separator. The screws for transom should not affect the transom gaskets. The system should have a continuous base transom with suitable continuous EPDM base gasket.

(iv) The contractor shall also be responsible for providing the following:

- Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.
- Mock-ups, samples and test units.
- Performance testing of the curtain wall framing and glazing assembly.
- Co-ordination with the work of other trade.
- Protection during construction.
- All final exterior and interior cleaning and finishing of the curtain wall system.
- As built record drawings and photographs.
- Audit/inspection reports by principal system Supplier Company
- Guarantees and warranties.
- All hoisting, scaffolding, staging and temporary services.
- Conceptualizing and design of a suitable maintenance system for curtain glazing.

- (v) The water tightness and structural stability of the whole curtain wall system is the prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good at the risk and cost of the contractor.
- (vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

Design Requirements

- The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However, the contractor may propose alternatives on the construction details provided that all basic functional and architectural requirements are fulfilled.
- Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.
- All curtain walling, individual aluminum and glass components and all completed work shall be designed and erected to comply with the following requirements.

Testing

The following performance test are to be conducted on structural glazing system if area of structural glazing exceeds 2500 Sqm from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories), Department of Science & Technologies, India.

The NIT approving authority will decide the necessity of testing on the basis of cost of the work, cost of the test and importance of the work. Performance Testing of Structural glazing system Tests to be conducted in the NABL accredited lab or by any other accreditation body which operates in accordance with ISO / IEC 17011 and accredits labs as per ISO/ IEC 17025.

1. Performance Laboratory Test for Air Leakage Test (-50pa to - 300pa) & (+50pa to +300pa) as per ASTM E-283-04 testing method for a range of testing limit 1 to 200 mVhr
2. Static Water Penetration Test. (50pa to 1500p) as per ASTM E- 331-09 testing method for a range up to 2000 ml.
3. Dynamic Water Penetration (50pa to 1500pa) as per AAMA 501.01- 05 testing method for a range upto 2000 ml
4. Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTM E-330-10 testing method for a range upto 50 mm.
5. Seismic Movement Test (upto 30 mm) as per AAMA 501.4- 09 testing method for Qualitative test, Tests to be conducted on site.
6. Onsite Test for Water Leakage for a pressure range 50 kpa to 240 kpa (35psi) upto 2000 ml

SPIDER GLAZING:

Designing, fabricating, testing, installing and fixing in position spider glazing for all heights and all levels is included in scope of contractor

Suspended Spider Glazing system shall be designed to withstand the wind pressure as per IS 875 (Part-III). The Suspended System held with Spider Fittings of SS-316 Grade Steel of approved manufacturer with Laminated glass of approved quality (Laminated glass of 13.52mm overall thickness with 1.52mm thick polyvinyl butyl layer sandwiched between toughened glass of thickness 6 mm on both sides. PVB Interlayer; colour shall be as per approved sample of the Architects.) held together with SS- 316 Grade Stainless Steel Spider & bolt assembly with laminated glass fins 21 mm thick. The Glass fins and glass panel assembly shall be connected to Slab/ beams by means of SS- 316 Grade stainless steel brackets & Anchor bolts and at the bottom using SS channel of 50x25x2mm using fastener & anchor bolts, non staining weather sealants of approved make, Teflon/ nylon bushes and separators to prevent bi-metallic contact, all complete to perform as per specification and approved drawings. The complete system to be designed to accommodate thermal expansion & seismic movements etc. The joints between glass panels (6 to 8 mm) and gaps at the perimeter & in U channel of the assembly to be filled with non staining weather sealant, so as to make the entire system fully water proof & dust proof. Spider glazing item includes all design, Engineering and shop drawing including approval from structural designer, labour, T&P, scaffolding, other incidental charges including wastage, enabling temporary services all fitting fixers nut bolts, washer, Buffer plates, fastener, anchors, SS channel laminated glass etc. all complete. Shop drawings shall be submitted for approval from the Engineer in charge before the execution of work.

SKYLIGHTS GLAZING:

Base frame of all skylights shall be M.S tubular frame of approved make & size as per architectural GFC drawings fixed with the help of Stainless steel grade 304 anchor fastener on concrete surface. All MS frames shall be painted with polyurethane paint over two coat of Surface Tolerant Epoxy primer after surface preparation as per manufacturer's specification. Over the MS frame work 13.52 mm thick laminated glass shall be fixed with the help of aluminium sections, profiles, trim section, caps etc. of size as mentioned in architectural GFC drawing. Junctions of laminated glass shall be covered with aluminium capping profile / section as shown & of size mentioned in GFC drawing including backer rod & weather sealant to seal the junctions complete as directed by Engineer-in-Charge. Shop drawings shall be submitted for approval from the architects before the execution of work.

STRUCTURE GLAZING:

ALUMINIUM EXTRUDED TUBULAR AND OTHER ALUMINIUM SECTIONS

Fixing of Aluminium extruded tubular and other aluminium sections as per the architectural drawings and approved shop drawings, the aluminium quality as per grade 6063 T5 or T6 as per BS 1474, including super durable powder coating of 60-80 microns

conforming to AAMA 2604 of required colour and shade as approved by the Engineer-in-Charge including material such as cleats, sleeves, screws etc. necessary for fabrication of extruded aluminium frame work.

IGU PANELS IN THE CURTAIN GLAZING

Designing, fabricating, testing, protection, installing and fixing in position semi (grid) unitized system of structural glazing (with open joints) for linear as well as curvilinear portions of the building for all heights and all levels, including:

- (a) Structural analysis & design and preparation of shop drawings for the specified design loads conforming to IS 875 part III (the system must passed the proof test at 1.5 times design wind pressure without any failure), including functional design of the aluminum sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)-cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation & drainage and protection against fire hazard including:
- (b) Fabricating serrated M.S. hot dip galvanised / Aluminium alloy of 6005 T5 brackets of required sizes, sections and profiles etc. to accommodate 3 Dimentional movement for achieving perfect verticality and fixing structural glazing system rigidly to the RCC/ masonry/structural steel framework of building structure using stainless steel anchor fasteners/ bolts, nylon seperator to prevent bimetallic contacts with nuts and washers etc. of stainless steel grade 316, of the required capacity and in required numbers.
- (c) Filling, two-part pump filled, structural silicone sealant and one part weather silicone sealant compatible with the structural silicone sealant of required bite size in a clean and controlled factory / work shop environment, including double sided spacer tape, setting blocks and backer rod, all of approved grade, brand and manufacture, as per the approved sealant design, within and all around the perimeter for holding glass.
- (d) Fixing in position flashings of solid aluminium sheet 1 mm thick and of sizes, shapes and profiles, as required as per the site conditions, to seal the gap between the building structure and all its interfaces with curtain glazing to make it watertight.
- (e) Making provision for drainage of moisture/ water that enters the curtain glazing system to make it watertight, by incorporating principles of pressure equalization, providing suitable gutter profiles at bottom (if required), making necessary holes of required sizes and of required numbers etc. complete. Also include all inputs of designing, labour for fabricating and installation of aluminium grid, installation of glazed units, T&P, scaffolding and other incidental charges including wastages etc., enabling temporary structures and services, cranes or cradles etc. as described above and as specified. Shop drawings checked by a structural designer, dully approved by Engineer-in-charge. The item also includes the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working structural glazing as specified, cleaning and protection till the handing over of the building for occupation. In the end, the Contractor shall provide a water tight structural glazing having all the performance characteristics etc. all complete as required, as per the Architectural

drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Engineer- in-Charge.

Note:- 1. Above shall include provision of extruded aluminium frames, shadow boxes, extruded aluminium section capping for fixing in the grooves of the curtain glazing and vermin proof stainless steel wire mesh.

Note:-2. The following performance test are to be conducted on structural glazing system if area of structural glazing exceeds 2500 Sqm from the certified laboratories accredited by NABL(National Accreditation Board for Testing and Calibration Laboratories), Department of Science & Technologies, India. Cost of testing is payable separately.

The NIT approving authority will decide the necessity of testing on the basis of cost of the work, cost of the test and importance of the work. Performance Testing of Structural glazing system Tests to be conducted in the NABL accredited lab or by any other accreditation body which operates in accordance with ISO / IEC 17011 and accredits labs as per ISO/ IEC 17025.

1. Performance Laboratory Test for Air Leakage Test (-50pa to - 300pa) & (+50pa to +300pa) as per ASTM E-283-04 testing method for a range of testing limit 1 to 200 mVhr
2. Static Water Penetration Test. (50pa to 1500p) as per ASTM E- 331-09 testing method for a range up to 2000 ml.
3. Dynamic Water Penetration (50pa to 1500pa) as per AAMA 501.01- 05 testing method for a range upto 2000 ml
4. Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTM E-330-10 testing method for a range upto 50 mm
5. Seismic Movement Test (upto 30 mm) as per AAMA 501.4- 09 testing method for Qualitative test, Tests to be conducted on site.
6. Onsite Test for Water Leakage for a pressure range 50 kpa to 240 kpa (35psi) upto 2000 ml

VISION GLASS PANELS

Vision glass panels (IGUs) comprising of hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of approved colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthned clear float glass 6mm thick, spacer tube 12mm wide, dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor. Coloured tinted float glass 6mm thick substrate with reflective soft coating on face # 2, + 12mm Airgap + 6mm Heat Strengthened clear Glass of approved make having properties as visible Light transmittance (VLT) of 25 to 35 %, Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/m² degree K etc. The properties of performance glass shall be decided by technical sanctioning authority as per the site requirement.

Openable side / top hung vision glass panels (IGUs) including providing and supplying at site all accessories and hardwares for the openable panels as specified and of the approved make such as heavy-duty stainless-steel friction hinges, min 4-point cremone locking sets with stainless steel plates, handles, buffers etc. including necessary stainless steel screws/ fasteners, nuts, bolts, washers etc. all complete as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge.

ACOUSTICAL WALL PANELLING & ACOUSTICS DOOR

ACOUSTICAL WALL PANELLING

The Contractor shall carry out acoustical study by engaging acoustical consultant (at his own cost) of the Meeting Halls/Lecturehalls/classrooms (where ever wall panelling is given) taking account of drawings and should mention to E.I.C before starting of work if the drawings are good enough or not to achieve good acoustics of Meeting Halls/Lecturehalls/classrooms. The contractor shall also suggest ways to achieve desired values of various parameters for good acoustics to E.I.C for which nothing will be paid extra.

Post construction the contractor has to carry out acoustical study from an independent agency/acoustical consultant to verify the various acoustical parameters achieved or not. In case of non-achievement of these parameters on account of faulty execution, the modifications will have to be carried out by the contractor at no extra cost.

TYPE P1: OAK / CEDAR VENEERED PLY PANELLING

Materials: -

Wood: - 4mm thick Oak / Cedar veneered ply & 6mm thick water proof marine ply, Steel Screws & dash fasteners: - As specified or as per approved sample, MS tube, MS Angles, Flats etc, Steel Primer, Enamel Paint, Wood Polish: - As specified or as per approved sample.

Installation: - MS angle 50x50x5 supports / cleats of suitable size fixed to wall surface with dashfasteners of 8 mm dia, 75 mm long bolt as shown in drawing. Tubular frame work shall comprise of 50x50x1.6mm hollow MS tube, fixed away from the wall surface by MS angle supports/cleats of suitable size. The hollow MS tubes to be mounted in a grid pattern with spacing @ 400mm / 1000mm centre to centre (horizontally & vertically) or at required spacing near opening, with necessary fixing / welding at junctions and fixing the frame to wall with steel dash fasteners of 8 mm dia, 75 mm long bolt, including providing with two coats of approved steel primer etc. The tubular framework to have welded connections, minimum 20mm fillet weld on each side.

Providing and fixing 4mm thick Oak / Cedar veneered ply (approved make) on 6mm thick water proof marine ply, phenolic bonded (approved make) and the surface finished with moulded Oak / Cedar beading of 15 x 25mm in pattern as per drawing with 38mm long self tapping and self drilling steel screws on framework. Entire work to be done as per drawing, specifications and direction of Engineer-in-charge. To be wax polished in natural colour.

TYPE P2: OAK / CEDAR WOOD SLAT PANELLING WITHOUT INSULATION

Materials: -

Wood: - First class Oak / Cedar Wood, 6 mm thick marine ply, Steel Screws & dash fasteners: - As specified or as per approved sample, MS tube, MS Angles, Flats etc, Steel Primer, Enamel Paint, Wood Polish, Glass wool, Black dyed jute upholstery fabric (not hessian): - As specified or as per approved sample.

Installation: - MS angle 50x50x5 supports / cleats of suitable size fixed to wall surface with dashfasteners of 8 mm dia, 75 mm long bolt as shown in drawing. Tubular frame work shall comprise of 50x50x1.6mm hollow MS tube, fixed away from the wall surface by MS angle supports/cleats of suitable size. The hollow MS tubes to be mounted in a grid pattern with spacing @ 400mm / 1000mm centre to centre (horizontally & vertically) or at required spacing near opening, with necessary fixing / welding at junctions and fixing the frame to wall with steel dash fasteners of 8 mm dia, 75 mm long bolt, including providing with two coats of approved steel primer etc. The tubular framework to have welded connections, minimum 20mm fillet weld on each side.

In order to minimize visibility of screws panel of size as per drawing supported on MS flats 20 x 6 mm at top & bottom are to be made with 80 x 12 mm & 32.5 x 12 mm thick timber slats with a groove of 15mm between slats in pattern as per drawing with stainless steel screws from the rear. MS flats shall be painted with two coats of enamel paint over two coats of approved steel primer. Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be same as specified in the drawings. The grains of timber panels shall be sawn in the directions of grains & shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions.

These timber slat panels shall be fixed to the tubular frame as per pattern shown in drawing with self tapping stainless screws. The slats to be backed with black dyed jute upholstery fabric (not hessian) fix over 6 mm thick marine ply. Finally, the slats shall be wax polished after wood filler and sand papering to a smooth finish in its natural colour complete as per drawing, specifications and direction of Engineer-in-Charge.

TYPE P3: OAK / CEDAR WOOD SLAT PANELLING WITH INSULATION

Materials: -

Wood: - First class Oak / Cedar Wood, Steel Screws & dash fasteners: - As specified or as per approved sample, MS tube, MS Angles, Flats etc, Steel Primer, Enamel Paint, Wood Polish, Glass wool, Black dyed jute upholstery fabric (not hessian): - As specified or as per approved sample

Installation: - MS angle 50x50x5 supports / cleats of suitable size fixed to wall surface with dash fasteners of 8 mm dia, 75 mm long bolt as shown in drawing. Tubular frame work shall comprise of 50x50x1.6mm hollow MS tube, fixed away from the wall surface by MS angle supports/cleats of suitable size. The hollow MS tubes to be mounted in a grid pattern with spacing @ 400mm / 1000mm centre to centre (horizontally & vertically) or at required spacing near opening, with necessary fixing / welding at junctions and fixing the frame to wall with steel dash fasteners of 8 mm dia, 75 mm long bolt, including providing with two coats of approved steel primer etc. The tubular framework to have welded connections, minimum 20mm fillet weld on each side.

In order to minimize visibility of screws panels of size as per drawing supported on MS flats 20 x 6 mm at top & bottom are to be made with 80 x 12 mm & 32.5 x 12 mm thick timber slats with a groove of 15mm between slats in pattern as per drawing with stainless steel screws from the rear. MS flats shall be painted with two coats of enamel paint over two coats of approved steel primer. Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be same as specified in the drawings. The grains of timber panels shall be sawn in the directions of grains & shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions.

These timber slat panels shall be fixed to the tubular frame as per pattern shown in drawing with self-tapping stainless screws. The slats to be backed with black dyed jute upholstery fabric (not hessian) held on 24G x 10mm wire mesh and 50mm thick resin bonded glass wool (24 kg/m³) cut to size and inserted in GI framework held on 24Gx12 GI wire netting. Finally the slats shall be wax polished after wood filler and sand papering to a smooth finish in its natural colour complete as per drawing, specifications and direction of Engineer-in-Charge.

TYPE P4: OAK / CEDAR WOOD SLAT PANELLING WITH INSULATION & MINIMUM 50 MM AIR GAP

Materials: -

Wood: - First class Oak / Cedar Wood, Steel Screws & dash fasteners : - As specified or as per approved sample, MS tube , MS Angles, Flats etc, Steel Primer, Enamel Paint, Wood Polish, Glass wool , Black dyed jute upholstery fabric (not hessian) : - As specified or as per approved sample

Installation: - MS angle 50x50x5 supports / cleats of suitable size fixed to wall surface with dash fasteners of 8 mm dia, 75 mm long bolt as shown in drawing (**in such a manner to get a minimum clear space / air gap of 50 mm thick between the wall & paneling**) . Tubular frame work shall comprise of 50x50x1.6mm hollow MS tube, fixed away from the wall surface by MS angle supports/cleats of suitable size. The hollow MS tubes to be mounted in a grid pattern with spacing @ 400mm / 1000mm centre to centre (horizontally & vertically) or at required spacing near opening, with necessary fixing / welding at junctions and fixing the frame to wall with steel dash fasteners of 8 mm dia, 75 mm long bolt, including providing with two coats of approved steel primer etc. The tubular framework to have welded connections, minimum 20mm fillet weld on each side.

In order to minimize visibility of screws panels of size as per drawing supported on MS flats 20 x 6 mm at top & bottom are to be made with 80 x 12 mm & 32.5 x 12 mm thick timber slats with a groove of 15mm between slats in pattern as per drawing with stainless steel screws from the rear. MS flats shall be painted with two coats of enamel paint over two coats of approved steel primer. Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be same as specified in the drawings. The grains of timber panels shall be sawn in the directions of grains & shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions.

These timber slat panels shall be fixed to the tubular frame as per pattern shown in drawing with self tapping stainless screws. The slats to be backed with black dyed jute upholstery fabric (not hessian) held on 24G x 10mm wire mesh and 50mm thick resin bonded glass wool (24 kg/m³) cut to size and inserted in GI framework held on 24Gx12 GI wire netting. Finally the slats shall be wax polished after wood filler and sand papering to a smooth finish in its natural colour complete as per drawing, specifications and direction of Engineer-in-Charge.

Automatic Hermetically Sealed Sliding Door

Door and Frames: Hermetically Sealed Sliding Automatic Door inside OT: Size 1500mm x 2100mm with vision panels, 300mm X 300 mm. To maintain sterility and the correct air pressure in the room, all doors into and out should be of the sliding, hermetically sealing type. Track system and door blade guide system: Automated or a Manual Hand operated hermetically sealing sliding main door on OT, of appropriate size, 2100mm (ht.) x 1000 / 1500 / 1800mm (wd.). As required. Door Leaf Strength of leaf core: 40mm (33mm tubular chipboard (core) + 3mm MDF (medium-density fibreboard) on both sides + 0,8mm HPL (High Pressure Laminate of approved make) on both sites). Circumferential profile: Anodized aluminium profile, circumferential 56 mm, V- shaped in the bottom area towards door lead on ground lobes. Surface: 0.8 mm HPL-laminate on 3 mm MDF-board as carrier material; depending on the chosen material a free passage of 1.15 m or more may require a seam in the laminate. Sealing: Rubber gaskets embedded in the door leaves press against the frame and the door, providing a hermetic sealing of the door. Rail System

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

ACOUSTICS DOOR

Providing & fixing of 75mm thick Nonmetallic, Asbestos Free Accoustic cum fire/smoke door of 120 minutes fire rating, conforming to BS: 476 part 22 IS: 3614 part -II, suitable to achieve minimum 32-35db, sound reducing properties suitable for fixing in wooden door frame of suitable section 145X75 mm made out of **2nd Class Teakwood** and the shutter comprising of 2nos 12 mm thick non -combustible fire rated boards, sandwiching **45 mm thick** fire resistant & accoustic insulation filler. The shutter is faced with 4mm thick matching wood veneered ply facing on both sides of door in approved make, colour & shade and wooden lipping all around the shutter with heat activated intumescent fire seal strip of size 20x4mm on all sides except bottom (for smoke sealing) both in frame & shutter. The door shall be fixed with Acoustics seals for sound reduction properties. The shutter is fitted with the frame with the help of SS ball bearing hinges of size 100x89x3mm (Minimum 04 nos. per leaf). The rate includes providing and fixing of Accoustic seals as per the details, SS 304 pull handle of size 600mm, Tower bolts, Anchor/Dash fasteners, fire rated hardware i.e SS hinges, door closers, Satin Stainless steel 304 grade mortice dead lock etc. Painting/polishing all as per drawing and direction of Engineer-in-charge. This item also includes providing & fixing of 4 nos. of Galvanized Iron Hold fasts 40mm x 5mm flat 300 mm long including fixing to frame with 10 mm dia. bolt, nut and wooden plug and embedding in cement concrete 1 : 2 : 4 block of size 30 x 10 x 15 cm.

TOILET CUBICLE SYSTEM

Supply and installation of Toilet cubicle system of width and depth as per manufacturer's specifications / Architectural drawings. Toilet cubicle system consists of two parts – pilasters & doors and intermediate panels. All Intermediate panels shall be of 18 mm thick solid compact laminate as one continuous panel without any joints and pilasters & Doors shall be made of solid compact laminate 18 mm thick with edges chamfered. Cubicle height to be maximum 2100 mm. (Height is including 110 gap mm from bottom) & Door standard width is 600 mm. The product should have Green Guard & IGBC Certificate.

Made from solid grade compact high pressure laminate as per IS:2046 manufactured under high specific pressure > 5 MPa and temperature >120°C with bunch of kraft papers impregnated with thermosetting phenolic resin and decorative papers made of Alpha cellulose fiber impregnated with thermosetting melamine resin which provide superior scratch, abrasion, heat, chemical, impact, graffiti & moisture resistance along with anti-bacterial properties. Panels have a black core that when machined, presents a distinctive black edge. Top surface on both sides is melamine coated which is scratch and impact resistant. Panel thickness 18 mm. Design no. as specified by Arch. / Engr. in suede finish. Size of panels to be as per drawing.

All pilasters are to be supported by stainless steel "L" bracket with floor anchor bolt, which is concealed with stainless steel flat box-up of height 100 mm. The stainless steel box-up shoe is in SS Grade 316. Fixing of intermediate panels to the wall shall be with stainless steel grade -304 U channel section fixed into the wall with SS-304 screw inserts.

HARDWARE & ACCESSORIES

- (1) Door Knob in Grade-304
- (2) Spring Loaded butt Hinges in Grade-304 with cover
- (3) Thumb turn lockset with Occupancy indicator in Grade-304
- (4) Coat hook with rubber door stopper in Grade-304
- (5) Stainless steel "U" & "F" channel & " L " plate all in Grade-304
- (6) Stainless steel shoe box leg 18 mm in Grade-316
- (7) SS screw 304 grade with P.V.C wall plug
- (8) Rubber lining for groove

Installation: As per detailed Architectural Drawings, Manufacturer Technical Specification and as directed by Engineer-in-charge.

All the material supplied and installed shall be as per the description and specifications in the item. The shop drawing showing Detailed plans and elevations, details of framing

members, anchoring methods, clearances, hardware, and accessories for individual toilets as per site condition shall be submitted by the contractor for obtaining approval of the Engineer-in-charge before start of work. the work to be done authorized/Trained installer of manufacturer or as decided by E.I.C

STEEL FIRE DOORS (INSULATED & NON-INSULATED)

Fire Rated Insulated Doors

FIRE RESISTANT DOOR FRAME

Providing and fixing fire resistant door frame of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m²) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m³. The frame will have a provision of G.I. Anchor fasteners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter. The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge.

GLAZED FIRE-RESISTANT DOOR SHUTTERS

Providing and fixing 60 mm thick glazed fire resistant door shutters of 120 min Fire Rating confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m²) duly filled mineral wool insulation having density min 96 kg/ m³ and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge.

GLAZING

Providing and fixing glazing in fire resistant door shutters, fixed panels & partitions etc., with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m²) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c, including applying a coat of approved fire-resistant primer/ powder coating of not less than 30 microns on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per NBC 2016, IS 16231 (Part 3):2016 and as per direction of Engineer-incharge with glass of required thickness having 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 20 minutes of insulation (EI20). The manufacturer has to give test report/certification of fire glass and the glass should have the stamp showing the value of E, EW & EI. The glass shall be tested in approved NABL accredited lab or by any other accreditation body which operates in accordance with ISO/IEC 17011 and accredits labs as per ISO/IEC 17025 for testing and calibration scopes shall be eligible. The maximum glazing size shall not be more than 1100x2200 mm (w x h) or 2.42 sqm.

Providing and fixing panic bar / latch (Double point) fitted with a single body, Trim Latch & Lock on back side of the Panic Latch of reputed brand and manufacture to be approved by the Engineer- in- charge, all complete.

All hardware fittings should be minimum two-hour fire rating.

Fire Rated Un-Insulated Doors

Providing and fixing of Hollow metal Un-Insulated fire rated doors as per IS 3614 part-1, for stability and integrity. Pressed galvanized steel confirming to IS 277 with the following specification. Recommended fire door shall be tested to IS 3614 part 2 / ISO 834-1 Part 1 / BS476 Part 20 & 22, CBRI / Cerifire or third party certified or equivalent lab, for maximum rating of 120mins, in latched /unlatched condition (if used with deadbolts and pull handles). Labeled doors with certification shall be with vision glass as a part of complete assembly. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied shall be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory from Approved manufacturer or equivalent.

Size of door frame and shutter shall be as per the manufactures specification with 2 Hrs fire rating. Door frame shall be single rebate grooved profile of size 125 x 60mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet. Frames shall be mitered and field assembled with self-tabs. Frames to have in build grooved sealing system and shall be site fitted with fire rated EPDM gasket as standard. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening including necessary 3mm/4.8 mm thick steel hinge reinforcement, 1.2 mm thick steel lock strike reinforcement with tapped holes welded to the frame and 1.2mm thick mortar guard at the back of all hardware cutout in the frame. The frame will have a provision of G.I. Anchor fastners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of approved Size.. The frames should be zinc phosphated and finished with minimum 50 micron Thermosetting Powder Coating of approved colour and shade / finish in desired RAL Shade. Frames shall be filled with fire rated puff.

Door leaf shall be 46mm thick fully flush double skin door, Un-insulated with or without vision lite as per GfC drawing. Door leaf shall be manufactured from 1.2mm (18gauge) minimum thick galvanized steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be structural small cell resin bonded Honey comb craft paper treated with appropriate fire retardent paint. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors integrated astragals has to be provided on the meeting stile for both active and inactive leaf. Vision

lite wherever applicable should be provided as per manufacturer's recommendation with a clip-on arrangement. The glass should be 6mm clear borosilicate fire rated glass of relevant rating of the door. The shutters should be zinc phosphated and finished with minimum 50 micron Thermosetting Powder Coating of approved colour and shade / finish in desired RAL Shade.

All doors and frames should be zinc phosphated and finished with minimum 50 micron Thermosetting Powder Coating of approved colour and shade / finish in desired RAL Shade and shall have passed minimum 500 hours of salt spray test.

Item shall include supply and installation of door and hardware as a complete assembly as mentioned in the door and hardware schedule. Once frame installed should be filled with PUF as recommended by the manufacturer.

120Mins Fire Rated Door Single/double leaf of size as mentioned in GFC Drawing with vision panel 200x300mm with hardware set stainless steel grade 304 ball bearing butt hinges, stainless steel grade 304 pull handle of 300mm long on both side, mortise dead lock with both side cylinders, Fire rated surface mounted door closer, groove seal for smoke, all hardware are as per List of preferred makes & inclusive of PUFF Grouting. All hardware fittings should be minimum two hour fire rating.

MS STRUCTURAL STEEL WORK: -

T-IRON FRAMES

For Doors, Windows and Ventilators of mild steel Tee-sections, joints mitred and welded, including fixing of necessary butt hinges and screws and applying a priming coat of approved steel primer. Fixing with 15x3 mm lugs 10 cm long embedded in cement concrete block 15x10x10 cm of C.C. 1:3:6 (1 Cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size).

PRESSED STEEL DOOR FRAMES

Pressed Steel Door Frames conforming to IS: 4351, manufactured from commercial mild steel sheet of 1.60 mm thickness, including hinges, jamb, lock jamb, bead and if required angle threshold of mild steel angle of section 50x25 mm, or base ties of 1.60 mm, pressed mild steel welded or rigidly fixed together by mechanical means, including M.S. pressed butt hinges 2.5 mm thick with mortar guards, lock strike-plate and shock absorbers as specified and applying a coat of approved steel primer after pre-treatment of the surface as directed by Engineer-in-charge:

Profile B - Fixing with adjustable lugs with split end tail to each jamb metre 417.60

Profile C - Fixing with adjustable lugs with split end tail to each jamb metre 444.35

Profile E - Fixing with adjustable lugs with split end tail to each jamb metre 484.50

M.S. TUBULAR FRAMES

M.S. Tubular frames for doors, windows, ventilators and cupboard with rectangular/ L-Type sections, made of 1.60 mm thick M.S. Sheet, joints mitred, welded and grinded finish, with profiles of required size, including fixing of necessary butt hinges and screws and applying a priming coat of approved steel primer. Fixing with 15x3 mm lugs 10 cm long embedded in cement concrete block 15x10x10 cm of C.C. 1:3:6 (1 Cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size)

STRUCTURAL STEEL

Structural steel of grade E250 confirming to IS2062 shall be used for M.S. Steel ladder, M.S. Hand rail, M.S. Insert Plates / Base / gusset / stiffener plates as per Architectural / Structural drawings. M.S. Tube (Pipe / square / rectangular) sections shall be of grade E310 for Pipes / E350 for RHS & SHS shall be used for Architectural Pergolas, Façade members if any as per corresponding Architectural / Structural drawings.

MS support (angle, tube, channel, etc.) at wall / ceiling for services line (Plumbing, Electrical, HVAC, etc.) shall be provided as per approved shop drawing, design and direction of E-I-C. MS supports to be fixed with 100x8mm anchor fasteners in concrete / hold fast with grade of concrete as shown in drawing.

Mild steel round holding down bolts with nuts and washer plates shall be as per GFC drawing.

MS Steel railing shall be provided as per details, locations shown in GFC drawing. MS works in Monkey ladder for O.H.T.machine Room terrace, Mumty terrace & Plumbing shaft as per architectural drawing.

Library & Data centre : Fire Escape staircase shall be made with MS structural steel with MS railing as per detail given in GFC structural / Architectural drawing.

Architectural Pergolas shall be made at various locations as shown in architectural drawing with M.S. Tubular (Pipe / square / rectangular) sections of sizes & design as per detailed GFC drawing.

M.S. Screen with gates shall be provided at various locations as per details provided in the architectural GFC detailed drawings using M.S. tubular section, solid M.S. square bar , M.S. plates etc as required. The gate shall be fixed with MS heavy duty hinges, all hardware such as heavy duty MS Aldrops, tower bolts etc, as shown in GFC drawings or as directed by E-I-C / Architect.

MS support (angle, tube, channel, etc.) at wall / ceiling for services line (Plumbing, Electrical, HVAC, etc.) shall be provided as per approved shop drawing, design and direction of E-I-C. MS supports to be fixed with 100x8mm anchor fasteners in concrete or as shown in drawing

Steel work welded in built up sections/ framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc. as required. In stringers, treads, landings etc. of stair cases, including use of chequered plate wherever required, all complete.

All MS/Structural Steel works shall be finished with acrylic aliphatic polyurethane paint as per specification given

General specifications/points to be followed by Contractor for doing MS / Structural Steel work :-

Material Report: Prior to start of delivery of structural steel required for contractor shall submit the following to the Engineer-In-Charge for review.

a) Certified copies of mill test reports including chemical analysis and physical properties as required by the applicable Indian Standards for each consignment of steel.

Shop/Fabrication Drawings: Before commencement of any structural steel fabrication work, the contractor shall submit the following to the Engineer-In-Charge for his approval:

a) Fabrication drawings including details of connections.

b) Assembly, erection and installation drawings and manuals indicating the sequence of work, welding and bolting procedure to be used. Cambers for trusses and large span girders shall be shown.

c) For composite construction the details and calculation of details and calculation of false work and forms supporting the concrete work in steel structure shall be submitted.

d) The drawings prepared by the contractor and all subsequent revisions etc. shall be at the cost of contractor for which no separate payment will be made.

Handling & Storage

Structural steel shall be stored out of mud and dirt and proper drainage of the storage area shall be provided. Protect from damage or spoiling by adjacent construction operations.

Fabricated steel shall not be handled until the paint has thoroughly dried. Care shall be taken to avoid paint abrasions and other damager. Steel work shall be transported in the largest practical lengths and in such a way as not to overstress the fabricated sections. All pieces bent or otherwise damaged shall be replaced by the Contractor at his own cost.

As far as practicable, stacking of fabricated steel shall be done in sequence of erection. But heavy members shall not be stacked on top of the light ones.

Cutting

Gas Cutting shall normally be permitted for mild steel only. Gas cutting of high tensile steel may be permitted provided special care is taken to leave sufficient metal to be removed by matching so that nil metal that has been hardened by flame is removed. Gas cutting shall preferably be done by machine, Hand flame cutting; may only be permitted subject to the approval of the Engineer-In-Charge. Gas cut edges shall be free of gouge. Any gouges that remain after cutting shall be removed by grinding.

For tubular construction cutting of the pipe and preparation of joint surface shall be done in a neat manner for a good fit up. The ends of the tubes may be flattened or otherwise framed for connections provided that the methods adopted for such flattening do not injure the material. The change of section shall be gradual.

Holing

Holes shall preferably be done by drilling. Punching shall not be permitted unless previously approved by the Engineer-In-Charge. In any case, punching of holes in materials having a thickness in excess of the connector diameter or in the materials thicker than 16mm shall not be permitted. Where punching is permitted the holes shall be punched 3 mm less in diameter than the required size and reamed after assembly to the full size.

Steel members adjustment shall be provided with slotted holes as shown on the drawings. Suitable templates shall be used for proper location of the holes.

Fabrication Tolerances: Unless otherwise shown on the drawings, the fabricating tolerances shall generally be as follows:

- a) Compression members shall not deviate from straightness by more than $1/1000$ of the axial length between points which are to be laterally supported.
- b) A variation of 1 mm is permissible in the overall length of members with both ends finished for contact bearing. Members without ends finished for contact bearing which are to be framed together in parts of the structure, may have a variation from the detailed length not greater than 2mm for members 10 metres or less in length and not greater than 3 mm for members over 10 metres in length.

Assembly

All connections shall be either bolted or welded as shown on the drawings. Contractor shall not redesign or alter any connection without prior approval of Engineer-In-Charge.

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be prepared so that the specified camber if any is provided. Drafting done during assembly shall not distort the metal or enlarge the holes. Poor matching of holes shall be cause of rejection. However if permitted by the Engineer-In-Charge, holes that must be enlarged due to mismatching shall be reamed.

Bolting

High strength bolts shall be used in bearing or friction as shown on the drawings.

Anchor bolts shall be set by use of templates secured firmly in place to permit true positioning of the bearing plates and assemblies. When in drawings anchor bolts are shown to be installed in sleeves, the sleeves shall be completely filled with grout.

Welding

Welding shall be done in accordance with IS:816.

Welding procedures shall be based on the specific analysis of any given heat of steel (based on the certified mill test reports) and shall be subject to the review of the Engineer-In-Charge.

These procedures shall call for one or all of the following

- a) Proper bead shape.
- b) Minimized penetration to prevent dilution of the weld metal with the alloy elements.
- c) Preheating, controlled interpass temperature and controlled heat input.

Welding shall be performed only by qualified and tested welders specifically trained and experienced for the type of job required to execute the welding work to the complete satisfaction of the Engineer-In-Charge. However periodical testing of welders shall be done as per IS 817, IS 7310 (Part I) and IS 738 (Part I).

Use of standard weld symbols as adopted by IS : 813 is mandatory. Pre-qualified joints which are detailed, prepared and welded in accordance with the requirement of IS : 816 shall be invariably used.

Structural welding shall not commence until joint elements are bolted or tacked in intimate contact and adjusted to dimensions shown with allowance for any weld shrinkage that is expected. Welding sequence shall be planned and controlled to minimise undue stress Increase or undue distortions in restrained members. Heavy sections and those having a high degree of restrain shall be welded with low hydrogen type electrodes.

If copper wire spacers are used between two surfaces to be welded to reduce transverse stresses in the weld, care shall be taken that it does not mix with the weld metal.

Concave bead shape shall be avoided. Ratio of weld width to weld depth shall preferably vary from a minimum of 1 to 1, to a maximum of 1.4 to 1.

$$\frac{\text{width-of-weld}}{\text{depth of fusion}} = 1 \text{ to } 1.4$$

Subsequent to fabrication, the overlapping or contacting surfaces, or other closed sections (such as tubular, box section) which are inaccessible to painting shall be seal welded. When the end of the tube is not automatically sealed by virtue of its connection by welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tube shall be made dry and free from loose scale.

Order of assembly of the tubular sections shall consist of welding the tensile member to the main member first. Compression members shall be cut back to overlap the tensile member and then welded to both of these members.

No welding shall be done when the surface of the member is wet nor during periods of high wind. No welding shall be done on base metal at a temperature below -50°C . Base metal shall be preheated to the temperature as per relevant IS codes.

Each layer of multiple layer weld except root and surfaces runs may be moderately peened with light blows from blunt tool. Due care should be taken to prevent scaling or flaking of weld and base metal from over peening.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

Tolerances: The dimensional and weight tolerances for rolled shapes shall be in accordance with IS 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerance for fabrication of structural steel shall be as per IS 7215.

End milling: Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment

Inspection

The contractor shall give due notice to the Engineer-In-Charge in advance of the work getting ready for inspection. All rejected material shall be promptly removed from the site.

No materials shall be painted or erected or despatched to site without inspection and approval by the Engineer-In-Charge.

The Contractor shall provide all the testing and inspection services and facilities for shop works except where otherwise specified.

For fabrication work carried out at site, the same standard of supervision and quality control shall be maintained and inspection and testing shall be conducted in a manner satisfactory to Engineer-In-Charge.

Testing of welds

Welds shall be inspected as per CPWD Specification for flows by any of the methods given below. The choice of method shall be determined by Engineer-In-Charge.

Liquid penetrate inspection: These tests shall be carried out as per IS codes. All defects shown shall be repaired and rechecked.

Radiographic Inspection: These tests shall be carried out as per IS/relevant codes. All defects shown shall be repaired and rechecked.

Test failure: In event of failure of any member to satisfy inspection or test requirement, the contractor shall notify the same to Engineer-In-Charge. Before repairing contractor

shall obtain permission from Engineer-In-Charge. The quality control procedures to be followed to ensure satisfactory repairs subject to approval of Engineer-In-Charge.

The contractor shall maintain records in all inspection and testing which shall be made available to the Engineer-In-Charge as and when required.

Erection

As far as possible, the Contractor shall deliver the fabricated steel work to the site in the same sequence as that which he wishes to follow for the erection. Dispatch should be scheduled to avoid cluttering up of the site. The bolts required for erection shall be bagged according to size prior to dispatch.

All structural work shall be erected in accordance with IS : 800/IS : 806 and IS : 1915 and as per the approved erection drawings. The Contractor shall be responsible for setting out the works. The suitability any capacity of all plant and equipment used for erection shall be to the Satisfaction of Engineer-In-Charge. These shall be regularly serviced and maintained. Occupational safety practices shall be strictly adhered to and shall be to the satisfaction of the Engineer-In-Charge.

No permanent bolting or welding shall be done until proper alignment has been obtained. Erection of the parts with any moderate amount of reaming, chipping or cutting shall be immediate reported to the Engineer-In-Charge. The steel work shall be rejected unless corrective action is approved by the Engineer-In-Charge.

No erection shall be permitted more than 2 story above a complete bolted and/ or welded floor or above a decked surface.

Placement of joists shall not start until the supporting work is secured. Temporary bridging, connections and anchors shall be provided to assure lateral stability during erection. Bridging to steel joists shall be installed immediately after joist erection, before any construction loads are applied. Horizontal or vertical bridging shall be provided in accordance with the type of span of the joists. Ends of the bridging lines shall be anchored at top mid bottom chords whom terminating to walls or beams.

Erection Tolerances: The Contractor shall control the erection of steel structures in such a way that in level no components are more than 10mm out of their correct position nor shall the lines of the structure depart from straightness and plumb by more than a 3mm in metres. The error shall be measured from the designed position of level given by the dimensions and co-ordinates on the drawings.

In structures where movements due to temperature change considerable the deviations listed above will apply at the morning position of the member being checked.

Field Modification

Correction to accommodate minor misfits in steel structure by moderate use of drift pins and reaming will be permitted. Errors that cannot be corrected by these measures, but require modifications must be reported immediately to the Engineer-In-Charge along with Contractors proposed solution.

Grouting under base plates

Grouting under base plates shall be done after erection of the structural steel unless otherwise approved by the Engineer-In-Charge. All bearing plates, bearing assemblies and masonry plates shall be steel level and to the elevations shown on plans. These shall be shimmed with approved means and grouted to assure full bearings on the supporting substrata regardless of the tolerances otherwise permitted.

The grout to be used in superstructure stanchion bases shall be cement mortar 1: 2 (1 cement: 2 coarse sand) and shall have a 28 days compressive strength of at least 300 kg/sqm. The surface which are to receive the grout shall be thoroughly cleaned immediately prior to the grouting operation. The grout shall be carefully worked under the base plates and shall completely fill the space under the base plates. Air pockets in the grout packing shall be avoided.

After the grout has had its initial set, the grout shall be cut back flush with the base plate and the surplus grout shall, be removed. Before leaving the site the Contractor shall retighten the nuts of all anchor bolts.

Cleaning & Paint touching

After erection, exposed surfaces of field connections, unpainted areas adjacent to tie connections and damaged area in the shop coat shall be cleaned to the same standards required on the shop cost. These shall then be painted with the same used in the shop coat.

Inserts & Embedments: Various steel inserts and embedment are required under the Contract to be fabricated, positioned and secured firmly into place inside the formwork prior to concrete being poured. There are also requirements of jointing, threading, bolting and inserts and embedment of different concrete and structural steel elements in order to establish structural continuity and connection. Great care shall be exercised by the Contractor in executing all aspects of the work related to inserts and embedment -

including tolerances so that the final assembly of the concrete elements can meet satisfactorily the continuity and contiguity requirements intended in the structure.

MS perforated Sheet for Access corridor:

2mm thick MS perforated Sheet on MS Tubular framework with 6mm dia holes at 10mm c/c pitch @ 45 degrees etc. complete shall be provided as per architectural drawing or as directed by Architect / Engineer- in-Charge. Acrylic Aliphatic Polyurethane Paint to be done as per specifications.

Rolling shutters : Rolling shutters shall be of approved make, made of 80x1.25 mm size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with mechanical device chain and crank operation for operating rolling shutters complete, including providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 , ball bearing & M.S. top cover 1.25 mm thick for rolling shutters . Rolling shutters shall be partly grilled or partly fixed as per architectural GFC drawing. Grilled rolling shutters manufactured out of 8 mm dia M.S. bar instead of laths as per design approved by Engineer-in- charge.

Acrylic Aliphatic Polyurethane Paint on M.S Structural Steel

On MS Structural Steel Coming in Access Corridor

Surface Preparation: Preparing the structural steel surfaces to ensure complete removal of mill scale by grit / sand blasting confirming to SA 2.5 Swedish Standard. to achieve rust free surface. The surface should be free of all visible oil, grease, dust, dirt, mill scale, rust, oxides, corrosion products and other foreign matter. The entire work shall be carried out as per manufacturers specification or as per directions and to the satisfaction of the Engineer-in-charge.

Anti-corrosive protective paint & primer:

- (a) First coat of two component Zinc Silicate Primer, with minimum dry film thickness (DFT) of 65 microns and a Zinc content of 80% on dry film, the primer shall be applied by spray only. Brushes shall be used only for touch-up work.
- (b) Second Coat of High solid, micaceous iron oxide pigmented epoxy coating for structural steel surfaces with minimum dry film thickness of 100 microns per coat and Volume solid 80%
- (c) Finish coat shall be one coat of two components, high solid acrylic aliphatic polyurethane Satin finish with minimum dry film thickness (DFT) of 60 microns with Volume Solid approx 64% complete as per manufacturers specification, the

entire work shall be carried out as per directions and to the satisfaction of the Engineer-in-charge.

Total minimum DFT of the system shall be 225 Microns

On MS Structural Steel coming in any other building other than Access Corridor

Surface preparation: Preparing the Structural steel surfaces to ensure complete removal of mill scale by ST2/ST3 using power / manual tool (Hand tool cleaning is a method of preparing steel surfaces by the use of power hand tools or non-power hand tools. Hand tool cleaning removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. The entire work shall be carried out as per manufacturers specification or as per directions and to the satisfaction of the Engineer-in-charge.

Anti-corrosive protective paint & primer :

(a) Two coat of two component Surface Tolerant Epoxy Primer with minimum dry film thickness (DFT) of 150 microns(75 microns each coat) and Volume Solid of 80% , The primer shall be applied by spray only. Brushes shall be used only for touch-up work.

(b) Final coat shall be followed by applying one coat of two component, high solid acrylic aliphatic polyurethane Satin finish coat of approved list brand, shade and quality with minimum dry film thickness (DFT) of 60 microns with Volume Solid approx 64%, The entire work shall be carried out as per directions and to the satisfaction of the Engineer-in-charge.

Total minimum DFT of the system shall be 210 Microns

STAINLESS STEEL WORK

STAINLESS STEEL GRADE AISI 304 “WELD FREE” RAILING

Stainless steel grade AISI 304 “weld free” railing are coming at different location as mentioned in GFC drawing are following

- a)** S.S Railing comprises of 50 mm dia tube top handrail, 38 mm dia pipe single vertical balusters, 4 Nos. mid rail of S.S. tube dia 19mm.
- b)** S.S Railing comprises of 50mm dia Handrail fixed on 10x50x210mm (or approved equivalent size) S.S. Solid baluster with glass holding accessories (including top

bracket to hold hand railing), placed at maximum 1200mm c/c along with 12mm thick toughened glass connected with baluster with special glass holding fixtures.

- c) S.S Railing comprises of 50 mm dia tube top handrail, Single vertical balustrade SS Flat 50 X 10 mm minimum thickness, 3 nos. mid rail of SS tube 19mm.

Or as per the approved GFC Drawing & instructions of E-I-C.

Detail description

- A.** Providing modular passivated satin stainless steel “weld free” railing system at all locations & levels (as per architectural drawings) of approved size and shape conforming to grade AISI 304 with all modular accessories using flexible bends & modular system or expansion & ball socket system as per manufacturer’s specifications or as per detailed Architectural Drawings, Manufacturer Technical Specification and as directed by Engineer-in-charge. Load calculations & Material test reports for SS 304 grade to be submitted by vendor. The material comprises of top handrail shall be S.S. tube dia 50 mm x 1.5 mm (+/-0.1mm) minimum thickness, single vertical balusters shall be of 38 mm dia pipe of 1.5 mm (+/-0.1mm) minimum thickness at 1m to 1.2 m c / c & at turning with 4 Nos. mid rail of S.S. tube dia 19mm x 1.5 mm (+/-0.1mm) minimum thickness and mounted all balusters with blind rivet. The balusters may be fixed on the horizontal or vertical surface as desired with minimum 6 mm thick SS base plate & base plate shall be concealed with suitable SS 304 grade cover cap as per manufacturers specification. Baluster to hold handrail using flexible bends & modular system or expansion & ball socket system for all joints, turns etc. The entire fixing shall be completed as per manufacturer's specification & as per architectural drawing and approval of Engineer-in-charge.
- B.** Supply and installation of AISI 304 Grade Stainless Steel satin finish Knock Down railing system comprising Ø 50mm Handrail fixed on 10x50x210mm S.S. Solid baluster with glass holding accessories (including top bracket to hold hand railing), placed at maximum 1200mm c/c along with 12mm thick toughened glass connected with baluster with special glass holding fixtures. The Glass height should be taken as minimum 845mm. The balustrade would be fixed onto floor with SS 304 Grade base plate of 100x60x8mm thickness. Base plate shall be concealed with suitable S.S. 304 grade cover Cap so that the mounting anchor fasteners are not visible after installation. Wall thickness of all Pipes shall be taken as 1.5mm along with all visible components developed in High Grade S.S. and whenever required, joints to be filled with bushings for extra strength. Railing height to be taken 1000 mm from floor level. The entire fixing shall be completed as per manufacturer's specification & as per architectural drawing and approval of Engineer-in-charge.
- C.** Providing & fixing modular passivated Satin stainless steel finish “weld free” railing system at suitable locations at all levels of approved size and shape conforming to grade AISI 304. Top Handrail Shall be SS Tube of minimum dia 50 mm X 1.5 mm minimum thickness, Single vertical balustrade shall be of SS Flat 50 X 10 mm minimum thickness at 1m to 1.2m C/C & at turning with 3 nos. mid rail of SS tube 19mm X 1.5mm minimum thickness fix with connectors to all balusters to support infill as per manufacturers specification, The balustrade will be fixed on the vertical surface (side

mount) with SS 304 grade wall bracket by SS 304 M10x100 fasteners & Anchor (M10X70 mm) or as per manufacturers specification. Entire fixing shall be completed as per manufacturer's specification & as per architectural drawing and approval of engineer -in-charge. Load calculations & Material test reports for SS 304 grade to be submitted by vendor. Railing height will be 1000 mm from FFL.

Samples & Shop drawings: All work to be done as per GFC Drawing. Sample including complete modular system & shop drawings shall be submitted by the contractor for approval prior to the execution of work.

The works also protected by wrapping bubble sheet till completion / handing over of the building whichever is later. If any scratches and damages occurs shall be replaced or rectified at their own cost and nothing extra shall be paid against the same.

STAINLESS STEEL GRADE 304 WALL LINING

Providing, fabricating & fixing in position as per detail given in GFC drawing, gutter & drain wall lining (minimum 2 mm thick SS sheet) & other similar work as called for with Stainless Steel of SS Grade-304 consisting of S.S. sheet, S.S. flats, S.S. plate, angles, S.S. hinges etc. including all fixing accessories such as S.S. inserts etc., all cutting, bending, welding, grinding, drilling, tapping and all other incidentals, and approved buffing to stainless steel members as directed by the Engineer-in-charge. complete.

Freight Lift: Stainless steel grade 304 jambs over M.S. framework shall be provided at all levels of freight lift as per GFC drawing.

Note: All stainless steel works shall be executed through authorized/trained/recommended installer of manufacturer or as decided by Engineer in charge.

FLOORING

Floor finishing margin shall be 100 mm out of which lower part 50 mm is left for services (Raceways, conduits etc) filled with cement concrete 1:3:6/1:2:4 as shown in GFC drawing& balance 50mm thick is for floor finishing / leveling requirement shall be catered with 1:4 cement mortar up to desired level for which nothing extra shall be paid.

The works should be protected by laying 2mm thick POP over paper till completion / handing over of the building whichever is later. If any scratches and damages occur they shall be replaced or rectified at their own cost and nothing shall be paid against the same.

All flooring works with or without pattern shall be executed as per design/ mockup approved by Architect and E-I-C.

IPS Flooring (Cement Concrete Flooring): 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications. This includes cost of cement slurry and nosing of steps etc. complete if required.

Cement Plaster Skirting: 18 mm thick Cement plaster skirting up to 30 cm height, with cement mortar 1:3 (1cement: 3 coarse sand), finished with a floating coat of neat cement.

Floor strips: Aluminium strip 35 mm wide and 3 mm thick to be fixed in a pattern as shown in drawings or as directed by E-I-C in joints of cement concrete floors.

Vacuum dewatered flooring: C.C. flooring of mix M-35 or as mentioned in drawing. The ready mixed concrete shall be laid and finished with screed board vibrator, vacuum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-incharge. The slump of concrete shall be maintained in range 30-50

Polished Kota / Polished Tandur stone/ Sand blasted leather finish kota / Sand blasted leather finish Tandur stone / Polished Rajim / Sand blasted leather finish Rajim stone / polished Mandana / Sand blasted leather finish Mandana stone with cement mortar shall be provided in a pattern / combination at locations as shown in GFC drawings and as per CPWD Specification.

Stone flooring with Epoxy joints; Stone flooring with Epoxy joints shall be provided at location & pattern as shown in GFC drawings including keeping the joints 4 mm wide & 6 mm deep around & filled with approved quality epoxy grout as per manufacturers specification in flooring. For detail refer GFC drawings.

The treads & risers of steps should be in one single long piece up to 2000mm length as per the drawing. Nosing / moulding in treads shall be as per GFC drawings.

Polished Mandana stone 30 mm thick: Polished mandana stone 30 mm thick shall be provided over all external window cills, Parapet tops / low height walls, planters tops, coping etc including nosing / moulding as per GFC drawing and design.

Polished kota / Tandur stone 25 mm thick: Polished kota / Tandur stone 25 mm thick shall be provided over all internal window sills, planters tops, coping, cills etc including nosing / moulding as per GFC drawing and design.

Bilha stone (Polished / Unpolished) shall be provided at plinth protection or similar locations as mentioned in GFC drawings and as per CPWD Specification.

Gang-saw-cut 18mm thick Mirror Polished Granite & Sand blasted leather finish Granite (of approved shade) for flooring, Skirting, Treads, riser and wall cladding:

Gang-saw-cut 18mm thick Mirror polished granite & Sand blasted leather finish Granite of required size, approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement: 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels.

The treads & risers of steps should be in one single long piece up to 2000mm length as per the drawing. Nosing / moulding in treads shall be as per GFC drawings. Granite Wall Cladding of height as shown in GFC drawing shall be provided at all lifts Fascias in all floors.

All skirting shall be 100 mm/150 mm (as per GFC) of same material unless specified. It should be flush with wall with groove 10x6 mm.

Mirror Polish: Mirror polishing on Granite work / stone work shall be done where ever required as shown in Architectural Drawings to give high gloss finish complete as per manufacturers specification.

Sand blasted Leather finish: Sand blasted Leather finish on Granite work / stone work shall be done where ever required as shown in Architectural Drawings to give high gloss finish complete as per manufacturers specification.

Vitrified tiles flooring

20 mm thick Antiskid/full body Industrial Vitrified tiles flooring & skirting : Flooring shall be approved uniform colour and size (60cm x 60cm) 20 mm thick fullbody Antiskid Industrial Vitrified tiles of approved make including cleaning the surface thoroughly with wire brush, applying bonding coat with neat cement slurry on concrete surface and fixing tiles over 20 mm thick cement mortar bedding 1:4 (1 cement:4coarse sand) admixed with approved admixture in proportion (50 kg cement+200 kg sand+3 litre admixture + requisite water) with neat cement slurry admixed with approved admixture in proportion (50 kg cement+5 litre admixture + water) @ 3.3kg per sqm, keeping the joints 3 mm wide& minimum 6 mm deep alround & filled with approved quality epoxy grout. Skirting shall be with same tiles laid over 12 mm (average) thick cement mortar 1:3 (1 cement: 3 coarse sand).

15 to 16 mm thick Antiskid/full body Industrial Vitrified tiles flooring & skirting :

Flooring shall be approved uniform colour and size (60cm x 60cm) 15 to 16 mm thick fullbody Antiskid Industrial Vitrified tiles of approved make including Cleaning the surface thoroughly with wire brush, Applying bonding coat with neat cement slurry on concrete surface and fixing tiles over 20 mm thick cement mortar bedding 1:4 (1 cement:4coarse sand) admixed with approved admixture in proportion (50 kg cement+200 kg sand+3 litre admixture + requisite water) with neat cement slurry admixed with approved admixture in proportion (50 kg cement+5 litre admixture + water) @ 3.3kg per sqm, keeping the joints 3 mm wide & minimum 6 mm deep around & filled with approved quality epoxy grout. Skirting shall be with same tiles laid over 12 mm (average) thick cement mortar 1:3 (1 cement: 3 coarse sand).

Matt / polished /Antiskid/full body/Double Charged Glazed Vitrified floor tiles 9 to 10 mm thick :

Flooring shall be approved uniform colour and size 60 X 30 cm / 60 X 60 cm / 80 X 80 cm/ 60 X 120 cm/100 X 100 cm/80 X 120 cm/120 X 120 cm 9 to 10 mm thick Antiskid/full body/Double Charged Glazed Vitrified floor tiles of approved make including Cleaning the surface thoroughly with wire brush, Applying bonding coat with neat cement slurry on concrete surface and fixing tiles over 20 mm thick cement mortar bedding 1:4 (1 cement:4coarse sand) admixed with approved admixture in proportion (50 kg cement+200 kg sand+3 litre admixture + requisite water) with neat cement slurry admixed with approved admixture in proportion (50 kg cement+5 litre admixture + water) @ 3.3kg per sqm. Keeping the joints 3 mm wide & minimum 6 mm deep around & filled with approved quality epoxy grout. Skirting shall be with same tiles laid over 12 mm (average) thick cement mortar 1:3 (1 cement: 3 coarse sand).

Matt / polished Vitrified wall tiles 9 mm (+/- 1 mm) thick :

Wall cladding / dado shall be of approved uniform colour and size 60 X 30 cm / 60 X 60 cm 9 mm thick Matt / polished Vitrified wall tiles of approved make including fixing tiles over 12 mm thick bed of cement mortar 1:3 (1 Cement : 3 Coarse sand) and jointed with grey cement slurry @ 3.3 Kg per sqm including pointing in white cement mixed with pigment of matching shade including keeping the joints 3 mm wide & minimum 6 mm deep around & filled with approved quality epoxy grout. The heights of dado shall be as per GFC architectural drawing.

All tiles shall be of 1st quality as per approved sample, brand, manufacture, colour and shade.

Ceramic Glazed Floor tiles 8 mm thick: Rectified Glazed Ceramic floor tiles shall be of size 300x300 mm or more 8mm thick, of 1st quality conforming to IS : 15622, of approved make, in colours White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1 : 4 (1 Cement: 4 Coarse sand), jointing with grey cement slurry @ 3.3 kg/ sqm including grouting the joints with white cement and matching pigments etc., complete.

Ceramic Glazed Wall tiles 8 mm thick: Ceramic glazed wall tiles (1st quality) conforming to IS: 15622 8mm thickness, of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse

sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete.

Antistatic Flooring - ESD vinyl

It should meet the most relevant needs of the customer interests - including cost, durability, ergonomics, compliance with safety standards, appearance, total cost of ownership and of course ESD properties. The flooring should conform to standards EN 1081/IEC 613404, EN 1815 & EN 12466. Solid vinyl tile (SVT) (2mm). It should be simple to repair and easy to clean. The joints between individual tiles should be welded by heat fusion process to get a seamless floor the joints in the flooring should be sealed by using a PVC welding bar of matching colour to supply by the manufacturer using a hot air gun for fusion of welding bar with flooring. SVT should be conductive flooring within the OT area to prevent damage to sensitive medical electronic equipment, inadvertent movement of surgeons / technicians, accumulation of static dirt. Providing & fixing 2mm thick Conductive flooring with carbon backing total thickness 2.00mm, total weight 3.000 g/m² polyurethane reinforced, scratch resistant, fire resistant, chemical resistant, slip resistant, anti-fungi & bacterial growth, dimensional stability ≤0.40%, static electrical charger < 2Kv, impact sound reduction approx. +4bd, electrical resistant. Installation: The flooring would be installed on a smooth, clean sub floor which should be free from any undulation Copper grounding strips. (0.05mm thick, 50mm wide) will be laid flat on the floor in the conductive adhesive and connect to copper wire of grounding.

Epoxy Grout-Grouting the joints of flooring tiles / stones having joints of 3 & 4 mm width, using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg), including filling / grouting and finishing complete as per direction of Engineer-in-charge.

Lecture Halls Tier: All lecture hall tiers, shall be made based on levels mentioned in drawings with 230 mm thick cement based fly ash brick wall as toe walls (with 1st class) in cement mortar 1:6 (1 cement: 6 coarse sand) as per drawings. The tier thus formed shall be filled with light weight machine mixed Autoclaved aerated cement (AAC) blocks concrete in volumetric proportion 1:4:8 (1 cement: 4 coarse sand: 8 AAC block aggregate 40 mm nominal size) & 75 mm thick PCC 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 20 mm nominal size) below the final floor finish as per GFC drawing.

Raised / false access flooring as per item code 11.54 DSR 2018 : Providing and fixing removable raised / false access flooring with system and its components of approved make for different plenum height with possible height adjustment up to 50 mm, comprising of modular load bearing floor panels supported on G.I. rectangular stringer frame work and G.I. Pedestal etc. all complete, as per the architectural drawings, as specified, as per manufacturer specification and as directed by Engineer-in-charge for 600 mm finished floor height (FFH) or height as mentioned in GFC drawing.

Providing at required spacing to form modular framework, pedestals made out of GI tube of thickness minimum 2 mm and 25 mm outer diameter, fully welded on to the G.I. Base plate of size 100mm x 100mm x 3mm at the bottom of the pedestal tube, G.I. pedestal head of size 75mmx75mmx3.5 mm welded with GI fully threaded stud 16mm outer diameter with two GI Check nuts screwed on the stud for level adjustment upto 50mm, locking and stabilizing the pedestal head in position at the required level. The pedestals shall be fixed

to the subfloor (base) through base plate using epoxy based adhesive of approved make or the machine screw with rawl plug.

Stringers system in all steel construction hot dipped galvanized of rectangular size 570x20x30x0.80mm thick having holes at both ends for securing the stringers on to the pedestal head using fully threaded screws ensuring maximum lateral stability in all directions, the grid formed by the pedestal and stringer assembly shall receive the floor panel, this system shall provide adequate solid, rigid support for access floor panel, the system shall provide a minimum clear uninterrupted clearance between the bottom of the floor for electrical conduits and wiring etc. all complete as per the architectural drawings, as specified and as directed by the Engineer-in-charge.

Access Floor panel of 600x600x32 mm medium grade Filled Steel anti static high-pressure Lamination of 800H grade (FS800H). Access Floor panel shall be steel welded construction with an enclosed bottom pan with uniform pattern of 64 hemispherical cones. The top and bottom plates of Steel Gauges: top 0.6 mm and bottom 0.7 mm fused spot welded together (minimum 64 welds in each dome and 20 welds along each flange). The panel should be Corroresist epoxy coated for lifetime rust protection and cavity formed by the top and bottom plate is filled with noncombustible Portland cementitious core mixed with lightweight foaming compound. The access floor shall be factory finished with Anti-static High-Pressure laminate with Non-Warp technology upto 1mm thickness for superior adhesion and Surface flatness within 0.75mm. The panel is to withstand a Concentrated Load of 363 kgs applied on area 25mm x 25mm without collapse in the centre of the panel which is placed on four steel blocks. The panel will withstand and Uniformly Distributed Load (UDL) minimum 1250 kg/sqm and an impact load of 50kg all complete as per the approved manufacturers specification and as per the direction of Engineer-in-charge. All specification must be printed on the side of the panel to ensure the quality of the product.

Heat Resistant Tile :- Providing and fixing Heat Resistant Terrace Tiles (300 mm x 300 mm x 20 mm) with SRI (solar refractive index) > 78, solar reflection > 0.70 and initial emittance > 0.75 on waterproof and sloped surface of terrace, laid on 20 mm thick cement sand mortar in the ratio of 1:4 (1 cement : 4 coarse sand) and grouting the joints with mix of white cement & marble powder in ratio of 1:1, including rubbing and polishing of the surface upto 3 cuts complete, including providing skirting upto 150/300 mm height along the parapet walls in the same manner.

Stone With Epoxit Grout :- Providing & laying 25 mm thick sand blasted leather finish/polished Rajim/Kota/ Kadappa stone in areas as mentioned in drawing to the approved pattern as directed using 25 mm (nominal) thick stone slabs with machine cut edges (straight or raked as called for) of sizes 600x600mm. The stone shall be fixed as per detail specification below

(1) Cleaning the surface thoroughly with wire brush.(2) Applying bonding coat with neat cement slurry @ 2.75 kg/sqm on concrete/brick bat coba surface. (3) Fixing stones with cement paste @ 4.4 Kg/SqM over green finishing top coat 20 mm thick cement mortar 1:4 (1 cement : 4 coarse sand) of brick bat coba, keeping the joints 4 mm wide & 6 mm deep all-round for epoxy grouting complete including rubbing and polishing as directed by Engineer-in-Charge. The joint should be filled with approved quality anti-fungal epoxy grout of approved make, as per manufacturer specifications or as directed.

Skirting shall be with 20 mm thick stones over 12mm (average) thick CM 1:3 (1 cement: 3 coarse sand).

Tactile tile : Providing and laying tactile tile (for vision impaired persons as per standards) of size 300x300x9.8mm having with water absorption less than 0.5% and conforming to IS: 15622 of approved make in all colours and shades in for outdoor floors such as footpath, court yard, multi modals location etc., laid on 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per direction of Engineer-in-Charge

Phenol bonded Bamboowood flooring: Providing & fixing in position Phenol bonded Bamboowood flooring with planks of sizes 14mm thick, minimum 1800mm length and minimum 100 mm wide, in approved colour, texture and finish, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The flooring shall be fixed with tongue and groove interlocking system, with underlayment of 4mm thick expanded polyethylene foam sheets having density 40kg/cum, over prepared surface with necessary quarter round planks of size 1900mm x 18mm and door reducer of size 1900mm x 44mm, wherever required. The bamboowood planks shall have minimum density of 1000 Kg/cum & minimum Hardness 1000 Kgf. with Eco friendly UV coating, all complete as per direction of the Engineer in-charge.

Wash basin Counter: 18 mm thick gang saw cut mirror polished Granite stone (premoulded and prepolished) machine cut of required size of approved shade, colour and texture laid over 20mm thick base cement mortar 1:4 (1 cement: 4 coarse sand) with joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing moulding as per drawing and polishing to edge to give high gloss finish.

Wash basin fascia & drops: 18 mm thick gang saw cut mirror polished Granite stone (premoulded and prepolished) machine cut of required size of approved shade, colour and texture of width upto 150 mm fixed with epoxy resin based adhesive of approved make including cleaning.

Wash basin openings: Opening of required size & shape for wash basins platform, and similar location in marble/stone work including necessary holes for pillar taps etc. including rubbing and polishing of cut edges shall be provided & nothing extra to be paid for this account.

Mirrors : Mirror shall be 6 mm thick bevelled edge mirror of superior float glass (of approved quality) complete over 6 mm thick marine ply fixed to wooden cleats with stainless steel screws, washers and caps complete as per drawing or as directed by E-I-C.

Over Head Tanks: Internal floor & wall finish of Overhead Water Tanks / domestic / Fire / Flushing tanks shall be Acrylic Cementitious Modified two component waterproofing as per manufacturers specification finished with 300x300mm glazed Ceramic tiles over 12

mm thick bed of cement mortar 1:3 (1 Cement : 3 Course sand) and jointed with grey cement slurry @ 3.3 Kg per sqm including pointing in white cement mixed with pigment of matching shade. For detail refer GFC drawings.

Over Head tank top cover shall be 455 X 610 mm rectangular C.I. Cover with frame (light duty) including lockable arrangement, the total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg.) & rungs shall be orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS: 10910 on 12mm dia steel bar conforming to IS :1786 having minimum cross section as 23 mm x 25 mm and over all minimum length 263mm and width as 165mm with minimum 112mm space between protruded legs having 2mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138mm as per standard drawing or as per CPWD specification.

All work in general shall be carried out as per CPWD Specifications- 2019 - Vol.I& Vol. II with upto date correction slips.

Whenever flooring is to be done in patterns tiles/ stone, the contractor shall get samples of each pattern laid and approved by the Engineer-in-Charge before final laying of such flooring for which nothing extra shall be paid.

Different stones/ tiles used in pattern flooring as per the approved architectural drawings and nothing extra for laying pattern flooring shall be paid. No additional wastage if any shall be accounted for any extra payment.

The proper gradient shall be given to flooring for toilets, verandah, kitchen, court yard, etc. as per the directions of Engineer-in-Charge. For this there may be extra thickness of dry mortar below the tiles/stone slabs. These gradients should be insured in the shuttering itself for which nothing extra shall be paid.

One-piece stone for treads / risers in staircase shall be used and nothing extra shall be paid on this account.

FALSE CEILING

Materials shall be of the best-approved quality obtainable and they shall comply with the respective latest Standard Specifications. Samples of all materials shall be got approved before placing order and the approved sample shall be deposited with the Engineer in Charge, which will be displayed at site as a control sample.

In case of non-availability of materials in metric sizes, the nearest size in FPS units shall be provided with the prior approval of the E.I.C.

Materials shall be tested in any approved testing Laboratory and the test certificate in original shall be submitted to the Engineer-in-Charge.

All work to be done by Manufacturer's Authorized/Recommended/Trained Installer or as approved by Engineer-in-Charge.

Note:-Trap door/Inspection door of required size to be provided by contractor in false ceiling as per service requirement and approved shop drawing or as decided by EIC and door opening/closing should be smooth and robust for easy maintenance.

GYPSUM BOARD SINGLE LAYER FALSE CEILING

Providing and fixing 12.5 mm thick tapered edge gypsum plain board conforming to IS: 2095 false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound , jointing tapes , finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed (if any additional members required at cutouts shall be provided free of cost) all complete as per drawings, specification and direction of the Engineer in Charge including final finishing and painting as per GFC drawing.

GYPSUM BOARD DOUBLE LAYER FALSE CEILING

a. Material : Gypsum board Plain 12.5 mm thick which have gray face paper and brown reverse side paper suitable for most applications where Normal fire, Structural and Acoustic levels are specified. Applicable standard of the boards should be IS 2095 (Part 1):2011 (BIS Certified) and should have thermal conductivity and thermal resistance of 0.16 and 0.078 (w/m²K).The boards should have Taper edge along length of board and Square edge along width of board. Flexural breaking load of Gypsum board as per IS 2095 (Part 1):2011 is 180 N in Transverse Direction and 500 N in Longitudinal Direction. Ceiling is in 2 layers with staggered joints.

b. Frame work :- Providing and fixing of frame work made of special/seratted sections, power pressed from M.S. sheets and galvanized with zinc coating of minimum 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 900 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate

G.I. channels 45x15x0.9 mm running at the spacing of 900 mm centre to centre to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction Perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of double layer of 12.5mm tapered edge Gypsum board Plain (conforming to IS 2095-Part 1:2011, BIS Certified board) is then screw fixed to ceiling section with 25mm drywall screws for first layer and 35 mm drywall screws for second layer at 230mm centres on ceiling section & 150mm at periphery of ceiling including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound, jointing tapes, with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed (if any additional members required at cutouts shall be provided free of cost) all complete as per drawings, specification and direction of the Engineer in Charge including painting as per GFC drawing.

ALUMINIUM TILE FALSE CEILING

1. LAY-IN PLAIN TILE ALUMINIUM FALSE CEILING

a. Material: Aluminium metal ceiling consisting of 600 mm X 600 mm / 600 mm x 1200 mm Aluminium Lay-in plain tiles in 0.7 mm thickness. The tile shall be Powder coated minimum 60microns in the manufacture's standard colour shades, with Microlook edges and flanges, produced on advanced equipment, which includes several levelling stages in the manufacturing process. The tiles should have Fire Performance of Class 0/Class 1 as per BS476 Part 6 & 7 standard in module size of 600 mm X 600 mm / 600 mm x 1200 mm

2. LAY-IN PERFORATED TILE ALUMINIUM FALSE CEILING

a. Material: Aluminium Metal Ceilings system Microlook, Micro Perforated (having 1.8 mm diameter holes & 20 % open area) consisting of 600 mm X 600 mm / 600 mm x 1200 mm Lay in tiles in 0.7 mm thick Aluminum pre coated to Global white color with Acoustical fleece of approved make hot pressed on the back of the perforated tile. The tile shall be Powder coated minimum 60 to 80microns in the manufacture's standard colour shades.

The tiles would have NRC of 0.70. The tiles would have Fire Performance of Class 0/Class 1 as per BS476 Part 6 & 7 standard in module size of 600 mm X 600 mm / 600 mm x 1200 mm.

3. LAY-IN PERFORATED TILE ALUMINIUM FALSE CEILING WITH 50 MM THICK FIBRE GLASS WOOL

a. Material : Aluminium Metal Ceilings system Microlook, Micro Perforated (having 1.8 mm diameter holes & 20 % open area) consisting of 600 mm X 600 mm / 600 mm x 1200 mm

Lay in tiles in 0.7 mm thick Aluminum pre coated to Global white color with Acoustical fleece of soundtex or equivalent make hot pressed on the back of the perforated tile to achieve NRC upto 0.7 & 50 mm thick Resin Bonded Fibre glass wool conforming to IS : 8183, density 24kg / m³ & NRC upto 1.0, wrapped in 40 to 45 GSM Fibre glass tissue laid over perforated tile. The tile shall be Powder coated minimum 60 to 80microns in the manufacture's standard colour shades. The tiles would have Fire Performance of Class 0 / Class 1 as per BS476 Part 6 & 7 standard in module size of 600 mm X 600 mm / 600 mm x 1200 mm

Frame work & Installation : - All tiles to be installed on a standard 600 mm X 600 mm / 600 mm x 1200 mm module 15mm table exposed metal grid. Grid system to be designed to satisfy ASTM C635 loading and deflection criteria. The main and cross runners to be provided with beyonet coupling for quick installation and shall have a height of 38mm.

The tile false ceiling suspended on inter locking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 15 x 38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross "T" of size 15 x 38 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main "T" at 600 mm center to center to form a grid of 1200x600 mm and secondary cross "T" of length 600 mm and size 15 x 38 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 19x19x0.3 mm and laying false ceiling tiles of approved texture in the grid including, required cutting / making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Main "T" runners to be suspended from ceiling using M6 Anchor Fasteners with hanger hole, pre Straightened Hanger wire of dia. 2.5 mm of 1.80 m length having a tensile strength of 344-413 MPa and a minimum pull strength of 110 kgs. Adjustable hook clips of 0.7mm thick, galvanized spring steel can also be used for installation purpose as an additional accessory. The adjustable clip also consists of a 4 mm aquiline wire to be used with the main runner.

The first/last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall. Bottom exposed width of 15 mm of all T-sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by Engineer-in-charge

Finally the tiles shall be laid in place from below into the standard grid. In case of end tiles lesser than 600mm, use lay-in end cap / edge profile for installation to have a Microlook effect on perimeters. This system also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channel suitably fixed all complete as per drawing and specification and direction of the Engineer-in-charge.

CLIP-IN PLAIN TILE ALUMINIUM FALSE CEILING

Material: Providing & fixing true horizontal level suspended ceiling comprising of Aluminum Clip-in plain tiles with double clip self-leveling feature and special tabs to allow removal of tile to enable plenum access with plain visual consisting of 600 mm X 600 mm / 600 mm x 1200 mm clip in tiles of 0.7mm thick Aluminum with bevel edge in Global white

color. The tile shall be Powder coated 60-80 microns in the manufacture's standard colour shades. The tiles would have Fire Performance of Class 0/Class 1 as per BS476 Part 6 & 7 standard in module size of 600 mm X 600 mm / 600 mm x 1200 mm

b. Frame work & Installation: Frame work includes providing and fixing 'C' wall angle of size 20x30x20 mm made of 0.5 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive). Cut tiles to be secured to the wall angles using a spring clamp procedure. Installation to be carried out by company trained Installation team & Installation should be carried out as per manufacturer specification & recommendation.

8 MM THICK CALCIUM SILICATE BOARD FALSE CEILING

Providing & fixing 8 mm thick Calcium Silicate Board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process false ceiling at all height including providing & fixing of framework made of special section, power pressed from M.S. sheets and galvanised with zinc coating of 120 gms/ sqm (both side inclusive) as per IS : 277 and consisting of angle cleat of size 25mm wide x 1.6mm thick with flanges of 27mm and 37mm, at 1200mm c/c, one flange fixed to the ceiling with dash fastener 12.5mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25 x10 x0.50mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I channels 45 x15 x 0.90mm running at the spacing of 1200 mm c/c, to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26 mm each having lips of 10.5mm, at 450mm c/c, shall be fixed in a direction perpendicular to G.I intermediate channel with connecting clip made out of 2.64mm dia x 230mm long G.I wire at every junction, including fixing perimeter channels 0.50mm thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/ partitions with the help of Rawl plugs at 450mm centre, with 25mm long dry wall screws @ 230mm interval, including fixing of Calcium Silicate Board to ceiling section and perimeter channels with the help of dry wall screws of size 3.5 x25mm at 230mm c/c, including jointing & finishing to a flush finish of tapered and square edges of the board with recommended jointing compounds, jointing tapes, finishing with jointing compounds in three layers covering up to 150mm on both sides of joints and two coats of primer suitable for boards, all as per manufacture's specification and also including the cost of making opening for light fittings, grills, diffusers, cut outs made with frame of perimeter channels suitably fixed, (if any additional members required at cutouts shall be provided free of cost) all complete as per drawings, specification and direction of the Engineer in charge including final finishing and painting as per GFC drawing.

GI CLIP IN METAL CEILING

GI Clip in Metal Ceiling System of 600x600 mm module which includes providing and fixing 'C' wall angle of size 20x30x20 mm made of 0.5 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive), fixing with clip in tiles into spring T with : GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5 mm thick with 25 mm height, made of G I sheet having galvanizing of 100 gms/sqm (both sides inclusive) and 20% perforation area with 1.8 mm dia holes and having NRC of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation.

MINERAL FIBRE FALSE CEILING TILES

Mineral fibre false ceiling tiles at all heights of size 595X595mm of approved texture, design and pattern with 20 mm thick beveled tegular mineral fibre false ceiling tile (NRC 0.7). The tiles should have Humidity Resistance (RH) of 99%, Light Reflectance? 85%, Thermal Conductivity $k = 0.052 - 0.057 \text{ w/m K}$, Fire Performance as per (BS 476 pt - 6 & 7) in true horizontal level suspended on interlocking T-Grid of hot dipped all round galvanized iron section of 0.33 mm thick (galvanized @120 gsm) comprising of main T runners of 15x32 mm of length 3000 mm, cross T of size 15x32mm of length 1200 mm and secondary intermediate cross T of size 15x32 mm of length 600 mm to form grid module of size 600x600 mm suspended from ceiling using galvanized mild steel item (galvanised@80gsm) 50 mm long 8mm outer diameter M-6 dash fasteners, 6 mm diameter fully threaded hanger rod up to 1000 mm length and L-shape level adjuster of size 85x25x2 mm, spaced at 1200 mm centre to centre along main "T". The system should rest on periphery walls /partitions with the help of GI perimeter wall angle of size 24x24X3000 mm made of 0.40 mm thick sheet, to be fixed to the wall with help of plastic rawl plug at 450 mm centre to centre & 40 mm long dry wall S.S. screws. The exposed bottom portion of all T-sections used in false ceiling support system shall be pre-painted with polyester baked paint, for all heights. The work shall be carried out as per specifications, drawings and as per directions of the engineer-in-charge.

WATER PROOFING

Different types of waterproofing treatment mentioned below to be executed by contractor at locations mentioned in GFC Drawing of various buildings.

ACRYLIC CEMENTITIOUS MODIFIED TWO COMPONENT WATERPROOFING :

Providing and applying waterproofing treatment to the sunken slabs, Balconies or other location as per GFC drawing, including cleaning of surface to remove dust, loose particles, etc with compressed air or any other suitable technique depending on site conditions, grinding any sharp edges, etc as per the instructions of Engineer in charge and post cleaning applying a two component acrylic modified cementitious coating system at a total consumption of 1.8 to 2 Kgs/Sqm in two coats complete as per manufacturers specification or as directed by E.I.C..

The waterproofing system should exhibit the following properties: density: 1.5 to 2 kg/ltr, Elongation at break (ASTM D412): 200 to 250%, Crack resistance at 20 degree centigrade > 2 mm

All corners in sunkens must be sealed a SealTape S, an elastic waterproof sealing tape with a woven bonding mesh on each surface and an elastic expansion zone in the center. The waterproofing should be taken to a height of 300 mm in the vertical.

The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee against any leakage.

BRICK BAT COBA WATERPROOFING TREATMENT

Providing and laying integral cement-based brick bat coba waterproofing treatment to required slope / gradient as per drawing with average thickness of 120mm or can be increased as per site requirement and minimum thickness at khurra as 65 mm as per CPWD specification including preparation of surface as required for treatment of roofs, balconies, terraces etc. consisting of following operations:

- a) Applying a slurry coat of neat cement using 2.75 kg/sqm. of cement admixed with water proofing compound conforming to IS:2645 and approved by Engineer-in-charge over the RCC slab including adjoining walls upto 300mm height including cleaning the surface before treatment.
- b) Laying brick bats with mortar using broken bricks/brick bats 25mm to 115 mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with water proofing compound conforming to IS:2645 and approved by Engineer-in-charge over 20mm thick layer of cement mortar of mix 1:5 (1 cement: 5 coarse sand) admixed with water proofing compound conforming to IS:2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs.
- c) After two days of proper curing applying a second coat of cement slurry using 2.75 kg/sqm of cement admixed with water proofing compound conforming to IS:2645 and approved by Engineer-in-charge.
- d) Finishing the surface with 20mm thick jointless cement mortar of mix 1:4 (1 cement :4 coarse sand) admixed with water proofing compound conforming to IS:2645 and

approved by Engineer-in-charge including laying glass fibre cloth of approved quality in top layer of plaster and finally finishing the surface with trowel with neat cement slurry and making of 300 X 300 mm square 3mm deep.

- e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge.

BRICK BAT COBA WATER PROOFING TREATMENT WITH ROOF INSULATION

Providing and laying Water proofing treatment & roof insulation including preparation of surface as required for treatment of roofs, balconies, terraces etc. consisting of following operations:

1. Cleaning all the surface area to remove loose particles such as mortar, dust etc., with wire brush & air blower complete in all respect as per the direction of Engineer-in-Charge.
2. Providing & laying thermal insulation with 50mm thick extruded polystyrene having closed cell structure, ideal for insulation of roofs. XPS should have density of 32-35 Kg/cum (EN 1602), compressive strength of 300 KPa (as per EN 826); Resistance to Fire of "E" Class; Water Absorption of <0.7% (as per EN 12087); Thermal resistance of 1.5 sqm.KW; Thermal Conductivity of 0.029- 0.034 W/m-k (as per EN 12667) and should be laid directly over the mother slab, spot stuck using cold bitumen as per manufacturer specification
3. Over extruded polystyrene providing and fixing of anti-punching and vapor diffusion layer made of a geotextile felt NT fibers of polypropylene is 100% pure, thermotreated, needlepunched, resistant microorganisms, weight > 200 gr /sqm.
4. For Terrace : Over geotextile felt providing and fixing 1.5mm mechanically fastened polyvinyl chloride (PVC-P) roof membrane. PVC membrane shall be reinforced with glass fibre of 50g/sqm and should have minimum roll size of 1.6m x 20m rolls) to minimize joints & shall be asbestos free. It should be mechanically fixed around the perimeter with a pre-drilled bar on the horizontal or vertical surface at the base of the upstand as per manufacturer specification. Roof Membrane should be overlapped with minimum 100 mm lap and seamed using hot air heat welding equipment.

For Parapet / wall : Over geotextile felt providing and fixing 1.5mm (60 mil) mechanically fastened polyvinyl chloride (PVC-P) by using metal perimeter profile on vertical wall /parapet. The PVC membrane is welded with Leister hot air gun over the entire length of the PVC metal Sheet. The overlaps for vertical section to be minimum 100 mm, to be sealed using hot air gun.

PVC membrane shall have following minimum properties , (i) Thickness : 1.5mm as per EN 1849-2, (ii) Tensile Strength > 9 N/sqmm as per EN 12311-2, met B (iii) Elongation

of > 200% as per en 12311-2, met B (iv) Tear Resistance > 135 N as per EN 12310-2, and Cold bending of minimum < -25 deg as per EN 495-5.

5. Over PVC membrane providing separation layer with laying polyester geo textile of minimum 150 gsm.. Geotextile separation layer should have weight of minimum 150 gsm ; static puncture resistance of > 250N; Dynamic punsture resistance of 40MM; and should be laid over the entire area before laying Brickbat coba / screed to slope as per DSR 2023 item no. 22.7.
6. The entire treatment will be taken upto 30 cm on parapet wall or upto parapet projection as per manufacturer's specification.
7. The above mentioned waterproofing treatment & insulation finally covered with brick bat coba waterproofing treatment to required slope / gradient as per drawing with average thickness of 120mm or more as per site requirement and minimum thickness at khurra as 65 mm as per CPWD specification including final finishing layer i.e layer of plaster with trowel with neat cement slurry and making of 300 X 300 mm squares 3 mm deep groove or heat resistant tiles / stone flooring, whichever is given in GFC drawing.

Note: - A layer of PCC or Cement concrete screed is not mentioned in above treatment but to be provided if mentioned in GFC drawing.

This specification covers waterproofing & insulation of concrete roof using XPS insulation & PVC waterproofing Membrane. The sheets are welded together by applying hot air or using hot wedge, with manual or automatic welder.

The work shall be executed with the best modern practices, special instruction of the material manufacturer and to the complete satisfaction of the Engineer.

Library & Data Center: for usable roofs, balconies etc as per GFC drawing

A. Water proofing treatment without insulation

1. Cleaning all the surface area to remove loose particles such as mortar, dust etc., with wire brush & air blower complete in all respect as per the direction of Engineer-in-Charge.
2. Separation Layer: Providing and laying 500 GSM Polypropylene Geotextile on the Surface with 100mm overlap. Geotextile shall be non-woven needle punctured on both sides made of 100% virgin and high tenacity polypropylene short fibres. Having high

tenacity, High resistance to alkalinity and inert towards the various chemical elements present in the soil. And High puncture resistance. Geotextile shall have following properties: Static Puncture Resistance: 7900N; Tensile Strength (DM/DT) : 35/46 KN/m; Elongation (DM/DT) : 75/80%.

3. Waterproofing Membrane: Synthetic membrane manufactured in Thermo Plastic Olefin (TPO), double colour sand-grey (signal layer)/black, obtained by co-extrusion, reinforced by a polyester mesh. The upper sand grey layer is featured by a very high resistance to weather and UV rays, while the underlying black layer is punching resistant.

TPO membrane shall be asbestos free, and should exceed /meet specifications of EN 13956:2012. TPO Roof Membrane shall accept roof movement and thermal shock, loosely laid on the geotextile. TPO Roof Membrane should be lapped and seamed using hot air heat welding equipment with an overlap of 80mm. TPO membrane shall have following minimum properties, (i) Thickness : 1.5 mm membrane system as per EN 1849-2 with -5% & +10% tolerances as per EN 13956. (ii) Tensile strength ≥ 1100 N/5cm as per EN 12311-2; (iii) Tear Resistance ≥ 300 N as per EN 12310-2; (iv) Resistance to impact ≥ 800 mm as per EN 12691; (v) Cold bending of minimum ≤ -40 deg as per EN 495-5; (v) Fire classification – Class E as per EN 13501-1 & EN ISO 11925-2, (vi) Static Puncture Resistance ≥ 20 kg as per EN 12730.

4. Separation Layer: Over waterproofing membrane providing and laying 500 GSM Polypropylene Geotextile on the Surface with 100mm overlap. Geotextile is a high tenacity non-woven needle punctured on both sides made of 100% virgin and high tenacity polypropylene short fibres. Having high tenacity, High resistance to alkalinity and inert towards the various chemical elements present in the soil. and High puncture resistance. Geotextile shall have following properties: Static Puncture Resistance: 7900N; Tensile Strength (DM/DT): 35/46 KN/m; Elongation (DM/DT): 75/80%

The entire treatment will be taken upto 30 cm on parapet wall or upto parapet projection as per manufacturer specification.

B. Water proofing treatment with insulation

1. Cleaning all the surface area to remove loose particles such as mortar, dust etc., with wire brush & air blower complete in all respect as per the direction of Engineer-in-Charge.

2. Providing & laying thermal insulation with 50mm thick extruded polystyrene having closed cell structure, ideal for insulation of roofs. XPS should have density of 32-35 Kg/cum (EN 1602), compressive strength of 300 KPa (as per EN 826) ; Resistance to Fire of "E" Class; Water Absorption of $<0.7\%$ (as per EN 12087) ; Thermal resistance of 1.5 sqm.KW; Thermal Conductivity of 0.029- 0.034 W/m-k (as per EN 12667) and should be laid directly over the mother slab, spot stuck using cold bitumen as per manufacturer specification

3. Separation Layer : Over extruded polystyrene providing and laying 500 GSM Polypropylene Geotextile on the Surface with 100mm overlap. Geotextile shall be non-woven needle punctured on both sides made of 100% virgin and high tenacity polypropylene short fibres. Having high tenacity, High resistance to alkalinity and inert towards the various chemical elements present in the soil. and High puncture resistance.

Geotextile shall have following properties: Static Puncture Resistance : 7900N; Tensile Strength (DM/DT) : 35/46 KN/m; Elongation (DM/DT) : 75/80%.

4. Waterproofing Membrane: Over geotextile felt providing and fixing Synthetic roof membrane as per specification. Synthetic membrane manufactured in Thermo Plastic Olefin (TPO), double colour sand-grey (signal layer)/black, obtained by co-extrusion, reinforced by a polyester mesh. The upper sand grey layer is featured by a very high resistance to weather and UV rays, while the underlying black layer is punching resistant.

TPO membrane shall be asbestos free, and should exceed /meet specifications of EN 13956:2012. TPO Roof Membrane shall accept roof movement and thermal shock, loosely laid on the geotextile. TPO Roof Membrane should be lapped and seamed using hot air heat welding equipment with an overlap of 80mm. TPO membrane shall be asbestos free, and should have CE marking and BBA approved with life expectancy in excess of 30 years. TPO membrane shall have following minimum properties , (i) Thickness : 1.5 mm membrane system as per EN 1849-2 with -5% & +10% tolerances as per EN 13956. (ii) Tensile strength ≥ 1100 N/5cm as per EN 12311-2; (iii) Tear Resistance ≥ 300 N as per EN 12310-2; (iv) Resistance to impact ≥ 800 mm as per EN 12691; (v) Cold bending of minimum ≤ -40 deg as per EN 495-5; (v) Fire classification – Class E as per EN 13501-1 & EN ISO 11925-2, (vi) Static Puncture Resistance ≥ 20 kg as per EN 12730.

5. Separation Layer: Over waterproofing membrane providing and laying 500 GSM Polypropylene Geotextile on the Surface with 100mm overlap. Geotextile is a high tenacity non-woven needle punctured on both sides made of 100% virgin and high tenacity polypropylene short fibres. Having high tenacity, High resistance to alkalinity and inert towards the various chemical elements present in the soil. and High puncture resistance. Geotextile shall have following properties: Static Puncture Resistance : 7900N; Tensile Strength (DM/DT) : 35/46 KN/m; Elongation (DM/DT) : 75/80%

The entire treatment will be taken upto 30 cm on parapet wall or upto parapet projection (except insulation) as per manufacturer specification.

WATER PROOFING TREATMENT FOR ACCESS CORRIDOR

Providing and applying roof waterproofing with single component pitch modified polyurethane at 1.3mm thickness cures by reaction with atmospheric moisture to give a tough elastomeric waterproof membrane.

Standard compliance: Single component pitch modified polyurethane at 1.3mm thickness meets the requirements of ASTM C836-84

Technical properties:

- | | | |
|---|--------------------------|------------------|
| 1 | Elongation (ASTM D412) : | >600% |
| 2 | Specific gravity : | 1.5 to 1.55 g/cc |

3	Tensile strength : (ASTM D412)	1.5 N/mm ²
4	Modulus @ 100% elongation (ASTM D412)	0.62 N/mm ²
5	Tear resistance (ASTM D624)	15 N
6	Water vapour transmission for 1.3mm film (ASTM E96)	9.7 g/m ² /24 hrs
7	Permeability (ASTM E96)	0.063 ng/m/sec/Pa*

Chemical properties: Unaffected by a range of mild acids, alkalis and water borne salts and is resistant to biodeterioration.

Instructions for use

Preparation: All surfaces to be waterproofed should be sound, clean and dry.

Concrete surfaces should have a light steel-trowel followed by a fine hair-broom or equivalent finish which is dry and free of dust, oil and other contaminants. All high spots should be removed.

All metal surfaces should be made clean of paint, oils, rust and other contaminants.

Priming: Priming is not normally required on good quality concrete substrates. However, absorbent surfaces such as porous concrete, sand/cement and cement boards will require sealing (as per manufacturers specification) to prevent absorption of polyurethane waterproofing.

Cracks: All shrinkage and non-moving structural cracks should be pretreated with not less than a 1.3mm coating of polyurethane extending 75mm either side of the crack. Allow to cure overnight before general application.

Application: Single component pitch modified polyurethane should be applied by brush, trowel, squeegee or airless spray (two coat application for standard grade on vertical surfaces) at a minimum wet film thickness of 1.3mm (1.3 litre/m²).

If a water test is to be run, the membrane should be fully cured.

Flood test: Prior to placement of protection, flood to a minimum depth of 50mm of water for 24 hours. Drains shall be plugged and barriers placed to contain the water.

Curing and protection: Polyurethane membrane waterproofing must be cured for a minimum of 24 hours @ 25°C before placing protection. Where damage to the membrane is possible (by traffic, backfilling, etc) it should be protected by a cementitious screed or protection boards.

For vertical surface: The entire treatment will be taken upto 30 cm on parapet wall or upto parapet projection as per manufacturer's specification.

WATER PROOFING TREATMENT FOR “BASEMENT”

Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fiber brush. The material shall meet the requirements as specified in ACI-212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50 mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage.

For Horizontal Surface: one coat @1.10 kg per sqm.

For Vertical surface : two coats @ 0.70 kg per sqm.

WATER PROOFING TREATMENT FOR “UNDERGROUND TANK”

For Horizontal Surface: Integral cement based treatment for water proofing on horizontal surface at all depth below ground level for under ground structures as directed by Engineer-in-Charge and consisting of:

- (i) 1st layer of 22 mm to 25 mm thick approved and specified rough stone slab over a 25 mm thick base of cement mortar 1:3 (1 cement: 3 coarse sand) mixed with water proofing compound conforming to IS:2645 in the recommended proportion over the leveling coarse (leveling coarse to be paid separately). Joints sealed and grouted with cement slurry mixed with water proofing compound.
- (ii) 2nd layer of 25 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) mixed with water proofing compound in recommended proportions.
- (iii) Finishing top with stone aggregate of 10 mm to 12 mm nominal size spreading @ 8 cum/sqm thoroughly embedded in the 2nd layer.

For Vertical surface : Integral cement based treatment for water proofing on the vertical surface by fixing approved and specified rough Kota stone slab 22 mm to 25 mm thick with cement slurry mixed with water proofing compound conforming to IS:2645 in recommended proportions with a gap of 20 mm (minimum) between stone slabs and the receiving surfaces and filling the gaps with neat cement slurry mixed with water proofing compound and finishing the exterior of stone slab with cement mortar 1:3 (1 cement : 3 coarse sand) 20 mm thick with neat cement punning mixed with water proofing compound in recommended proportion complete at all levels and as directed by Engineer-in-charge.

WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCS. BATHROOM

Providing and laying water proofing treatment in sunken portion of WCs, bathroom etc., by applying cement slurry mixed with water proofing cement compound consisting of applying :

- (a) First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.
- (b) Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours.

FIBRE REINFORCED ELASTOMERIC LIQUID WATER PROOFING

Providing and applying fibre reinforced elastomeric liquid water proofing membrane with resilient acrylic polymers having Sun Reflectivity Index (SRI) of 105 on top of concrete roof in three coats @10.76 litre/ 10 sqm. One coat of self-priming of elastomeric waterproofing liquid (dilution with water in the ratio of 3:1) and two coats of undiluted elastomeric waterproofing liquid (dry film thickness of complete application/system not less than 500 microns). The operation shall be carried out after scrapping and properly cleaning the surface to remove loose particles with wire brushes, complete in all respect as per the direction of Engineer-in-Charge.

WATER PROOFING TREATMENT FOR WATER TREATMENT PLANT BUILDING

Water proofing to be done at locations as shown in GFC Drawing.

For Horizontal Surface: Horizontal water proofing shall be 1.2mm thick self-adhesive HDPE membrane conforming to IS 16471 Type I standard for below ground structures having the following technical properties-

Puncture resistance 1000 N ((\pm 5 to 10%)as per ASTM E 154

Tensile strength of 25 Mpa as per ASTM D412

Elongation	of	500%	as	per	ASTM	D	412
Peel	adhesion	to	concrete	880N/m	as	per	ASTM D 903

45 Days UV Exposure test-Pass.

The system should be fully bonded to the RCC and consists of highly resilient HDPE layer, a pressure sensitive adhesive layer which is covered by a weather proof protective layer. The membrane shall have minimum of 100 mm laps which shall be sealed with double sided adhesive tape. The size of the membrane should not be less than 3 Mtr. x 20 Mtr. to minimize the joints.

All vertical surfaces will be fixed using prefixed gaskets etc. complete as per manufactures specification with 10 years guarantee for waterproofing performance (against leakage, seepage etc) to be given by the principal manufacturer / main supplier for both supply and application.

For Vertical Surface: Horizontal water proofing shall be minimum 1.5 mm thick SBS modified self-adhesive waterproofing membrane topped with impervious, non-perforated HDPE valeron film, for use in retaining walls, confirming to the requirements of ASTM D5147 for thickness with a puncture resistance of >200 N as per ASTM E154. The vital physical and chemical parameters of the membrane shall be as under:

Tensile strength in (L/T) as min 4 N /mm² (as per ASTM D882),

Tear resistance as min 150 N/mm (as per ASTM D 4073),

Peel Strength to concrete as min 2.2 N/mm as per ASTM C 794

Elongation (L/T) % - L -250-300,T- 250-350 (as per ASTM D 882),

Softening point of membrane not less than 105°C (as per IS 1205/1978),

Cold flexibility shall be upto -10°C when tested in accordance with ASTM D 5147

Crack bridging ability - min 1.5mm as per ASTM C 836

The application include cleaning the surface, priming the surface with cold applied bituminous primer, laying the membrane, rolling, properly sealing the joints & maintaining 75 mm overlap between the membrane selvedge & min 100 mm overlap on the end joints of the membrane over the slab etc.. complete. HDPE Dimple Protection board 8MM shall be spot bonded on retaining wall before backfilling as per manufacturers specification.

Grading roof for water proofing treatment should be given wherever mention in GFC Drawing

Cement concrete screed 1:2:4 (1 cement : 2 coarse sand : 4graded stone aggregate 20 mm nominal size) to required slope / gradient & thickness as per GFC drawing mixed with water proofing compound conforming to IS:2645 as per manufacturers specification finishing the surface rough to take required flooring over it.

Planters : All Planters floor & wall finish shall be root Resistant Single or Two Component Brush Applied 90% to 100% Polyurethane waterproofing as per manufacturers specification followed by 15 mm thick water proofing plaster cement mortar 1:3 (1

Cement : 3 Coarse sand) admixed with water proofing compound conforming to IS:2645 as per manufacturers specification & drain board. For detail refer GFC drawings.

Providing and applying waterproofing treatment to the planters including cleaning of surface to remove dust, loose particles, etc with compressed air or any other suitable technique depending on site conditions, grinding any sharp edges, etc as per the instructions of Engineer in charge and post cleaning applying primer over the prepared surface a two part epoxy primer applied at a total consumption rate of 0.25 Kgs/ Sqm broadcasted with quartz sand at a consumption of 0.8-1.0 kgs/Sqm for keying effect. Providing and applying 90% to 100% Solids, Root Resistant, single or two component solvent free cold applied, polyurethane coating waterproofing system at a total consumption rate of 1.2 to 1.5 Kgs/Sqm for 1.2 mm thickness applied in two coats. The waterproofing system should have following system properties. Tensile strength > 2 N/mm² Elongation at break ~ 400%; Abrasion Resistance < 30mg (ASTM D 4060) Shore A Hardness 60 to 75 ; Application By Roller, Squeeze or Brush.

Lift Pits, Toilet sunken floor , skylight top slab & Gutters : Lift Pits, Toilet sunken floor & Gutters floor & wall finish shall be acrylic cementitious modified two component waterproofing as per manufacturers specification followed by 15 mm thick water proofing plaster cement mortar 1:3 (1 Cement : 3 Coarse sand) admixed with water proofing compound conforming to IS:2645 as per manufacturers specification & drain board. For detail refer GFC drawings.

Cantilever Terraces except Library & Data Center / tertiary pump room terrace: Terrace floor & parapet wall finish shall be acrylic cementitious modified two component waterproofing as per manufacturers specification followed by Brick bat coba waterproofing treatment to required slope/gradient as per drawing& CPWD specification. For detail refer GFC drawings.

Balcony except Library & Data Center : Balcony floor & side treated with acrylic cementitious modified two component waterproofing as per manufacturers specification followed by brick bat coba waterproofing treatment to required slope/gradient as per drawing with average thickness of 120mm and minimum thickness at khurra as 65 mm as per CPWD specification. Finally all balconies finished with 25 mm thick sand blasted leather finish Rajim or Kadappa stone over 20mm (average) thick base mortar of 1:4. Skirting shall be with 20 mm thick stones over 12mm (average) thick CM 1:3 (1 cement: 3 coarse sand) keeping the joints 4 mm wide & 6 mm deep around & filled with approved quality epoxy grout as per manufacturers specification. For detail refer GFC drawings.

Mumty Slab, Machine room slab & overhead tank, underground tank & Water treatment plant tanks top slab: Mumty Slab, Machine room slab & overhead tank,

underground tank & Water treatment plant tanks top slab shall be finished with Brick bat coba waterproofing treatment or as shown in GFC drawing

Parapet Plaster; All parapets inside surface above the waterproofing treatment shall be treated with plaster / paint as per architectural GFC drawing.

Drainboard to be provided wherever mention in GFC Drawing

Providing & laying rolled matrix soil filter cum drainage system of minimum 7-8mm thickness having a compressive strength of > 240 KN/sqm of 8mm height with geotextile on top, as per manufacturers specification, complete as directed.

KHURRA: Making khurras 45cm x 45cm with average minimum thickness of 5cm cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20mm nominal size) finished with 12mm cement plaster 1:3 (1 cement: 3 coarse sand) and a coat of neat cement rounding the edges and making and finishing the outlet complete as per GFC drawing or as directed by E-I-C.

INTERNAL FINISHING

All paint finishing 1st quality material should have VOC (Volatile Organic Compound) content less than 50 grams / litre of approved brand, manufacture, colour and shade. Unless otherwise mentioned the consumption of all Paints/Primers & Chemicals shall be as per CPWD DSR/DAR 2018/CPWD Specifications.

All painting material shall brought to the site of work in the original sealed containers. The material brought to the site of work shall be sufficient for at least 30 days of work. The material shall be kept under the joint custody of contractor and representative of the Engineer-in-Charge.

All internal ceilings shall be plastered with 6 mm cement plaster of mix 1:3 (1 cement : 3 fine sand) except ceiling above false ceiling & exposed RCC finish ceiling as shown in GFC drawings. No plastering shall be done at Ceiling covered with false ceiling.

All junctions of concrete and masonry work and other locations shall be provided with approved galvanized chicken wire mesh (24 gauge 12mm size) fixing in position with galvanized wire nails as per specifications. Providing grooves of necessary size at the junctions as per architectural drawing.

Painting & finishing : All internal walls & all internal Ceiling areas (other than false ceilings) as per schedule of finishes shown in architectural GFC drawings, with premium

acrylic emulsion paint of interior grade two or more coats on new work including priming coat to achieve even colour and shade or Acrylic Distemper two or more coats on new work including priming coat to achieve even colour and shade including applying additional coats wherever required to achieve even shade and colour. The painting work commencing after base preparation by white cement based putty (1mm) of approved brand and manufacture over plaster for even and smooth surface.

All staircase walls as per schedule of finishes shown in architectural GFC drawings, shall be finished with three coats (first two coats are with brush and final coat is with roller) of Satin or Matt enamel paint of approved make, desired shade, brand and manufacture, at all heights & levels, to give an even shade, including thoroughly brushing the surface free from mortar droppings and other foreign matter and sand papering smooth. The paint shall be applied after applying a coat of primer of approved brand and preparation of base surface using plaster of paris putty / white cement putty / etc. as applicable or as per manufacturer's specification or as directed by E-I-C..

All service shaft shall be finished with 15 mm thick water proofing plaster in cement mortar 1:3 (1 Cement : 3 Course sand) admixed with water proofing compound conforming to IS:2645 as per manufacturers specification & cement paint over water thinnable cement primer as per specifications . All lift well shall be finished with 12 mm thick cement plaster (1:6) & cement paint over water thinnable cement primer as per specifications.

The painting work commencing after base preparation by white cement based putty (1mm) of approved brand and manufacture over plaster for even and smooth surface.

Wood works (frame, Beading, lipping, etc.) shall be finished with French spirit polish as per specifications and direction of E-I-C wherever required.

MS and MS structural works at all levels shall be finished with acrylic polyurethane paint over two coats of Surface Tolerant Epoxy primer after surface preparation as per given specification.

EXTERNAL FINISHING

There are 4 types of External finishing coming in any building namely Stone wall cladding, Exposed Aggregate plaster, External paint and Exposed RCC Surface.

1. EXPOSED RCC SURFACE

All Exposed RCC surface shall be treated with transparent silicone based water repellent coating conforming to BS: 6477-1984 in 2 coats with a consumption as per the manufacturers specification or direction of E-I-C.

2. EXTERIOR PAINT

External surfaces shall be finished with exterior grade acrylic paint if given in drawing at locations specified in the Elevation drawings.

3. EXPOSED AGGREGATE PLASTER

30mm thick exposed aggregate plaster shall be finish in two coats at all levels / height and on all masonry and concrete elements including scaffolding, curing etc. complete as per specifications or as per architectural drawings. All Exposed aggregate plaster shall be treated with transparent silicone based water repellent coating.

A Sample / Mockup shall be prepared for approval prior to start the work.

HIGH PRESSURE LAMINATES:

Must be 06 mm thick, single/both side decorative, EN 438- Part 6 complying, high pressure laminate panels, which are manufactured by high pressure and temperature in a hot press. The core of the panel consist of desired numbers of imported, long fibre virgin kraft papers, impregnated with specially formulated double hardened Phenolic resin and another top layer of imported virgin Blue wool scale passed, decorative paper layer impregnated with Melamine resin. The panels must be flame retardant type class 1 as per BS: 476 Part 7, ASTM E84 and EN 438- Part 6. Poly-methyl methacrylate UV protecting films must be provided at the top of the Deco layer for optimum UV protection (passes 1500 hours). Panels have a tested Flexural Modulus of $\geq 11,000$ MPa and Flexural strength of ≥ 100 MPa which makes the product enormously sturdy from inside. This product must shows no distortion in extreme climatic changes such as from -20°C to $+80^{\circ}\text{C}$ or from dry climate to a relative humidity in excess of 85% – 90%. Panels must be equipped with a maximum possible weather resistance at extreme oceanic climates as it has duly passed the salt spray test conducted for 500 hours and pass a 3000 hours artificial weathering and are rated with a 5 for Gray scale rating:

1. 1200X2400 DECORATIVE ANTI VIRAL/ ANTI BACTERIAL /LAMINATE FOR VERTICAL AND HORIZONTAL SURFACE USES (SUEDE FINISH):

1.0mm (1mm +) thick Greenlam or equivalent High Pressure Decorative Laminates (conforming to latest and applicable IS:2046-1995, EN 438:2016 and NEMA LD3-2005 quality standards), made out of, urea free, thermosetting phenolic resins treated Kraft papers as core material and Amino plastic resin treated decor papers on the finish surface. Performance properties of laminates to meet classification HGS for Resistance to surface wear (350 revolutions), Resistance to staining (Rating/Index 5), Resistance to dry heat (180°C -Rating/Index 4), Resistance to cracking (Rating/Index 4) & Resistance to scratching (Rating/Index 3), Resistance to Color Change-Xenon Arch Lamp (Rating

5/Index 6). Colour/Décor, size, thickness and finish of laminates should be finalized according to the specifier's choice and as agreed for supply.

Laminates must have Antibacterial and Antifungal properties (conforming to JIS Z2801:2010 and ASTM G21-2015 standards respectively) and fulfil the applicable indoor air quality certifications, Formaldehyde emission of 0.0073 PPM and Total VOC emission of less than 0.22 milligram per cubic mtr with Greenguard-Gold Certification. Laminate should also have the necessary FSC certification for obtaining LEED points.

Texture, Finish, Design and Shades are as per the choice of Architect and Engineer-in-chief.

2. 1200X2400 GREENLAM CUSTOM DESIGN DIGITAL PRINT HIGH DEFINITION LAMINATE:

1.0mm (1mm +) thick Greenlam Digital High Pressure Decorative Laminates or equivalent (conforming to latest and applicable IS:2046-1995, EN 438:2016 quality standards), made out of, urea free, thermosetting phenolic resins treated Kraft papers as core material and Amino plastic resin treated decor papers on the finish surface.

Performance properties of laminates to meet classification VGS for Resistance to surface wear, Resistance to staining, Resistance to dry heat, Resistance to cracking, & Resistance to scratching. The Décor surface should have Sharp and High Definition Digital print or customized print with superior quality and optimal color intensity. There must not be any smudging of ink, picture or print blur.

Laminates must have Antibacterial and Antifungal properties (conforming to JIS Z2801:2010 and ASTM G21-2015 standards respectively) and fulfil the applicable indoor air quality certifications, Formaldehyde emission of 0.0073 PPM and Total VOC emission of less than 0.22 milligram per cubic mtr with Greenguard-Gold Certification.

Design and shades are as per the choice of Architect and Engineer-in-chief.

3. 1200X2400 FIRE RETARDANT LAMINATE: 1.0mm (+/-0.1mm) thick Greenlam or equivalent High Pressure Decorative Laminates with defined Fire Rating (conforming to latest and applicable IS:2046-1995, EN 438:2016 and NEMA LD3-2005 quality standards), made out of, urea free, fire retardant thermosetting phenolic resins treated Kraft papers as core material and Amino plastic resin treated decor papers on the finish surface. The product must also conform to either or all of Fire Rating norms of CS1D0 when classified in accordance with EN 13501-1: 2007. BS 476-Part 6:1989+A1:2009 and BS 476-Part 7:1997 UL723 - Standard for Surface Burning Characteristics for Building Materials The Fire Retardant Additive must be Halogen free in order to protect environment. Performance properties of laminates to meet classification HGS for Resistance to surface wear (350 revolutions), Resistance to staining (Rating/Index 5), Resistance to dry heat (180°C-Rating/Index 4), Resistance to cracking (Rating/Index 4) & Resistance to scratching (Rating/Index 3), Resistance to Color Change-Xenon Arch Lamp (Rating 5/Index 6). Colour/Décor, size, thickness and finish of laminates should be finalized according to the specifier's choice and as agreed for supply. Laminates must have Antibacterial and Antifungal properties (conforming to JIS Z2801:2010 and ASTM G21-2015 standards respectively) and fulfil the applicable indoor air quality certifications,

Formaldehyde emission of 0.0073 PPM and Total VOC emission of less than 0.22 milligram per cubic mtr with Greenguard-Gold Certification.

Design and shades are as per the choice of Architect and Engineer-in-chief.

4. 1300 X 3050 LAMINATE:

1.0mm (+/-0.1mm) thick Greenlam or equivalent High Pressure Decorative Laminates (conforming to latest and applicable IS:2046-1995, EN 438:2016 and NEMA LD3-2005 quality standards), made out of, urea free, thermosetting phenolic resins treated Kraft papers as core material and Electron beam cured transparent resin treated decor papers on the finish surface. Performance properties of laminates to meet classification HGS for Resistance to surface wear (600 revolutions minimum), ANTI FINGERPRINT PROPERTIES, SELF HEALING ON SCRATCHES, Close to zero reflection GU of 3 ± 1 when measured at an angle of 60 determined according to EN 13722, Resistance to staining (Rating/Index 5), Chemical Resistant as per SEFA Chemical Spot Test (except concentrated sulphuric acid and aqua regia) Resistance to dry heat (180°C-Rating/Index 4), Resistance to cracking (Rating/Index 4) & Resistance to scratching (Rating/Index 4), Resistance to Color Change-Xenon Arch Lamp (Rating 5/Index 6).

Laminates must have Antibacterial and Antifungal properties (conforming to JIS Z2801:2010 and ASTM G21-2015 standards respectively) and fulfil the applicable indoor air quality certifications and VOC emission norms of less than 0.22 PPM with Greenguard-Gold Certification. Laminate should also have the necessary FSC certification for obtaining LEED points.

Design and shades are as per the choice of Architect and Engineer-in-chief

5. 1200X2400 ESD LAMINATES:

1.0mm (1mm +) thick ESD Grade or equivalent High Pressure Decorative Laminates (conforming to latest and applicable IS:2046-1995, EN 438:2016 quality standards and possessing performance properties of Electro Static Dissipation), made out of, urea free, thermosetting phenolic resins treated Kraft papers as core material and Amino plastic resin treated decor papers on the finish surface. Resins are modified to impart ESD properties in the final product.

Performance properties of laminates to meet classification HGS for Resistance to surface wear (350 revolutions), Resistance to staining (Rating/Index 5), Resistance to dry heat (180°C- Rating/Index 4), Resistance to cracking (Rating/Index 4) & Resistance to scratching (Rating/Index 3), Resistance to Color Change-Xenon Arch Lamp (Rating 5/Index 6). The value of Surface resistance of the product to have a controlled values of 10⁹ or 10¹⁰ Ω when tested as per IEC 61340& ESD S-4.1, S-20.20. Colour/Décor, size, thickness and finish of laminates should be finalized according to the specifier's choice and as agreed for supply.

Laminates must have Antibacterial and Antifungal properties (conforming to JIS Z2801:2010 and ASTM G21-2015 standards respectively) and fulfil the applicable indoor air quality certifications, Formaldehyde emission of 0.0073 PPM and Total VOC emission of less than 0.22 milligram per cubic mtr with Greenguard-Gold Certification.

Scaffolding : For all exposed plaster work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Preparation of surface: The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface. Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacings of not more than 5 cm c/c, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

Materials

Stone Grit : Stone grit shall be free of dust and deleterious material. The grit shall be a combination of broken Dholpur, white marble, bilha & Katni graded stones of 10 mm to 12 mm in proportions as per approved sample Stone grit shall be thoroughly washed with water and sieved before use.

Mortar : Cement mortar for under coat and cement mortar to be mixed with stone grit for top coat shall be as specified.

Bonding Coat : Appropriate bonding coat of approved make shall be done concrete surfaces as per manufacturers specification..

Application of Plaster

12 to 15 mm thick Under Coat : Under coat of cement mortar 1:4 (1 cement : 4 coarse sand) with approved integral waterproofing compound in the proportions recommended by the manufacturer, shall be applied except that the finishing, after the mortar has been brought to level with the wooden straight edge, shall be done with wooden float only. The surface shall be further roughened by furrowing with a scratching tool. Furrowing shall be done diagonally both ways and shall be about 2 mm deep to provide a key for the top coat. The scratched lines shall not be more than 10 cm apart. The surface shall be kept wet till top coat is applied.

15 to 18 mm thick Top Coat : Top layer 15-18 mm thick comprising cement (50% White & 50% grey) and stone grit in mix 1:1.5 (1 cement including 15 percent Marble dust: 1.5 stone grit 10 to 12 mm nominal size) including addition of 15% marble dust to the cement. The top coat is cost in panels by means of wooden beading. The top coat shall be applied a day or two after the under coat has taken the initial set. The surface of the under coat shall be cleaned and a coat of cement slurry at 2 kg of cement per sqm shall be applied before the application of top coat. The top coat shall be applied in uniform thickness on the under coat after the application of slurry and sufficiently pressed with wooden float for proper bonding with the under coat. Vacant space, if any shall be filled with the specified mix.

Finish: The top coat of plaster shall be finished to a true and plumb surface. The surface shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All the corners angles and junctions shall be truly vertical or horizontal as the case may be. Rounding or chamfering of corners junctions etc. where required shall be true to template.

Finished surface of the top coat after the mix has taken the initial set, shall be scrubbed and washed with suitable brushes and plain water. Scrubbing and washing shall continue till the stone chippings are sufficiently exposed. Stone chippings which may come out while scrubbing shall be replaced using the specified mortar mix.

Grooves: The aggregate plaster finish shall be laid in panels, grooves of size upto 12mm to 15mm shall be provided with hard wood beading with application of shuttering oil between panels and corners as per Architectural drawing including removal of beading and repairs to the edges of panel. Tapered wooden battens to match the size and shape of the grooves shall be fixed on the under coat with nails before the application of the top coat and these shall be removed carefully so that the edges of the panels of top coat are not damaged. Damage, if any, shall be made good by the contractor.

Cleaning: The entire surface of the aggregate shall be washed with water and with a solution of dilute oxalic acid or hydrochloric acid to remove stains and excess mortar as per the directions of the Engineer-in-charge.

Groove Pointing: All grooves shall be pointed with cement mortar 1:1 (1 cement: 1 coarse sand) mixed with water-proofing compound as per manufacturer's specification to a depth of at least 6mm.

Curing: Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days.

Drip Course : The contractor shall forming drip course in exposed aggregate plaster as called for in the architectural drawings including shuttering & finishing .

Chicken Wire mesh : Providing and fixing Chicken wire mesh 200 mm wide at junction of R.C.C., brickwork, edges, corners, chiseled and repaired brickwork prior to plaster over concealed conduit, etc. shall be as directed by the Engineer-In-Charge or his representative. It shall be considered as part of the work.

4. STONE WALL CLADDING

Wherever External stone cladding is shown in GFC drawings, all external walls shall be finished with 15 mm cement plaster in Cement Mortar 1:4 (1 Cement: 4 coarse sand) with water proof compound prior to the stone cladding.

Stone shall be of the type as specified in the item / Drawings. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins patches of soft or loose materials etc. Thickness of stone shall be minimum 30 mm or as specified in drawing. Samples of each item of stone work either individually or in combination shall be prepared for approval of Engineer-in-Charge before commencement of work.

Stone shall be machine cut to the required size and shape on all beds and joints so as to be free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be 30 mm thick as specified with permissible tolerance of + 2 mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-Incharge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

Stacking and Storing

Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Fixing

The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge. The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced with provision for insertion of pins / bolt attached with the stainless steel cramps along the sides of the stone as per GFC drawing. Adequate cutting in stone shall be made with precision instruments to hold the cramps pins at the joints. Stone shall be secured with cramps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge/ Architect.

The cramps shall be of stainless steel grade 316 of Hilti or approved equivalent make. The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-charge / Architect. The samples of stainless steel grade 316 cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to support and transfer the load of stone to the supporting structure and approval of the same shall be obtained from the Engineer-in-Charge.

The stone shall break joints on the face of the wall unless otherwise shown in the drawings. The stone shall be in regular courses as per drawing and all stones shall be of the size mentioned in the drawing also with grooves where ever mentioned.

Jointing

The thickness of joints shall be as small as possible, not exceeding as specified in drawing. The fine joint shall be uniform throughout. Joints horizontal and vertical shall be filled with weather sealant of make & colour as approved by Engineer-in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

Protection

Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction. All Exposed surface of stone shall be treated with transparent silicone based water repellent coating.

Materials :

Gang-saw cut Bilha stone : 1st Quality locally best available as approved by EIC

Rough Bilha stone : 1st Quality locally best available as approved by EIC

Polished Mandana stone : 1st Quality as approved by EIC

Stainless Steel Clamps : All clamps / cramps shall be of stainless steel grade 316. The clamp weight shall be minimum 250gms. The clamp body shall be of minimum 5mm thickness and shall be able to carry a dead load of 79.5 kgs at minimum offset. The clamp shall be offset lengths from 50-65mm. Test certificate shall be submitted by the manufacturer, if required. Clamps shall be fastened by M10X90 Stainless Steel grade (316) mechanical torque controlled Stud anchor (on concrete). Anchor should be pre-assembled with a stud, expansion sleeve, a nut and a washer. Top end of stud should contain threads and bottom end should be cold formed conical head . / M10X100 Stainless Steel grade (316) (on bricks/aerated blocks) . Anchor should possess ETA approval and comprises of polyamide PA 6 grade sleeve and stainless steel A4 (316) grade double threaded screw with hexagonal head. Fixing methodology should be followed as per manufacturer guidelines. The contractor have to arrange onsite pull out test of clamps/cramps from the manufacturer.

Important note:-It will be responsibility of Contractor alone to ensure that each and every Cladding stone and clamp is well installed as per CPWD Specs or relevant code/practice and if any mishap/unfortunate incident happens during execution of work or in future after completion of work/agreement due to falling of stone etc, then Contractor will be solely responsible.

Silicone based water repellent coating on External Finishes

Silicone based water repellent coating on exposed RCC surface, exposed stone surface of wall cladding and exposed aggregate plaster.

Providing and applying silicone based water repellent coating confirming to BS: 6477-1984 in 2 coats with a consumption as per the manufacturer specification or as approved by E.I.C.

The silicone-based water repellent coating should have the below mentioned technical properties-

Property	Typical Value
Appearance	Clear free flowing liquid
Colour	Water white to pale yellow
Nonvolatile matter %	3.5-5.0
Surface dry times in minutes	20-25
Water repellency as per IS 12027:1987	Repel water in bead form
Specific gravity@30-degree gms/ml	0.80+0.02

Surface Preparation

Surface should be dry and free from all debris, dirt, oil, grease, wax and all other contamination, which could prevent penetration.

Clean the saturated dirt of surface by thorough wire brushing, cleaning with compressed air followed by water washing.

De grease oil & grease by using appropriate solvents.

Allow the surface to dry completely before the application.

Thorough wire brushing followed by sanding with emery paper is recommended

Application

Apply one liberal coat of silicone coating confirming to BS: 6477-1984 simply by brushing evenly on the prepared surface.

Allow the surface to dry for a minimum of 24 hrs for best results.

Allow it to dry for 24 hrs.

Apply second coat wet on wet, to improve the penetration rate & performance.

Allow it to dry for 24 hrs.

Do not dilute with water or by any other means.

The coating should be applied in 2 coats with a consumption as per Manufacturer specification or as per DSR.

5. DRY STONE CLADDING

Material

Stone shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and

sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of + 2 mm. Before starting the work, the contractor shall get the samples of stone approved by Engineer-Incharge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct

positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

Stacking and Storing

Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Fixing

The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge. The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints. Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

Jointing: Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer-in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

Protection: Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

Measurement: The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

Fixing of Frame

The properly designed structural frame for withstanding the weight of stone slab are fixed/supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junction of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sands: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement

concrete including provision of necessary centring/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface. Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

ADJUSTABLE STAINLESS-STEEL CRAMPS

The cramps shall be stainless steel of make approved by the Engineer-in-charge.

- The weight of the stainless-steel clamp (including weight of nut and washer) shall not be less than 260 gms.
- Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.
- Necessary recessed are required to be done in stone slab which is required to be supported by clamps.
- The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.
- The rate includes cost of materials and other operations mentioned as above.

SOME ITEMS OF ANCILLIARY BUILDING'S

Machine / Equipment foundation : Machine / Equipment foundation of any shape, size & design as per manufacturer / supplier / GFC drawing shall be Ready mixed M-30 / M-35 grade concrete as per GFC drawing including necessary centering / shuttering, reinforcement steel, making necessary pockets of required size and shape (by providing moulds of required shape & size), fixing insert plates / pipes etc. in line, level and plumb complete as per drawing and grouting the same with cement concrete of richer mix and finishing, curing etc. complete as directed. Base concrete below the machine foundation shall be of grade 1:4:8 of 75 mm thickness or as per GFC drawing.

Cable Trenches: Foundation / base slabs & walls of trenches shall be Ready mixed M-30 grade concrete including reinforcement steel as per structural GFC drawing. Base concrete below the trenches base slab shall be of grade 1:4:8 of 75 mm thickness or as per GFC drawing. Top of all trenches shall be covered with 6 mm thick chequered plate supported on M.S. angle nosing / cross support with holdfast embedded in trench RCC wall as per detail given in GFC drawing. Floor & walls of trenches shall be finished with acrylic cementitious modified two component waterproofing as per manufacturers specification followed by 15 mm thick water proofing plaster in cement mortar 1:3 (1 Cement : 3 Coarse sand) admixed with water proofing compound conforming to IS:2645 as per manufacturers specification & cement paint over water thinnable cement primer as per specifications. For detail refer GFC drawings.

Eco Ventilators : Providing & fixing roof air ventilator assembly with base ring 24" ID (600mm) & 32" OD (800mm) Eco friendly SS construction with FRP Venture dome thickness 1.5 mm and transparent in colour. Central shaft will be made of bright bar material with internal arrangement of metlon bushing bottom ring & top of SS 304 Grade and 36 Nos turbine vanes in SS construction etc. complete as per manufacturers specification or as directed by E-I-C.

Water storage Tanks : Polyethylene water storage tank, IS : 12701 marked, of capacity as per GFC drawing & of approved make & colour, with cover and suitable locking arrangement and making necessary holes for inlet, outlet and overflow pipes including fittings and the base support for tank shall be provided at Security Complex & Security Cabin 1, 2A, 2B & Main Receiving Sub Station terrace.

Rolling shutters : Rolling shutters shall be of approved make, made of 80x1.25 mm size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with mechanical device chain and crank operation for operating rolling shutters complete, including providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of

adequate strength conforming to IS: 4454 - part 1 , ball bearing & M.S. top cover 1.25 mm thick for rolling shutters . Rolling shutters shall be partly grilled or partly fixed as per architectural GFC drawing. Grilled rolling shutters manufactured out of 8 mm dia M.S. bar instead of laths as per design approved by Engineer-in- charge.

G.I. chain link fabric fencing : G.I. chain link fabric fencing of height 1.2 m & gate of height 1.8 m in mesh size 50x50 & G.I. wire of dia 4 mm shall be provided at Transformer yard encloser complete as per detail given in GFC or as per the direction of Engineer-in-charge. G.I. chain link fabric fencing shall be fixed as per the detail given below :

a) Providing and fixing vertical post fabricated out of 2 nos. 50 x 50 x 6mm MS angles, 1.8 meter long with 150 x 150 x 6 mm thick base plate, at spacing as per GFC drawing, 500 mm grouted in toe wall in cc 1:2:4 block of size 230 x 230 x 500 mm.

b) To form rectangular panel frame out of ISA 50 x 50 x 6, of size as per drawing, welded to vertical posts by means of 4nos box cleats of ISA50x50x6 (2nos on either side), with necessary welding, nuts and bolts and washers, if required, etc complete.

c) Chain link of size 50mm x 50mm, covering the panels of MS angles, fixed with 32 x 6 mm MS flat as beading, with making necessary holes and fixing with 10 mm dia 40 mm bolts with washers, nuts etc. complete.

d) Gate shall be fabricated as per detail given in GFC drawings including required heavy duty hinges, aldrops& tower bolts complete as directed by Engineer-in-Charge

e) Painting the vertical posts , chain link panel etc. with polyurethane paint as per manufacturers specification.

Basement Floor Drain : Floor drain of size, slope & details shall be made as per GFC drawings in pump room & miscellaneous water tanks in Under Ground Tank (UGT) & Water Treatment Plant (WTP). All drains floor & walls shall be finished with 15 mm to 20 mm thick water proofing plaster in cement mortar 1:3 (1 Cement : 3 Coarse sand) admixed with water proofing compound conforming to IS:2645 as per manufacturers specification & floating coat of neat cement. Top of floor drain shall covered with M.S. grating of size & detail as per GFC drawing & finished with polyurethane paint as per manufacturers specification.

Leveling for Basement flooring : Cement Concrete 1:2:4 or as mentioned in GFC drawing shall be filled below pump room & other area flooring in slope as per detail given in drawing or as directed by Architect / E-I-C.

MS Structural Steel work

Structural steel of grade E250 conforming to IS2062 shall be used for M.S. Steel ladder, M.S. Hand rail, M.S. Insert Plates / Base / gusset / stiffener plates as per Architectural / Structural drawings. M.S. Tube (Pipe / square / rectangular) sections shall be of grade E310 for Pipes / E350 for RHS & SHS shall be used for Architectural Pergolas, Façade members if any as per corresponding Architectural / Structural drawings.

All cable trenches shall be covered with 6 mm thick chequered plate supported on M.S. angle nosing (not less than angle 40 x 40 x 6mm) / M.S. angle cross support with holdfast embedded in trench RCC wall as per detail given in GFC drawing.

All railings including staircases, spiral staircase , around cutouts , terraces etc., shall be MS railing as per drawing including Fire escape stair if any. MS works in Monkey ladder for O.H.T., machine Room terrace, Mumty, terrace & Plumbing shaft as per architectural drawing.

MS supports (angle, tube, channel, etc.) at wall / ceiling for services (Plumbing, Electrical, HVAC, etc.) shall be provided as per approved shop drawing, design and direction of E-I-C. MS supports to be fixed with 100x8 mm anchor fasteners in concrete / hold fast with M15 concrete block in brick work in adequate no. of spacing.

M. S. Gate : MS gate in Telephone exchange enclosure wall / M.S. gate & grills in Security Complex main entrance & pedestrian entrance / M.S. gate & grills in Security Cabin 1, 2A & 2B main entrance & pedestrian entrance shall be fabricate & fixed as per detail given in GFC drawing including polyurethane paint, all required hardware, MS heavy duty hinges etc., all completed as directed by Architect / E-I-C .

M.S. Gratings : Top of floor drain shall covered with M.S. grating of size & detail as per GFC drawing & finished with polyurethane paint as per manufacturers specification. Locations : UGT & WTP

Painting & finishing of Steel work : All MS structural steel works shall be finished acrylic aliphatic polyurethane paint as per specification

Under Ground Tank (UGT) / Water Treatment Plant (WTP) / Over Head Tanks

PVC water stops to be compulsorily provided at the construction joint during casting of wall of watertank and waterproofing compound shall be mixed in Concreting and plastering of all tanks as per direction of E-I-C in proportion recommended by manufactures

Providing PVC water stops conforming to IS:12200 for construction/ expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. complete with Serrated central bulb (225 mm wide, 8-11 mm thick),all complete as per E-I-C.

Internal floor & wall finish of all tanks in UGT & WTP / Soft Water Tank in Electric Sub Station & Plant Room, Academic Area shall be acrylic cementitious modified two

component waterproofing as per manufacturers specification finished with 300x300mm glazed Ceramic tiles over 12 mm thick bed of cement mortar 1:3 (1 Cement: 3 Coarse sand) and jointed with grey cement slurry @ 3.3 Kg per sqm including pointing in white cement mixed with pigment of matching shade. For detail refer GFC drawings.

Under Ground Tank (UGT) / Water Treatment Plant (WTP) / Over Head Tanks top cover shall be 455 X 610 mm rectangular double seal C.I. Cover with frame (light duty) including lockable arrangement, the total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg.) or 500 mm internal diameter double seal circular manhole cover with frame (medium duty) including lockable arrangement, total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) as shown in GFC drawing, Rungs shall be orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910 on 12mm dia steel bar conforming to IS :1786 having minimum cross section as 23 mm x 25 mm and over all minimum length 263mm and width as 165mm with minimum 112mm space between protruded legs having 2mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138mm as per standard drawing or as per CPWD specification.

Spouts / sleeves: Wherever shown in Drawings or as required GI spouts / sleeves of diameter as per GFC drawing, average 400 mm long or as required shall be fixed at all levels and locations including cutting & making good the walls / concrete with primer & painting complete as shown in drawing or as directed by E-I-C.

Crash Rail: Supply & apply Crash rail with 203 mm face dimension, Product to be supplied in 3000 mm Lengths with standard end Cap.

A. Engineered PVC Crash Rails to be Acrovyn: Surface mounted assembly consisting of standard aluminum clips with snap-on Acrovyn 2000 cover and integral shock absorbing cushions. End caps shall be mechanically fastened with concealed fasteners. Color matched end caps and corners shall be removable for ease of replacement; Extruded material should be high-impact Acrovyn 2000 with Shadowgrain texture, nominal .1.98mm thickness. Colors to be indicated in the finish schedule from one of manufacturer's available colors and patterns.

B. Re grind PVC: PVC-PVC re grind absorption cushion.

C. Aluminum: Extruded aluminum should be 6063-T6 alloy.

Crash Guard: Supply & apply of SCR 50 Surface mounted crashrail, 127 mm deep. Product to be supplied in 3000 mm lengths. With Standard End Cap Re grind PVC: PVC-PVC re grind absorption cushion. Aluminum: Extruded aluminum should be 6063-T6 alloy, nominal thickness. Minimum strength and durability properties as specified in ASTM B221

Corner Guard: Supply & apply of SM20 90 degree, surface mounted corner guard, 76 mm legs, aluminum retainer, caps included. Cut sizes and quantities to be listed below. SM20N. PVC regrind absorption cushion. Aluminum: Extruded aluminum should be 6063-T6 alloy, nominal thickness. Minimum strength and durability properties as specified in ASTM B221

MODULAR PARTITION WORKS

GYPSUM BOARD PARTITIONS:

G.I. frame and required board, including providing and fixing of frame work made of special section power pressed/ roll form G.I. sheet with zinc coating of 120 gms/sqm(both side inclusive), consisting of floor and ceiling channel 50mm wide having equal flanges of 32 mm and 0.50 mm thick, fixed to the floor and ceiling at the spacing of 610 mm centre to centre with dash fastener of 12.5 mm dia meter 50 mm length or suitable anchor fastener or metal screws with nylon plugs and the studs 48 mm wide having one flange of 34 mm and other flange 36 mm and 0.50 mm thick fixed vertically within flanges of floor and ceiling channel and placed at a spacing of 610 mm centre to centre by 6 mm dia bolts and nuts, including fixing of studs along both ends of partition fixed flush to wall with suitable anchor fastener or metal screws with nylon plugs at spacing of 450 mm centre to centre, and fixing of boards to both side of frame work by 25 mm long dry wall screws on studs, floor and ceiling channels at the spacing of 300 mm centre to centre. The boards are to be fixed to the frame work with joints staggered to avoid through cracks, M.S. fixing channel of 99 mm width (0.9 mm thick having two flanges of 9.5 mm each) to be provided at the horizontal joints of two boards, fixed to the studs using metal to metal flat head screws, including jointing and finishing to a flush finish with recommended jointing compound, jointing tape, angle beads at corners (25 mm x 25 mm x 0.5 mm), joint finisher and two coats of primer suitable for board as per manufacture's specification and direction of engineer in charge all complete. 75 mm overall thickness partition with 12.5 mm thick double skin fire rated Glass Reinforced Gypsum (GRG) plaster board conforming to IS: 2095: part 3 (Board with BIS certification marks) Glass reinforced Gypsum (GRG) plaster board 12.5 mm thick confirming to IS 2095 (Part 3):1996

Insulation with Resin Bonded rock wool:

Resin Bonded rock wool conforming to IS: 8183, having density 48 kg/m³, 50 mm thick, wrapped in 200 G Virgin Polythene Bags fixed to wall with screw, rawel plug & washers and held and in position by criss crossing GI wire etc. complete as per directions of Engineer in- Charge.

MODULAR GLASS PARTITION:

12mm toughened glass with proprietary Slimline partition systems of as per Manufacturers specification as verticals and horizontals at top and bottom with option for installing glass & glass to glass joint with other required accessories as per the drawing and instructions of the Architects.

The rate shall include all design, Providing & fixing Printed frosting film of 3M make of crystal range with approved image printed on the film as per design & installed over the glass partition as per manufacturer's specification & installation guidelines. Vendor shall

include wastage while quoting. Vendor shall provide 10 year warranty as per manufacturer's guidelines.

FROSTING FILM HEIGHT OF 750MM

MISCELLANEOUS ITEMS

CLEAN ROOM ITEMS

Modular Wall Panel : Supply and installation of 80 mm thick double skin modular wall panel system made of 0.8 mm thick Powder coated (60-80 microns) GPSP sheet on both sides over an aluminium frame work with sealed and insulated interior, PUF (Class O rating) as a infill material of density 40 +/- 2 kg/m³ is sandwiched between the two skins and sealed from the exterior by the aluminium frame work, GI floor profiles with leveling adjustment are provided for reinforcement along the periphery and accommodate the Epoxy/ vinyl floor flush with wall panels. The wall panels are constructed with an interior Aluminium frame work for self supporting. Partition to Partition connections are maintained with precision with aluminium profiles that create uniform seams. wall panels are inter changeable with doors & vision Panel, special fasteners and profiles are provided for easily dismantable. The Partition seams are sealed by silicone food grade sealant with a perfectly flush finishing. The panel will come with prefabricated cutouts for switch sockets with proper flashing & sealing of cutouts as well as inclusive of PVC Heavy Grade conduit of 3 metre length having outer dia. of 32 mm. Both sides of panels provided with protective film to prevent surface damage during shipping and installation.

Walkable False Ceiling: Supply and installation of 50mm thick double skin totally flush walkable false ceiling panel made of 0.8mm thick powder coated (60-80microns) GPSP sheet on both side over an aluminium frame work with sealed and insulated interior, PUF (Class O rating) as a infill material of density 40 +/- 2 kg/m³ is sandwiched between the two skins and sealed from the exterior by the aluminium frame work. The ceiling panel system comprise of aluminium ceiling grid suitable for easy installation, load bearing, flushed to the ceiling panels, Indexing screws for easy mounting of the system, reinforcing clamps and brackets, turn buckles & threaded rods are fastened to the overhead support at fixed intervals and other hardware for easy & faster leveling of the system etc. All the suspension material is of Galvanized finish. Panel to Panel connections are maintained with precision with aluminium profiles that create uniform seams. The Partition seams are sealed by silicone food grade sealant with a perfectly flush finishing. The panel will come with prefabricated cutouts for light fixtures &Hepa filters with proper flashing & sealing of cutouts as well as inclusive of PVC Heavy Grade

conduit of 3 metre length having outer dia. of 32 mm. Both sides of panels provided with protective film to prevent surface damage during shipping and installation.

Doors : Supply and installation of 46 mm thick both side flush doors of size as per drawing, made of 0.8 mm thick PU painted GPSP sheet with PUF as a infill material of density 40 +/- 2 kg/m³ is sandwiched between the two skins, 1.2 mm thick standard 50mm frame width GPSP powder coated door frames totally flush with the wall panels,

necessary hardware like stainless steel hinges, stainless steel 'D' type of handles on pull side, stainless steel push plates on push side, Dorma TS 71 door closers or equivalent, Dead lock with both side key operation, double glazed view glass of standard size with self adhesive tape & food grade silicon sealant, SS ball bearing butt hinges, kick plate and concealed automatic door bottom seal etc.

Coving : Supply and installation of extruded aluminium powder coated covings of R50 to fill the gap between wall panel to false ceiling and also between wall panel to wall panel at corners.

1. Covings for wall to ceiling & wall to wall
2. 3D internal & external

View Panels : Supply and installation of view / glazed panels with flush design & size as per drawing. The view panels provided with 6mm thick float glass on both sides with flush design, necessary gaskets, food grade silicon sealants and all required accessories.

In-built Return Air riser : Supply and installation of In-built Return Air Risers made of GPSP sheets in 80mm thick wall panels with 150mm projection at the top of ceiling. The scope includes necessary stiffeners, flange connections to connect Ducting, permanent magnet/ mechanical holding system to hold the perforated grills on Risers, fixing screws etc.

1. Inbuilt RAR with collar projected 150 mm above the panel and with flange to connect duct

Return Air Risers grills : Supply and installation of Return Air Risers grills (Powder coated) complete as per manufacturers specification or as directed by Engineer - in - Charge.

Pre filter for Return Air Risers : Supply and installation of Pre filter for Return Air Risers (G-4) complete as per manufacturers specification or as directed by Engineer - in - Charge.

Epoxy flooring : Epoxy flooring for clean room shall be 3mm thick Epoxy Self Leveling Flooring which include Solvent Free Epoxy Primer, along with top coat in 3mm Thickness (Self Leveling Epoxy Top Coat) having minimum compressive strength of 55N/sqmm and Flexural Strength of 31N/sqmm and Tensile Strength of 18N/sqmm(Must satisfy requirements classified under BS 6319) in approved color on Concrete VDF floor / IPS floor. Surface preparation should be done mechanically with Diamond Grinder or scarifier complete as per manufacturers Specification

Air Shower : Supply, installation, testing and commissioning of air shower made of 16 gauge SS 304 sheet on both sides and working area of 2000mm(W) x 1300mm (D) x 2400mm (H). The air shower comprise return air collection at bottom with EU-4 pre-filter & perforated GI powder coated grill, fan with adequate static pressure & EFF-1 class motor, HEPA filter section with EU-13/14 grade HEPA filters of 99.995% efficiency down to 0.3 particles, air outlet chamber with SS air nozzles and air velocity through nozzles to be 20- 22 m/s to ensure efficient scrubbing action necessary to remove particulate matter, vinyl flooring with conductive and antistatic properties, cleanroom compatible Doors with sandwich type construction, view panels and light fixture, microprocessor controller to supervise all functions, emergency stop buttons on both sides of shower, indicator lights on both sides of shower exterior to control traffic flow in & out of cleanroom. Air shower is designed to meet minimum of 370 ACPH, minimum of 6 nozzles for proposed working area, fully tested and certified in compliance with ISO 5 class as per ISO -14644-2&3 and IES-RP-CC-002-86.

SUN LOUVER SYSTEM

Double Fin Rectangular Sun Louver System : Supply & fixing of Double Fixed Double Fin Rectangular Sun Louver System of size 50mm thick X 450mm depth consisting of extruded aluminium square shaft & butterfly clamps covered with aluminium metal cover skin on both sides, rectangular shaped aluminium fin skin with crowning manufactured out of 0.7mm aluminium alloy AA3005 fixed on both sides of square shaft, fin bearing block, axle, axle lock, nylon end cap, end cap screws, and end cap connector & accessories for fixed system. The maximum module of fin for fixed system is 390mm and the length of fin shall be determined based on the wind load calculation and deflection, subject to a maximum length of 3.5 M (for horizontal application) & up to a maximum length of 4 M (for vertical Application). The factory assembled Double rectangular 400mm fin will be fixed on both ends to suitable Installation frames of MS sections/Aluminium provided by the contractor. The installation frame shall be fixed mechanically to concrete structure with MS or Aluminium brackets. The erected substructure shall be aligned within the tolerances of span/1000 of plumb line and level with a non-cumulative tolerance of a maximum of 2 mm. The louver Fin skin shall be coil coated in PVDF finish suitable for exterior applications.

REFLECTING POOL NEAR LIBRARY

Note: -Work shall be done as per respective GFC drawing, nonetheless items are given to facilitate the Contractor

- Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated surplus earth within the campus. Back filling shall be done as per GFC drawing.

- Providing and laying in position cement concrete of grade 1:4:8 (1 Cement : 4 coarse sand(zone-III) : 8 graded stone aggregate 40 mm nominal size) All work up to plinth level.
- Providing and laying in position cement concrete of grade 1:1.5:3 (1 Cement : 1.5 coarse sand (zone-III) : 3 graded stone aggregate 20 mm nominal size) All work up to plinth level.
- Providing and laying in position ready mixed M-25 grade concrete for reinforced cement concrete work, using cement content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer - in - charge. All works upto plinth level.
- Centring and shuttering including strutting, propping etc. and removal of form for: Foundations, footings, bases of columns, etc. for mass concrete.
Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
- Steel Reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars / hot rolled deformed bar of grade Fe500 D or more.
- Brick work with Cement based fly ash (non modular) bricks of 1st class in foundation and plinth in Cement mortar 1:6 (1 cement : 6 coarse sand)
- Brick work with Cement based fly ash (non modular) bricks of 1st class in superstructure above plinth level up to floor V level in all shapes and sizes in Cement mortar 1:4 (1 cement : 4 coarse sand)
- Half brick masonry with Cement based fly ash (non modular) bricks of 1st class in superstructure above plinth level up to floor V level in cement mortar 1:4 (1 cement : 4 coarse sand). 2 Nos 6mm dia. M.S. bars will be placed at every third course of half brick masonry.
- Providing and applying waterproofing treatment to the floor & wall sides of reflecting pool as per GFC drawing, including cleaning of surface to remove dust, loose particles, etc with compressed air or any other suitable technique depending on site conditions, grinding any sharp edges, etc as per the instructions of Engineer in charge and post cleaning applying a two component acrylic modified cementitious coating system at a total consumption of 1.8 to 2 Kgs/Sqm in two coats complete as per manufacturers specification or as directed by E.I.C..
The waterproofing system should exhibit the following properties: density : 1.5 to 2 kg/ltr, Elongation at break (ASTM D412): 200 to 250%, Crack resistance at 20 degree centigrade > 2 mm
All corners in sunken must be sealed a SealTape S, an elastic waterproof sealing tape with a woven bonding mesh on each surface and an elastic expansion zone in the center. The waterproofing should be taken to a height of 300 mm in the vertical.

The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee against any leakage.

- Providing and laying gang saw cut, pre moulded and pre polished machine cut 18 mm thick granite stone of required size and shape of approved shade, colour and texture in footpath, flooring in road side plazas and similar locations, laid over 20mm thick base of cement mortar 1:4(1cement1:4 coarse sand) grouting the joints with white cement mixed with matching pigment, epoxy touch ups etc. No mortar to be visible on the surface in joints, the sample of the Granite stone to be approved by the Engineer - In - Charge including rubbing, polishing complete.
- Polished Granite of 30mm thickness for wall lining (veneer work), backing filled with a grout of average 12 mm thick in cement mortar 1:3 (1 cement : 3 coarse sand), including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust) with an admixture of pigment to match the stone shade. To be secured to the backing by means of Cramp.
- Providing and fixing polished 30mm thick granite gang saw cut, premoulded and prepolished, machine cut for copings and similar locations of required size, approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels.
- Providing and fixing granite of gang saw cut, mirror polished, premoulded and prepolished, machine cut for wier 1 of required size 270mm wide 90mm thk., constructed by joining 3 layers of 30mm thick granite stuck together with araldite (adhesive), of approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels. Wier 1,2,3
- Providing and fixing 50mm thick granite of required thickness gang saw cut, mirror polished, premoulded and prepolished, machine cut in copings of required size 450mm wide including grooves 20mm x 20mm @70mm c/c as per design , approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels. Wier 4,5

- Prepolished 30mm thick Granite for wall lining (veneer work), backing filled with a grout of average 12 mm thick in cement mortar 1:3 (1 cement : 3 coarse sand), including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust) with an admixture of pigment to match the stone shade. To be secured to the backing by means of cramps. The Stone will have 6mm X 6mm grooves cut at 75mm distance centre to centre as per drawing.

AUTOMATIC SLIDING DOOR OPERATOR

Providing and fixing automatic bi-parting sliding doors with 12mm clear toughened glass shutter.

Automatic sliding door operator shall be as per approved dwg., Compliant with European standards and produced according to the guidelines for power-operated windows, doors and gates, BGR 232, the UVV and the VDE regulations. TÜV design tested, tested according to the low voltage guidelines, fulfils DIN 18650 standards for Pedestrian Safety, TÜV Design Tested for Durability of 1 million Cycles. The track profile should be separate from the main profile for enabling reduction in vibration insulation. Operator length = 6250 mm, Maximum clear passage opening width = 3000 mm, maximum clear passage height = 2500 mm, includes micro processor controlled drive unit, with self learning mechanism, program selector with knob, motion detector (eagle 6 radars, 02 nos), mechanical components, toothed belt, cover profile, floor guide for frameless glass (02 nos), glass clamping rail (02 nos), safety device-light barrier (01 pair). Body finish : standard silver anodised operator profile, electromechanical lock with 12 mm plain toughened frameless glass for complete elevation - 2 moving panels. UPS of 750 VA shall be provided, which will give power backup of 20 min. Only & if the duration of power cut to the operator is more than 30 min., then separate arrangement needs to be done for the same as automatic operator requires uninterrupted stabilized power supply. The above work complete in all respect as per approved shop drawings and to the satisfaction of engineer-in-charge / architect consultant.

FRAME LESS DOOR

Providing & fixing manual frameless double leaf glass doors with 12 mm clear toughened glass and S/S patch fitting (PT standard) of grade 304 : such as Top pivot, Top patch, Bottom patch, Corner lock with EPC, lock keeper plate & stainless steel grade 304 handles 38 mm dia and 600 mm long or as approved by the Engineer in charge and floor spring conforming to DIN EN1154 with adjustable spring strength EN(1-4) and Tested for durability of 500,000 cycles.. The above work complete in all respect as per approved shop drawings and to the satisfaction of engineer-in-charge.

GLAZED PARTITIONS

Supply and Fixing of Full Height demountable Glass partition including doors with 10mm Toughened Glass using Frame profiles 100 x 25 mm upto a height of maximum 4m or as per drawing using minimum 20 micron matt finished Anodised Aluminium in required colour & shade. The Fixed glass to be fixed using base profiles 100 x 25 mm at Top & Bottom & support profile 100 x 25 mm at sides. The profile size to be 100x25MM to be fixed on to the floor/wall/ ceiling as per the architect design. Over panel Profile of **100 x 50 mm** to be used for Over panel, H Junction profile to be used at all Glass to Glass vertical joints, 90 Deg L Junction Profiles and T Junction profiles necessary as per design. End Profile 100 x 25 mm to be used for Open glass edges and all around the door frame with seals and Over Panel End profile including filling the joints if required with Silicon sealant structural grade and weathering grade of Dow corning - USA or "GE Silicon - USA" or "WACKER - Germany"., complete as per detailed drawings & approved shop drawings. (The contractor must provide detailed shop drawings of individual profiles and also details of any other profiles that may be used clearly indicating all dimensions.)

The Profile shall be matt natural anodized, the Profile Manufacturer to supply all the necessary clips, seals and fixing accessories for the system. All Profiles to be with 2 mm Gauge thickness .

Hardware for Glazed Partition single or double leaf doors

Providing & fixing Dorma or approved equivalent make stainless steel grade 304 patch fitting in frameless glass single or double leaf door shutters which include Top pivot, Top patch, Bottom patch, Corner lock with EPC, lock keeper plate and 'H' shape pull handle (450 mm x 25 mm) SS 304 grade and floor spring with adjustable spring strength, suitable for door leaf weight upto 120 kgs, max leaf width 1100mm and Tested for durability of 500,000 cycles & other accessories including the cost of screw & all other incidentals complete as per detailed drawings & approved shop drawings.

Glass Block

Glass Blocks (transparent / colour) of approved make of size 190mm x 190mm x 80mm (approximate weight 2.0-2.5 kg per block) with 10 mm joint to achieve a 200 mm module with mortar grout of white cement and marble powder in proportion of 1: 2 respectively including 6mm dia steel reinforcement bars to be laid in horizontal and vertical joints as per manufacturers specification.

Glass block panels shall be supported on all sides by fabricated powder coated (minimum thickness of powder coating 60 micron) aluminium frames of nominal dimension 80mm x 40mm x 2mm size , and block should rest on top of the cement mortar 1:3 (1 cement : 3 sand). Aluminium frames shall not be load-bearing and shall be fixed to the surrounding structure.

The joints between the blocks to be sealed with transparent / colour Silicon Gel sealant of approved make complete as per manufacturer specification, as per drawing and instructions of the Architect.

Location: Glass block shall be provided at various location & levels as per GFC architectural drawing.

PRECAST CEMENT CONCRETE JALI

The jali shall be of cement concrete 1:2:4 (1 cement 2 coarse sand:4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified including centering and shuttering, roughening cleaning & fixing.

The jali shall be set in position true to plumb and level before the joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

GRC Customized Moulding/Cornice/Panel casted with Power Spray methodology

Glass Reinforced Concrete (G.R.C) Moulding / Cornice / Panel in approved size, pattern, design, shade and thickness of 50mm on frame and internal member in 18 – 20mm thick casted with layering technique Power Spray methodology have weight approximately between 5 – 7 Kg per Sq. Ft. and color of approved make. The moulding / cornice / Panel should be made from '53 grade' White Portland Cement, Fine graded Quartz & Silica Sand, Alkali Resistant Glass Fiber manufactured by 'N.E.G' or equivalent, Super Plasticizers manufactured by approved make, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation. The material casting should take place in FRP Moulds. The GRC flexural strength average L.O.P should be above or equivalent to 6 N/mm² & M.O.R should be above or equivalent to 15 N/mm² for tests done on 28 days cured samples.

The fixing of panels should be 'Dry fixing' i.e. to be done with stainless steel grade 304 L Clamps, anchor fasteners of approved make or self - tapping screws or as per approved shop drawings approved by E-I-C.

Technical Specifications

Plumbing Work

SECTION - I

- 1.1 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Indicative list of items and/or shown on the Plumbing Drawings.
- 1.2 Without restricting to the generality of the foregoing Sanitary installations shall include the following:
 - a) Sanitary Fixtures & CP Fittings including lab fittings etc. as per the GRIHA requirements.
 - b) Drinking water fountain near drinking water point.
 - c) Soil, Waste and Rain Water Pipes.
 - d) Internal and External Water Supply System i/c BMS enabled Flow meter
 - e) Terrace booster pump for lecture blocks (300 & 500 capacity)
 - f) Domestic water distribution system from master plan tapping point to building OHT.
 - g) Recycled water distribution system from from master plan tapping point to building OHT.
 - h) Water meter on the rising main of water supply system for each block.
 - i) Internal and External Sewerage and Storm water drainage system with excavation of pipe around the buildings.
 - j) Neutralization chamber for treatment of Lab waste.

In case of Non DSR Items details of specifications is separately mentioned but wherever specification not provided, Item should be executed as per DSR 2018 & Specification of CPWD (Latest with up to date correction slips).

All Concrete (PCC/RCC etc.) works shall be done with OPC 43 grade cement and for all other works, PPC cement shall be used.

SECTION - II

1. GENERAL INSTRUCTIONS

- 1.1 All works specified in the tender have to be executed in accordance with:

- a) The latest DSR & guidelines of CPWD specifications as maximum wherever possible.
 - b) The rules and regulations of Local Authority Having Jurisdiction, and as per the statutory regulations applicable.
 - c) Applicable norms to be laid down by the relevant sections of latest editions of National Building Code (NBC) and all relevant codes of Bureau of Indian Standards (B.I.S.) shall be followed as applicable.
 - d) The codes of the Uniform Plumbing Code of India and relevant British Standards shall be used as a general guide for good engineering practice, design and workmanship norms.
- 1.2 All materials used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner, as specified hereinafter.
- 1.3 It is the contractor's responsibility to ensure the competence of design to meet the above requirements.
- 1.4 Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Interior design drawings issued by the Engineer-in-Charge. Work will be executed only as per approved shop drawings.
- 1.5 Contractors shall furnish detailed Shop drawings, hydraulic and other design calculations for approval.
- 1.6 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.
- 1.7 The work shall be carried out strictly as specified in Indicative list of items, Technical Specifications and drawings.

2. LICENSE AND PERMITS

- 2.1 Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

3. METRIC CONVERSION

- 3.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.
- 3.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

4. **REFERENCE POINTS**

- 4.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.
- 4.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

5. **DRAWINGS ISSUED TO CONTRACTOR**

- 5.1 Service drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.
- 5.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.
- 5.3 Contractor shall verify all dimensions at site and bring to the notice of the Architects, all discrepancies or deviations noticed. Architects decision shall be final.
- 5.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.
- 5.5 All drawings supplied with the tender shall be returned in good conditions along with the tender.
- 5.6 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.

All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings.

6. SHOP DRAWINGS

Shop drawings submitted by the contractor have to be approved for their design, functionality and structural stability by IIT Bhilai/ Consultant. So contractor should submit shop drawing well in advance so that work progress doesn't get suffered. The Contractor shall submit to the Engineer in charge Shop Drawings for Plumbing works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit Shop Drawings for execution to the Engineer-in-Charge. The Contractor shall also submit four copies of the Technical Specifications and Catalogues for all items.

6.1 All Sanitary Engineering drawings issued to the Contractor shall be studied by them. Contractor shall also obtain the necessary architectural, structural and other services drawings, based on which they shall prepare their shop drawings as per site conditions.

6.2 Shop drawings shall incorporate the following:

- All proposed Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Typical details for Toilets & Fixtures required.
- Plumbing layout plans as required and for any changes in the layout of Plumbing/ Architectural Drawings.
- Equipment & piping layout for Mechanical and Electrical equipment's as required, SLDs, mounting details of circuit breakers, location of panels, installation of terminals and faucets etc. w.r.t. finishes, surrounding levels & locations.
- Manufacturer's and Contractor's fabrication drawings.

6.3 The Contractor can only commence the work after the approval of above documents by Engineer in charge.

6.4 Contractors shall ensure that the Shop drawings are approved by the Engineer-In-Charge in charge prior to any execution.

7. COMPLETION DRAWINGS & DOCUMENTS

7.1 On completion of work contractor shall submit one complete set of original tracings and two prints of "As Built" drawings for the Engineer-In-Charge. These drawings shall have the following information.

- a) Run of all pipes with diameters and length on all floors and vertical stacks.
- b) Ground and Invert levels of all Plumbing services pipes.
- c) Location of all valves.
- d) Location of all Mechanical equipment with layout and piping connection.

7.2 All "Warranty / Guarantee" cards / certificates in original issued by the manufacturers shall be handed over to the Engineer-In-charge also in the form of a comprehensive record book / documents.

8. MATERIALS (SUPPLIED BY THE CONTRACTOR)

- 8.1 All materials used in the works shall conform to the tender specifications.
- 8.2 As far as possible all materials shall be bearing I.S. certification marks as per approval of the Engineer-In-Charge.
- 8.3 All materials shall bear the necessary certification marks, conforming to the Tender Specifications / Drawings requirements.
- 8.4 Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, materials of makes and specifications mentioned with tender shall be used.

9. INSPECTION AND TESTING OF MATERIALS

- 9.1 All materials before being allowed to be brought into the site/store will be preliminary / visually inspected at the entry gate of the project site by contractor quality control team. All materials at site/store room shall be regularly inspected by the Jen/Aen of CPWD as per quality control plan.
- 9.2 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.
- 9.3 For examination and testing of materials and works at the site Contractor can be asked to provide Testing and Gauging Equipment necessary but not limited to the followings: -

- a) Theodolite
- b) Dumpy level
- c) Steel tapes
- d) Weighing machine
- e) Plumb bobs, Spirit levels, Hammers
- f) Micrometers
- g) Thermometers, Stoves
- h) Hydraulic test machine
- i) Smoke test machine

9.4 All such equipment shall be tested for calibration at any approved laboratory, and the test and calibration certificate shall be submitted to the Engineer-In-Charge / Owner.

9.5 All Testing Equipment shall be preferably located in special room meant for the purpose.

10. MATERIALS SUPPLIED BY THE OWNER

10.1 The Contractor shall verify that all materials supplied by the Owner conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Engineer-In-Charge.

10.2 After receipt of materials, it shall be the responsibility of the Contractor for any damage found and he shall be liable to pay the actual cost of the material as per market rate at that time.

11. RECOVERY OF COST FOR MATERIALS ISSUED TO CONTRACTORS FREE OF COST

If any materials issued to the Contractor, free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to the Owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. or the actual cost given by the Owner shall be final and binding on the Contractor.

12. CONTRACTORS RATES

12.1 Rates quoted in this tender shall be inclusive of cost of materials, labor, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage, sales tax on works contract and all such expenses as may be

necessary and required to completely do all the items of work and put them in a working condition.

- 12.2 Rates quoted are for all heights and depths required for this work.
- 12.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.
- 12.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-In-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.
- 12.5 Rates quoted shall be inclusive of cost incurred in testing, commissioning of works.

13. **MOCK UP AND TRIAL ASSEMBLY**

The installation of Sanitary Fixtures and fittings shall be as per the shop drawings approved by Architect / Engineer in charge.

The Contractor shall have to assemble at least one set of each type of Sanitary Fixtures and Fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc, which will be required for final installation of all Sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / interior designers.

The Fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.

14. **EXECUTION OF WORK**

- 14.1 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of Architectural, HVAC, Electrical, Structural / Green Building Engineer in charge and other specialized services drawings.

- 14.2 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programme.
- 14.3. On award of the work, Contractor shall submit a programme of construction in the form of a Pert Chart or Bar Chart for approval of the Engineer-In-Charge / Owner. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.
- 14.4 Contractor shall be responsible for co-ordination with other agencies working on the project relating to their scope of work and shall take approval from the Engineer-In-Charge / Owner wherever required.

14.5 Cutting & Making Good

No structural member shall be chased or cut without the written permission of the Engineer-In-Charge.

15. TESTING

- 15.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.
- 15.2 All Tests shall be performed in the presence of the CPWD Field staff i.e Jen/Aen.
- 15.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.
- 15.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other by-laws in force.
- 15.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.
- 15.6 All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The Contractor shall block the ends of waste and ventilation pipes and shall conduct air test.

16. SITE CLEARANCE AND CLEANUP

- 16.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.
- 16.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.
- 16.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

17. FINAL INSTALLATION

The Contractor shall install all sanitary fixtures and fittings in their final position in accordance with the approved trial assemblies and as shown on the Drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal / replacement of Sanitary Fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting and the receiving pipes before making the joint. It shall be ensured that the receiving pipes are clear of obstruction. When Fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

18. PROTECTION AGAINST DAMAGE

The Contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation and handling over. At the time of handling over, the Contractor shall clean, disinfect and polish all the fixtures and fittings. Any Fixtures found damped, cracked, clipped, strained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

19. GUARANTEE / WARRANTY

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

- 19.2 The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
- 19.3 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

SECTION - III**SANITARY FIXTURES****1. SCOPE OF WORK**

- 1.1 The work in general shall be carried out as per CPWD Specifications-2009 Volume-I to II with up to date correction slips.
- 1.2 The rules and regulations of Local Authority Having Jurisdiction, and as per the statutory regulations applicable.
- 1.3 The codes of the latest National building code, Uniform Plumbing Code of India and relevant British Standards shall be used as a general guide for good engineering practice, design and workmanship norms.
- 1.4 Work under this section shall consist of furnishing all Material and labour as necessary and required to completely install all Sanitary Fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Indicative list of item.
- 1.5 Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.
- 1.6 Sanitary fixtures and Fitting shall be as per the GRIHA requirements.
- 1.7 Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

2. GENERAL REQUIREMENTS

- 2.1 All Fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Indicative list of item, Specifications and Drawings.
- 2.2 All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/ Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

2.3 Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.

- a) All Fittings and Fixtures shall be fixed in a neat workmanlike manner true to Levels and Heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all Inlet and Outlet Pipes at correct positions. Faulty locations shall be good made and any damage to the finished floor, tiling or terrace shall be made good at Contractors cost.
- b) When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge/Owner. Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

3.1. **EUROPEAN W.C.**

- 3.1.1 European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed or concealed type flushing cistern, as specified in Indicative list of item. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair/bolts as per approval.
- 3.1.2 Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- 3.1.3 The edge between fixtures and wall shall be sealed with approved type of poly sulphide sealant.

3.2 **INDIAN W.C.**

- 3.2.1 Indian W.C. pan shall be Orissa pattern of size as specified in the Indicative list of item. Each W.C. shall be provided with a 100 mm dia cast iron or porcelain P or S trap with or without vent horn.
- 3.2.2 W.C. shall be flushed by means of an exposed or concealed type cistern or as specified in Indicative list of item.

- 3.2.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) joints between W.C. and flush pipe shall be made with a putty or other means and linseed oil and caulked well or with an approved rubber joint.

4. **URINALS**

4.1 **URINALS WITH WATER FLUSH**

- 4.1.1 Urinals shall be white glazed Vitreous China flat back half stall or lip type as specified in Indicative list of item.
- 4.1.2 Half stall Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge/Owner.
- 4.1.3 Half stall urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.
- 4.1.4 Urinals shall be flushed by means of automatically sensor operated flushing system as specified in Indicative list of item.

4.2 **WATER LESS URINAL**

- 4.2.1 Urinals shall be white glazed Vitreous China flat back half stall type as specified in Indicative list of item.
- 4.2.2 Half stall Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge
- 4.2.3 Half stall urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.
- 4.2.4 Urinals shall be flushed by liquid as specified in Indicative list of item.

5. **SINKS**

- 5.1 Sinks shall be of precast Terrazzo marble or White Glazed fire clay or vitreous china or stainless steel or any other material as specified in the Indicative list of item.
- 5.2 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Fixing shall be done as directed by Engineer-in-Charge.

6.0 **WASH BASIN**

- 6.1 Wash Basins shall be white glazed vitreous chinaware of size, shape and type as specified in the Indicative list of item.
- 6.2 Each Basin shall be provided with R.S. or C.I. brackets duly painted. The clips and the basin securely fixed to wall and have accessories as mentioned in the Indicative list of item. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Architect/Consultants.
- 6.3 Each basin shall be provided with 32 mm dia. C.P. waste of standard pattern with pop-up waste or rubber plug and chain as specified in the detailed engineering, PDR and system requirement, 32 mm dia. C.P. brass bottle trap and angle valve with C.P. pipe to wall and flange as given in the Indicative list of items.
- 6.4 Each basin shall be provided with auto closing pillar cock or as specified in the Indicative list of items.
- 6.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cm or as directed by EIC.

7. **ACCESSORIES**

- 7.1 Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge and given in the Indicative list of item.
- 7.2 All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with raw plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge/Owner.
- 7.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

8. URINAL PARTITIONS

- 8.1 Urinal partitions shall be of granite as specified in the Indicative list of item and granite.

9. EWG PAN CONNECTOR

The EWG pan connector shall be Flexible, soft and shall be made of single body construction with integral fins. The pan connector must be supplied with factory fitted spring loaded seal guard.

While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush / adaptor shall be used. The connector socket is pushed fully home onto the pan spigot, thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such a easy as to ensure that the seals and fins turn inward to ensure proper sealing.

10. Hand Drier:

- 10.1 The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.
- 10.2 The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).
- 10.3 The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.
- 10.4 The hand drier shall be of wall mounting type suitable for 230V, single phase, 50 Hz, AC power supply.

11. Toilets for Disabled:

- 11.1 Where specified in washroom facilities designed to accommodate physically handicapped, accessories should be provided as directed by the Engineer-in-Charge.
- 11.2.1 Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by physically handicapped as directed by the Engineer-in-Charge.

SECTION - IV SOIL, WASTE & VENT PIPES

1. SCOPE OF WORK

- 1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the Indicative list of item.
- 1.2 Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:
 - a) Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints supports and clamps and connections to Fixtures.
 - b) Connection of pipes to Gully Traps & Manholes etc.

2. GENERAL REQUIREMENTS

- 2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.
- 2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 2.4 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.
- 2.5 All works shall be executed as directed by Engineer-in-Charge.

3. CAST IRON PIPES & FITTINGS (IS: 15905)

3.1 Pipes & Fittings

All pipes & fittings shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects & shall conform to the specifications as per IS:15905 for Hubless Cast iron soil, waste & ventilating pipes fittings & accessories, complete in all respects & as specified in the relevant item of the Indicative list of items.

3.2 Other Fittings

- a) Other casted CI Fittings used for drainage pipes shall conform to the required specifications & as per site conditions & wherever possible to the relevant IS code.

3.3 **Fixing**

- All vertical pipes shall be fixed by structural support or clamp truly vertical as decided by Engineer in charge. Branch pipes shall be connected to the stack at the same angle as that of the fittings. Each stack shall be terminated at top with a Cowl (terminal guard).
- Horizontal pipes running along ceiling shall be fixed on structural support adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surface.

3.4 **Jointing**

CI pipes shall be jointed with EPDM rubber gasket with SS 304 coupling of approved make only.

4. **PP MATERIALS LOW NOISE LEVEL FOR LAB WATSE PIPES**

The PP Materials based Pipe is a sound-absorbing, hot water resistant pipe system that is suitable for all pressure less sewage pipes according to DIN EN 12056 and DIN 1986-100. The pipes and molded parts are made of PP-M (mineral reinforced Polypropylene), so that general sound protection is guaranteed from the extraction positions to the manifold. PP can be delivered in the DN 50 to DN 200 dimensions with the density of 1.9 gm/cm³. The pipe has long life, and like all plastic materials, it is corrosion-resistant and resistant to aggressive effluents. No crust formation takes place due to the smooth surface. The lesser weight in comparison with metallic pipes and the quick, safe plug in fittings of the system make it easy to lay.

The pipe is resistant to hot water and fulfils the requirements of DIN 1986, which means 95°C short term and 90°C long term temperature loading. The pipe can be used for the drainage of wastewater between pH 2 and pH 12, eg in professional kitchens up to the house connection duct.

5. **UPVC PIPES (I.S. 4985) FOR RAIN WATER**

5.1 6 kg/cm² Class selection shall be as per Indicative list of items.

All fittings for uPVC pipes up to 200 mm O.D. size shall be injections moulded as per manufacturer, confirming to IS: 4985 and as specified in Indicative list of items.

- 5.2 For Fittings of sizes which are not injection moulded but fabricated (Locally/ Imported) sample of the same shall be submitted for approval.

6. **CLAMPS / STRUCTURAL SUPPORTS**

- 6.1 G.I. clamps shall be of standard design and fabricated from M.S. flat 40x3mm thick with required Galvanization.
- 6.2 Where G.I. clamps are to be fixed on RCC columns or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design or 6mm nuts and bolts.
- 6.3 Structural support shall be fabricated from M.S Structural members e.g. rods, angles, channels flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black Enamel paint. Wooden saddles, where required shall be provided free of cost.
- 6.4 Slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in indicative list of items, angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- 6.5 Wherever G.I. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge / Owner.

7. **TRAPS**

- 7.1 Floor traps shall be of CI, deep seal with an effective seal of 50 mm as given in Indicative list of items. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cm of the required depth. Where traps are suspended below ceilings, they shall be provided with proper structural supporting arrangements.

The inside surface of core of trap for bore packing by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brushing followed water jet to remove any laitance or loose flaky particles. Providing necessary form work for packing the bore using suitable arrangement (depending upon site conditions). Applying a coat of styrene- butadiene based polymer coating using Nitobond SBR to enhance adhesion between the packing material and other surfaces and Application of swellable Supercast SW20 at the middle of over the pipe external side and. Packing the gap using non-shrink cement polymer based grout using Conbextra GP2 upto the surface of the bore whilst the Nitobond SBR is in tacky state completely for 100 mm dia. pipe as per the manufacturer's Instruction and as per direction of the engineer-in-charge.

7.2 **PP Floor trap**

PP Floor trap has unique feature such as an air tight baffle construction and the incorporation of seals. The trap can be applied directly within the soil & waste system design.

Important aspects in the designing process are: -

- Knockout prevention
- Seals.
- Absorb/correct installation mistakes
- Durability
- Resistant to difficult installation circumstances

7.3 **Urinal Traps**

Urinal traps shall be of CI, deep seal with an effective seal of 50 mm as given in Indicative list of items. and set in cement concrete block specified in Para above without extra charge.

7.4 **Floor Trap Inlet**

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type G.I. inlet hopper without or with one, two or three inlet sockets to receive the waste pipe. Hopper shall be connected to trap with at least 50 mm seal (Hopper and traps shall be paid for separately).

7.3 **Floor drain (Reducing elbow)**

Reducing elbow shall be provided of GI material of 100X50 mm size for carrying of waste into floor trap. Provision for 125 mm grating on top shall be made. It shall be fixed into 100-125 mm sunken area.

7.4 **C.P./Stainless Steel Gratings**

Floor and Urinal Traps shall be provided with 100-150 mm square or round C.P/Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4-5 mm or as specified in the Indicative list of item.

8. **CLEANOUT PLUGS**

Contractor shall provide brass cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a male threaded adaptor.

9. **WASTE PIPE FROM APPLIANCES**

- 9.1 Waste pipe from appliances e.g. wash basins, sinks, urinals, water coolers shall be of G.I. heavy duty as given in the Indicative list of item or as shown on the drawings.
- 9.2 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps at approved spacing.

10. **CEMENT CONCRETE**

Soil and Waste pipes under floors in sunken slabs and in wall chases (When cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals as directed by Engineer-in-Charge/Owner.

11. **CUTTING AND MAKING GOOD**

Pipes shall be fixed and tested as buildings proceeds. Contractor shall provide all necessary holes' cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition. Core cutting wherever necessary is to be done by contractor without any extra cost.

12. **Slot Drain near drinking water area**

Bidder has to provide and installed the drain of polymer concrete with slot at the top matching with the tiling plan as per EN standards complete in all respect as per direction of Engineer in charge.

13. **Prefab drain channel**

Prefab-fab polymer concrete channels conforming to relevant EN standards with V-shaped profile, tongue and groove jointing arrangement, in-built ductile iron edge rail, with in-built slope along the complete length of the channel, and polymer concrete channels to be made of zero water absorption, of density being 2.1 - 2.3gm/cm³, with surface roughness of approx 25 µm, with SS grating at the top complete in all respect including all necessary civil and finishing works as required as per site and the instructions of the engineer - in - charge.

14. **INSPECTION & TESTING**

14.1 **Inspection**

Work should be inspected during installation and tests applied on completion, care being taken that, all work which is to be encased for concealed is tested before it is finally enclosed.

Inspection should be carried out to ensure the following:

- a) Work accords with the drawing and specifications.
- b) All pipe brackets, clips etc. are securely fixed.
- c) Fixtures are correctly spaced.
- d) Pipe is protected where necessary by Thermal Insulation.
- e) Embedded pipe work is properly protected before sealing-in
- f) All access covers, caps or plugs.
 - Are accessible
 - Are so made that the internal faces truly complete in internal bore.
 - Cause no obstruction in the pipe bore
 - Are well joined.

14.2 **Testing**

The soil, waste piping system and rain water should be tested after installation as follows:

(a) **Water Test**

The pipes shall be tested after installation & before the appliances are connected, preferably in sections so as to limit the static head of 4.5m. The pipe shall be filled with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. Then it will be necessary to seal all openings and leaks at joints immediately as observed during the test and all defective pipes shall be rejected and removed from the site. Pipes with minor sweating shall be accepted at the discretion of the Engineer-in-Charge.

(b) **Smoke Test**

Alternatively, the Contractor may test all Soil, Waste and Rainwater stacks by smoke testing machine. The smoke test shall be carried out as under:

Smoke shall be pumped into the stack after plugging all inlets and connections at the lowest points from a smoke testing machine which consists of a bellow & burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detected by sight as well as by smell, if there is leak at any points of the pipe. The top end shall however be left open. The stack shall then be observed for leakiness and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge.

- 14.3 A test register shall be maintained and all entries shall be signed and dated by Contractors and CPWD field staff i.e Jen/Aen.

SECTION – V**WATER SUPPLY SYSTEM****1. SCOPE OF WORK**

- 1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Indicative list of item.
- 1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following: -
- a) Internal and External water supply system and making connection from external sources for all buildings etc.
 - b) Drinking water supply system
 - c) Pipe protection and painting.
 - d) Control valves, masonry chambers and other appurtenances.
 - e) Connections to all toilets, storage tanks and appliances.
 - f) Excavation and refilling of pipe trenches, wherever required.
 - g) Trenches for taking pipe lines for these services.

2. GENERAL REQUIREMENTS

- 2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge / Owner.
- 2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
- 2.4 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 2.6 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3. G.I. PIPES & FITTINGS

- 3.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239-1979 of class B.
- 3.2 Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include

Couplings, Bends, Tees, Reducers, Nipples, Unions, Bushes, Fittings shall be of I.S:1879 - (part I to X) 1975.

- 3.3 The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. Teflon Tape should be used on threads instead of 'Dhaaga/ Safeda'. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

4. **CPVC PIPES AND FITTINGS**

4.1 **Description**

CPVC piping shall be Fire Proof, Corrosion resistance with smooth, friction free interior surfaces and with anti - bacterial growth properties.

4.2 **JOINING TUBING & FITTINGS**

(a) **Cutting**

CPVC tubing shall be cut with a wheel-type plastic tubing cutter, a hack saw or other fine toothed hand or power saws. Use of ratchet cutters shall be permitted, provided blades are sharpened regularly. A milter box should be used to ensure a square cut when using a saw.

(b) **Deburring/Beveling**

Burrs and fillings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing. A chamfering tool shall be used for this purpose. A slight bevel on the end of the tubing shall be provided to enable entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

(c) **Fitting Preparation**

The surfaces shall be wiped clean of dirt and moisture from the fitting sockets and tubing end. Check the dry fit of the tubing and fitting. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket.

(d) Solvent Cement Application

Only approved type Solvent Cement shall have used for jointing the CPVC pipes, which shall be procured as per the manufacturer recommendations. Apply an even coat of Cement Solvent on the Pipe end after cleaning of whole pipe and also inside the fittings socket. Old or deteriorated or thickened or Lumpy Solvent Cement shall not be used.

(e) Assembly

Immediately insert the pipe into fitting socket, rotate the pipe $\frac{1}{4}$ to $\frac{1}{2}$ turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set-up. An even bead of cement should be evident around the socket edge; it may indicate that sufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and fitting surfaces for an attractive, professional appearance.

5. **STAINLESS STEEL PIPES FOR DRINKING WATER SYSTEM**

The SS pipe for drinking water purposes shall be of grade SS-316 & conforming to EN 10312 standard compete with Press type fittings with SC-Contur in accordance with international regulation (DVGW - W534) & as per approved makes & specifications, complete as per the instructions of Engineer-in-charge & as specified in the Indicative list of items.

6. **CLAMPS**

G.I. pipes in shafts and other locations shall be supported by M.S clamps. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

7. **UNIONS**

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge / Owner.

8. **FLANGES**

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge / Owner. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by

Engineer-in-Charge / Owner. Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

9. **TRENCHES**

The external water supply pipes below ground shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 150mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

10. **PAINTING ON EXPOSED WATER SUPPLY PIPES**

- 10.1 All surfaces shall be thoroughly cleaned before painting.
- 10.2 All pipes above ground shall be painted with one coat of primer and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge/Owner.

11. **PIPE PROTECTION FOR UNDERGROUND WATER SUPPLY PIPES**

Corrosion protection tape shall be wrapped on GI pipes to be buried in ground. This corrosion protection tape shall comprise of coal tar/asphalt component supported on fabric of organic or inorganic fibre and minimum 4 mm. thick and conform to requirement of IS:10221 - code of practice for coating and wrapping of underground line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then be wound around the pipe in spiral fashion and bounded completely to the pipe. There shall be no air pocket or bubble beneath the tape. The overlaps shall be 15 mm and 250 mm shall be left uncoated on either end of pipe to permit installation etc. This area shall be coated insitu after the pipe line is installed. The tape shall be wrapped in accordance with the manufacturer's recommendations. If application is done in cold weather, the surface of the pipe shall be pre-heated until it is warm to touch and traces of moisture are removed and then primer shall be applied and allowed to dry.

12 **BALL VALVES**

The Ball Valve shall be made from forged brass and tested to 16 Kg/cm² pressure. The valve shall be internally threaded to receive pipe connections. The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body bonnet gasket and gland packing shall be of Teflon. The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm² pressure. The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree.

13. **BUTTERFLY VALVES**

- The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS : 13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).
- The direction of opening and closing shall be marked and an open / shut indicator fitted.
- The material of valves shall be as under:-

Body	-	Cast iron
Disc	-	Ductile Iron
Seat	-	EPDM/Nitrile rubber
Shaft	-	Stainless Steel

- The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.
- Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

15 **Motorized Butterfly valve at the inlet of over head tanks:**

Contractor has to install the IP 67 (Weather Proof /Aluminium casing with positioner to indicate the valve position with key type manual overdrive) Motorized Butterfly valve for filling of over head water tank complete with high and low level float type sensors to control the valve. The sensors shall be installed in over head tanks. The sensors will close the valve when water level is high in over head tank and open the valve when over head water tank level is low. The system should be complete in all respects with control panel indicating the position of valve i.e open /closed with accessories like wiring /conduiting /flanges, nut bolts etc complete as per approved type and specifications as per instructions of the engineer - in - charge.

16. **Fittings and Inspection Chambers**

Fittings and chambers shall be provided as required.

16.1 **Anchor Block**

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

16.2 **Rubber Joints**

Joints between two pipes shall be made by pre-moulded rubber joints with suitable tackles in a manner recommended & approved by the manufacturer. No joints shall be covered until the lines are hydraulically tested.

17. **VALVE CHAMBERS**

- 17.1 Contractor shall construct chambers for all full way valves, butterfly valves and other type of valves as specified in the Indicative list of items. These shall be made, in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 coarse sand: 10 graded stone aggregate 40mm nominal size) 12 mm thick cement plaster 1:3(1 cement : 3 coarse sand) inside finished with a floating coat of neat cement with 8mm thick CI surface box with hinged cover and locking arrangement, 150 mm thick reinforcement cement concrete top slab of 1:2:4 (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size), as specified and shown in drawings, including excavation, back filling rammed and outside rough plaster of 15mm complete or as specified in Indicative list of items.

- 17.2 Valve chambers shall be constructed as specified in indicative list of items but generally shall be of following sizes:

	Length (mm)	Width (mm)	Depth (mm)
For pipes dia. up to 50 mm	300	300	500
For pipes dia. 65 to 80 mm	600	600	1000
For pipes dia. 80 mm and above	750	750	1000

18. **TESTING**

- 18.1 All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm² in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. ($\pm 10\%$). A test register shall be maintained and all entries shall be signed and dated by Contractor and Jen/Aen of CPWD

- 18.2 In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.
- 18.3 After completion of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

19. **DISINFECTION**

- 19.1 After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.
- 19.2 After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

20. **PRE COMMISSIONING**

- 20.1 Ensure that all pipes are free from debris and obstructions.

- 20.2 Check all valves for effective opening and closing action. Defects should be rectified or valves replaced.
- 20.3 Ensure that all Connections to Branches have been made.
- 20.4 Ensure that mains have been connected to the respective pumps, underground and overhead tanks.
- 20.5 Water supply should be available at main Underground tank.
- 20.6 All main line Valves should be closed.

21. **COMMISSIONING**

- 21.1 Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.
- 21.2 Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.
- 21.3 After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).
- 21.4 Fill Overhead tank to full.
- 21.5 Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.
- 21.6 Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.
- 21.7 Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.
- 21.8 The entire water supply system should be disinfected with bleaching powder and system flush cleaned.
- 21.9 Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

22. **RESPONSIBILITY**

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

SECTION – VI SEWERAGE / DRAINAGE SYSTEM AROUND THE BUILDINGS

1. SCOPE OF WORK

- 1.1 Work under this section shall consist of furnishing all Labour, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as required by the drawings and specified hereinafter or given in the Indicative list of item.
- 1.2 Without restricting to the generality of the foregoing, the sewerage system shall include:
- Installation of all sewer lines / effluent lines around the buildings.
 - Installation of all storm water drainage lines around the buildings
 - Construction of all catch basins, chambers, manholes & other related civil works etc. around the buildings

2. GENERAL REQUIREMENTS

- 2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.
- 2.2 Drainage lines shall be laid to the required gradients and profiles.
- 2.3 All drainage work shall be done in accordance with the local Municipal bye laws.
- 2.4 Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site.

3. ALIGNMENT AND GRADE

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge / Owner from time to time to meet the requirements of the works. Drawings are only indicative in nature, Contractor to submit shop drawing before execution of work.

4. **DWC PIPES FOR SEWERAGE LINE**

- 4.1 DWC Pipes shall confirm IS 16098 (Part-2) and of SN8 class, have a smooth internal surface and corrugated external surface. The corrugated external surface provides greater stiffness, withstands soil movement & takes higher loads (static & dynamic), whereas the internal surface helps in smooth flow of sewerage. DWC Pipes are manufactured using HDPE polymer. These pipes are resistant to various types of gases & chemicals which are generated due to purification of various ingredients flowing in the system.
- 4.2 All the pipes shall be jointed Socket & Spigot joint with elastomeric sealing ring.

5. **GULLY TRAPS**

- 5.1 Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters.

6. **REINFORCED CEMENT CONCRETE PIPES FOR STORM WATER SYSTEM**

- 6.1 All underground storm water drainage pipes where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of NP-2 class. Pipes shall be true and straight with uniform bore. Throughout cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

6.2 **Laying**

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings the cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge

6.3 **Jointing**

After setting out the pipes the collars shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools all joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly.

7. **TESTING**

All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole. All pipes shall be subjected to a test pressure of at least 1.5-meter head of water. The test pressure shall, however, not exceed 1.5-meter head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head. The tolerance figure of two liters per centimeter of dia per kilometer may be allowed during a period of ten minutes. Subsidence of the test water may be due to one or more of the following causes:

- Absorption by pipes and joints
- Sweating of pipe or joints
- Leakage at joints or from defective pipes

(a) **Trapped Air**

Allowance shall be made for (i) by adding water until absorption has ceased after which the test proper should commence. Any leakage will be visible and the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

(b) **Sewer and Drain Pipelines shall be tested for straightness by:**

- Inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invent of the pipe and emerge at the lower end.
- Means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

- (c) The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Engineer-in-Charge.
- (d) A test register shall be maintained which shall be signed and dated by Contractor and Assistant Engineer.

8. **CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.**

8.1 **Cement Concrete for Pipe Support**

- (a) Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed and haunching as mentioned.
- (b) Unless otherwise directed by the Engineer-in-Charge, cement concrete shall be laid as follows:-

Description	Bedding and Haunching
All underground Sewerage pipes around the buildings	All round (1:5:10)
All underground storm water drainage pipes around the buildings	Minimum width of bedding and haunching is D. Thickness of bedding is $d/4$ or 100mm which ever is higher and haunching is upto $D/4$ only.(d is internal diameter and D is external diameter of pipe).Grade of concrete is 1:5:10

- (c) R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.
- (d) Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

9. **MANHOLES AND CHAMBERS**

- 9.1 All manholes (other than RCC manholes), chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) or as specified in the Indicative list of item and standard details drawing.
- 9.2 All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix as given in the Indicative list of item or shown on the drawings or as per CPWD specifications

Where not specified, Manholes may be constructed as follows:-

(All dimensions internal clear in cms) (As / MMC Regulation)

Size of Manhole Type	90x80 Rect.	120X90 Rect.	91 dia Circular	122 dia Circular	152 dia Circular
Maximum depth	As per CPWD specifications				
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia)	61x45.5	560 dia.	56 dia	56 dia	56 dia
Weight of cover and frame not less than	Heavy duty as specified in the drawings	Heavy duty as specified in the drawings	Heavy duty as specified in the drawings	Heavy duty as specified in the drawings	Heavy duty as specified in the drawings

- 9.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm towards the channel. Benching shall be finished with a floating coat of neat cement.
- 9.4 All manholes shall be plastered with 12mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. All brick masonry Manhole shall also be plastered outside with 15mm thick cement mortar.
- 9.5 All manholes with depths greater than 1 M. shall be provided with plastic encapsulated foot rest as specified in indicative drawing vertically and staggered.

10. **NEUTRALIZATION CHAMBER**

These shall be provided on Laboratory Room waste lines before discharging the waste into the main sewer line. It shall be built in RCC masonry and shall be similar in construction to manholes. They shall be constructed to size as shown at the location on drawings and shall be provided with drop inlet, drop outlet, galvanized wrought iron sediment pan and a baffle wall. It shall be provided with 2 Nos., double seal DI Heavy duty manhole cover and frame.

11. **MAKING CONNECTIONS**

Contractor shall connect the new sewer line to the existing manhole by cutting the, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

12. **COMMISSIONING**

12.1 After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary pipings, labours, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of PWD Engineers whenever and as may be required. Generally, the following test/inspection has to be carried out:-

- (a) For any Leakages/seepages in the external sewerage and drainage pipes.
- (b) For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- (c) For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

8.0 INDICATIVE LIST OF ITEMS FOR INTERNAL PLUMBING SYSTEM

Note:- These items are given to facilitate the contractor to complete the work however if some minor items are found missing in the list but is required to complete functioning of the work. Nothing will be paid extra.

S. No.	Indicative List of Items
-----------	--------------------------

SH 8 PLUMBING WORKS

8.1 SANITARY FIXTURES

- 8.1.1 Providing & fixing white vitreous china wall hung type European type water closet with C.P. bolts, nuts, C.I. chair or other hanging arrangement, with white solid plastic seat and cover with lid, dual flush PVC expose cistern (4/2 lpf) with Cistern fittings, C.P. brass hinge rubber buffers, with accessories, C.I./M.S. brackets painted with two coats of enamel paint of approved shade over a coat of primer. C.P. brass screws, wooden cleats including cutting and making good the wall and floors wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.2 Providing and Fixing vitreous china floor mounted (European Type) water closet with 'P' or 'S' trap, C.P. bolts, nuts with solid plastic seat & lid, C.P brass hinged rubber buffers with (dual flush 4/2 lpf) cistern with flush pipe, clamp and rubber adapter joint C.P.brass screws and washers complete including cutting and making good the walls and floors wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.3 Providing and fixing water closet squatting pan (Indian type W.C. pan) with 100 mm sand cast Iron P or S trap, dual flush (4/2 lpf) white P.V.C. flushing cistern of 6 ltr, including flush pipe, with manually controlled device (handle lever) conforming to IS : 7231, with all fittings and fixtures complete, including cutting and making good the walls and floors wherever required etc. complete in all respect as per direction of Engineering-in-charge.

White Vitreous china Orissa pattern W.C. pan of size 580x440 mm with integral type foot rests

- 8.1.4 Providing and Fixing White vitreous china Under counter wash basin with C.I. brackets painted white, 15 mm CP Brass auto closing pillar cock of flow less than 3 lpm, 32mm dia. C.P. waste, C.P chain and rubber plug, C.P. connecting pipe to wall and C.P wall flange and rubber adapter for waste connection complete including cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.6 Providing and Fixing vitreous china urinal with electrical/battery operated concealed automatic flushing system flow less than 3.0 lpf CP Brass body with C.I. hangers, 15mm dia inlet to built in spreaders with inbuilt waste with C.P flange for urinal complete including cutting and making good the walls and floors wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.7 Providing and Fixing vitreous china water less urinal with C.I. hangers, 15mm dia inlet to built in spreaders with inbuilt waste with C.P flange, complete including cutting and making good the walls and floors wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.8 Providing and fixing stone slab with table rubbed, edges rounded and polished, of size 75x50 cm deep and 1.8 cm thick, fixed in urinal partitions by cutting a chase of appropriate width with chase cutter and embedding the stone in the chase with epoxy grout or with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) as per direction of Engineer-in-charge and finished smooth.
- Granite Stone of approved shade
- 8.1.9 Providing and fixing sink with C.I. brackets, C.P. brass chain with rubber plug, 40 mm C.P. brass waste complete, including painting the fittings and brackets, cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- a) White glazed fire clay sink of size 600x450x 250mm
- 8.1.10 Providing and fixing Stainless Steel A ISI 304 (18/8) kitchen sink as per IS: 13983 with C.I. brackets and stainless steel plug 40 mm, including painting of fittings and brackets, cutting and making good the walls wherever required :
- 510x1040mm bowl depth 200 mm (Kitchen sink with drain board)
- 8.1.11 Providing and Fixing of wall mounted C.P. brass Sink mixer flow less than 6.0 lpm including cutting and making good the walls wherever required complete in all respects as per direction of the Engineer-in-charge

- 8.1.12 Providing and fixing white vitreous china laboratory sink with C.I. brackets, C.P. brass chain with rubber plug, 40 mm C.P brass waste and 40mm C.P. brass trap with necessary C.P. brass unions complete, including painting of fittings and brackets, cutting and making good the wall wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- Size 600x450x200 mm
- 8.1.13 Providing & fixing CP brass elbow action bib cock for lab sink flow less than 6.0 lpm including cutting & making good the walls wherever required complete in all respects as per Engineer-in-charge.
- 8.1.14 Providing and Fixing 15 mm nominal bore CP Brass long body bib cock flow less than 6.0 lpm of approved quality conforming to IS Standards etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.15 Providing and Fixing C.P. brass towel ring "Round" fixed to PVC cleats with C.P. brass screws including cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.16 Providing and fixing SS liquid soap dispenser with push lever assembly with soap refill fixed in wall with Screws complete in all respect as per direction of the engineer-in-charge
- 8.1.17 Providing and fixing S.S. body tissue paper dispenser complete including cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.
- 8.1.18 Providing and fixing CP Brass Bottle Trap of approved quality & make etc. complete in all respect as per direction of Engineering-in-charge.
- a) 32 mm dia
 - b) 40 mm dia
- 8.1.19 Providing and fixing C.P. brass angle valve of approved quality conforming to IS:8931 etc. complete in all respect as per direction of Engineering-in-charge. 15mm nominal bore

- 8.1.20 Providing and Fixing C.P. Brass Toilet paper holder, including cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.21 Providing and fixing Health faucet with 1 metre long Flexible Tube and CP wall hook with PVC & SS Screws flow less than 6 lpm wherever required complete as directed by the Engineer-in-charge

- 8.1.22 Providing and Fixing two way bib cock flow less than 6.0 lpm complete, including cutting and making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.23 Providing and Fixing Handicapped set including white vitreous china floor mounted European type water closet including dual flush exposed cistern (4/2 lpf) , Flat Back wash basin with one pair of mounting brackets , complete with fittings, seat cover, two no hinged rail 76 cms and five nos of grab bar 60 cms including 15 mm dia autoclosing pillar cock flow less than 3.0 lpm for Handicaped Toilet complete in all respect as per direction of the engineer-in-charge.

- 8.1.24 Providing and fixing C.P cast brass Double coat hook as approved with C.P. brass screws complete as per instructions of the engineer-in-charge.

- 8.1.25 Providing and Fixing C.P brass Aerosol perfume dispenser, fixed to wooden cleats / Rawl Plug with C.P brass screws, complete wherever required etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.26 Providing & fixing CP emergency shower with pull chain connected to water supply pipes including cutting & making good the walls complete in all respects required as per Engineer-in-charge.

- 8.1.27 Providing & Fixing CP self closing eye wash fountain with CP waste, CP chain & rubber plug, CP cast brass bottle trap & CP connecting pipe to wall and CP wall flange & rubber adopter for waste connection complete in all respects including cutting & making good the walls wherever required etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.28 Providing and Fixing straight / offset type flexible single body push fit type WC pan connector with factory supplied seal guard with integral Single mould sealing fins made of flexible EVA body, including bush / adaptor for use with C.I. Pipe as supplied with the pan connector etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.29 Providing and fixing Stainless Steel Body Auto hand drier to be operated with 220 volts, single phase, with fully hygienic condition, with all accessories including cutting and making good the walls, wherever required etc. complete in all respect as per direction of Engineering-in-charge.

- 8.1.30 Providing and Fixing in position storage type Hot Water electrical vertical heaters with copper container, insulation, and stove enameled M.S. jacket, thermostatically controlled immersion heater, with pilot lamp, 15/20mm dia inlet with non return valve and 15/20mm dia outlet including making connections complete in all respects. (wall mounted with suitable M.S. bolts and nuts)
- a) 25 Ltr

8.2 SOIL, WASTE AND VENT PIPES

- 8.2.1 Providing and fixing soil, waste and vent pipes :

100 mm dia

Hubless centrifugally cast (spun) iron pipes epoxy coated inside & outside IS:15905

- 8.2.2 Providing and Fixing M.S. Holder bat clamp (factory manufactured) of approved design to sand cast iron / cast iron (spun) pipes comprising of M.S. flat brackets made of 50x5 mm flat of specified shape, projecting 75 mm outside the wall surface and fixed on wall with 4 Nos, 6 mm diameter expansion hold fasteners including drilling necessary holes in brick wall /CC/RCC surface and the cost of bolts etc. . The pipes shall be fixed to the already fixed brackets with the help of 30 mmx1.60 mm galvanized M.S. flats of specified shape and total length 420 mm and shall be fixed with M.S. nuts, bolts and washers of size 25x6 mm, one bolt on each side of the pipe.

Total bracket length 580 mm of approved shape and design, (for single 100 mm dia pipe)

Total bracket length 810 mm of approved shape and design, (for single 100 mm dia pipe)

- 8.2.3 Providing and fixing bend of required degree with access door, insertion rubber washer 3 mm thick, bolts and nuts complete.

100 mm dia

Hubless centrifugally cast (spun) iron epoxy coated inside & outside as per IS:15905

- 8.2.4 Providing and fixing plain bend of required degree.

100 mm dia

Hubless centrifugally cast (spun) iron pipes epoxy coated inside & outside IS:15905

- 8.2.5 Providing and fixing single equal plain junction of required degree :
100x100x100 mm
Hubless centrifugally cast (spun) iron epoxy coated inside & outside as per IS:15905
- 8.2.6 Providing and fixing double equal plain junction of required degree.
100x100x100x100 mm
Hubless centrifugally cast (spun) iron pipes epoxy coated inside & outside IS:15905
- 8.2.7 Providing and fixing door piece, insertion rubber washer 3mm thick, bolts & nuts complete :
100 mm
Sand cast iron S&S as per IS – 3989
- 8.2.8 Providing and Fixing 100 mm dia Terminal guard for Hubless centrifugally cast (spun) iron epoxy coated inside & outside as per IS:15905
100 mm
Hubless centrifugally cast (spun) iron epoxy coated inside & outside as per IS:15905
- 8.2.9 Providing and fixing shielded coupling for Hubless centrifugally cast iron pipe
100 mm dia
SS 304 grade coupling with EPDM rubber gasket
- 8.2.10 Providing and fixing M.S. stays and clamps for sand cast iron hubless pipes of diameter:
100mm
- 8.2.11 Providing and fixing trap of self cleansing design with screwed down or hinged grating with or without vent arm complete, including cost of cutting and making good the walls and floors :
100 mm inlet and 100 mm outlet
Hubless centrifugally cast (spun) iron epoxy coated inside & outside as per IS:15905
- 8.2.12 Making khurras 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1 m x 1 m x 400 micron, finished with 12 mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges and making and finishing the outlet complete.

- 8.2.13 Providing and Fixing G.I. Reducing elbow (Floor drain) of 100 x 50 mm in cement concrete 1:2:4 at all levels for floor drains for connection to floor traps in sunken portions, complete as per drawings and as per approval of the engineer-in-charge.
- 8.2.14 Providing, fixing, testing & Commissioning of PP materials filled low noise level soil, waste and vent pipe with density 1.9 g/cm³ conforming to DIN EN 12056 along with all required fittings like tees, bends, cowls, crosses with or without access doors jointed with approved push fit rubber ring socket joint / solvent cement fixed to walls and ceilings, cutting holes in brickwall wherever required, filling the annular space between pipe & wall/slab/beam with hand mixed concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and making good the floors, beams and walls with cement mortar where required complete of outer diameter.**(For LABS)**
- a) 50 MM OD
 - b) 75 MM OD
 - c) 110 mm OD
- 8.2.15 Providing and fixing on wall face unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion.(i) Single socketed pipes.
- a) 75 MM Diameter
 - b) 110 MM Diameter
- 8.2.16 Providing and fixing 100 mm diameter and 60 cm long rain water spout in cement mortar 1:4 (1 cement : 4 fine sand).
- a) uPVC spout Type A
- 8.2.17 Providing and fixing on wall face unplasticised - PVC moulded fittings/ accessories for unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion.
- a) Single Push fit coupler
 - 75 mm dia
 - 110 mm dia
 - b) Single Tee with door
 - 75x75x75 mm dia
 - 110x110x110 mm dia

c) Bend 87.5 Deg

75 mm dia

110 mm dia

d) Shoe (Plain)

75 mm dia

110 mm dia

8.2.18 Providing and Fixing of G.I. coated holder bat clamp of approved design to uPVC pipes comprising of G.I. coated holder flat brackets made of 50X5 mm flat of specified shape, projecting 75 mm outside the wall surface and fixed on wall with 2 nos. 6 mm dia. expansion hold fasteners, including drilling necessary holes in brick wall/CC/RCC surface and cost of bolts etc. The pipes shall be fixed to the already fixed brackets with the help of 6 mm dia. galvanised bar of specified shape and of total length 400 mm and shall be fixed with G.I. coated nuts, bolts & washers one bolt on each side of the pipe etc complete in all respect as per direction of Engineering-in-charge. (Rain water pipes)

a) 75 mm dia

b) 110 mm dia

8.2.19 Providing and Fixing to the inlet mouth of rain water pipe SS 304 grating of following diameter complete in all respects as per direction of the engineer-in-charge

a) For 75 mm dia

b) For 100 mm dia

c) For 150 mm dia

8.2.20 Providing and Fixing G.I. "B" class pipe complete with G.I. Fittings and clamps, including cutting and making good the walls etc. (Internal work)

a) 32 mm dia

b) 40 mm dia

c) 50 mm dia

8.2.21 Painting of G.I. Pipes and fittings with two coats of anti-corrosive bitumastic paint of approved quality.

a) 32 mm dia

b) 40 mm dia

c) 50 mm dia

- 8.2.22 Providing and fixing G.I. Inlet fittings with maximum 3 inlets 32, 40 & 50 mm size fabricated from 100 mm dia G.I. pipes and welded G.I. sockets, fixed to C.I. Trap with joints and set in cement concrete (1:2:4) complete as directed by Engineer-in-charge.
- 8.2.23 Providing and Fixing SS 304 Grating with frame and SS Screws casted heavy 125 mm dia complete as directed by Engineer-in-charge.
- 8.2.24 Providing and fixing cast brass cleanout plug / floor cleanout with suitable insert keys for opening, male threaded joint with G.I. socket caulked to spun soil pipe including cost of joint etc. complete as directed by Engineer-in-charge.
- a) 100 mm dia
- b) 150 mm dia
- 8.2.25 Providing and fixing 160 mm dia UPVC rain water pipes of 6 kg./cm² 'Type A' conforming to IS: 4985 including all fittings with or without access door or without access i.e bends, junctions, cowls, offsets, etc., and jointing with solvent cement and excavation, refilling and disposal of surplus earth, including cutting holes in walls and floors, excavation, refilling and disposal of surplus earth wherever required and making good the same, complete as directed by the Engineer-in-Charge.
- 8.2.26 Making core cutting holes for C.I. Pipe of 100 mm dia. etc. in R.C.C. floors and roofs for passing C.I. pipe etc. and repairing the hole after insertion of C.I. pipe etc. with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), including finishing complete so as to make it leak proof.
- 8.2.27 Providing and fixing 6 mm dia. G.I. level adjusting hangers (upto 1200mm length), fixed to roof slabs by means of ceiling cleats made out of G.I. flat 40x3mm size 60 mm long and stainless steel expandable dash fastener of 12.5 mm dia and 50 mm long, complete as per direction of Engineer-in-charge.
- 8.2.28 Preparing the inside surface of core for bore packing by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brushing followed water jet to remove any laitance or loose flaky particles. Providing necessary form work for packing the bore using suitable arrangement (depending upon site conditions). Applying a coat of styrene-butadiene based polymer coating using Nitobond SBR to enhance adhesion between the packing material and other surfaces and Application of swellable Supercast SW20 at the middle of over the pipe external side and. Packing the gap using non-shrink cement polymer based grout using Conbextra GP2 upto the surface of the bore whilst the Nitobond SBR is in tacky state completely **for 100 mm dia. pipe** as per the manufacturer's Instruction and as per direction of the engineer-in-charge.

- 8.2.29 Providing and fixing pre-fab polymer concrete channels conforming to relevant EN standards with V-shaped profile, tongue and groove jointing arrangement, in-built ductile iron edge rail, with in-built slope along the complete length of the channel, and polymer concrete channels to be made of zero water absorption, of density being 2.1 - 2.3 gm/cm³, with surface roughness of approx 25 µm, with SS grating at the top complete in all respect including all necessary civil and finishing works as required as per site and the instructions of the engineer - in - charge, for following sizes: Size 250 x 385 mm (B x H)
- 8.2.30 Supply and installation of Slot Drain K-100 Brickslot polymer concrete channels having Length of 1000 mm, Width of 130 and depth as per site requirement conforming to Euro Norms DIN EN 1433 of , V-shaped profile, tongue and groove jointing arrangement, inbuilt galvanized iron edge rail and a approx weight of 16 kg/unit. These channels have Stainless Steel Slot and conforming to Load Class A15 as per EN DIN 1433. Inspection Unit of 500 mm length ,130mm width and depth as per site requirement is also provided with the unit .

8.3 WATER SUPPLY (INTERNAL AND EXTERNAL AROUND THE BUILDING)

- 8.3.1 Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m :
All Kinds of Soil Pipes, cables etc, not exceeding 80 mm dia.
- 8.3.2 Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m :
All Kinds of Soil Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia
- 8.3.3 Providing and fixing G.I. pipes complete with G.I. fittings and clamps, i/c cutting and making good the walls etc. Internal work - exposed on wall
- a) 20 mm nominal bore
 - b) 25 mm nominal bore
 - c) 32mm nominal bore
 - d) 40 mm nominal bore
 - e) 50 mm nominal bore
 - f) 65 mm nominal bore
 - g) 80 mm nominal bore
- 8.3.4 Providing and fixing G.I. pipes complete with G.I. fittings including trenching and refilling etc. External works
- a) 25 mm nominal bore
 - b) 32 mm nominal bore
 - c) 40 mm nominal bore
 - d) 50 mm nominal bore
 - e) 65mm nominal bore
 - f) 80mm nominal bore
 - g) 100 mm nominal bore
 - h) 150 mm nominal bore

- 8.3.5 Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, i/c fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and the cost of cutting chases and making good the same including testing of joints complete as per direction of Engineer in Charge.

CONCEALED WORK, including cutting chases and making good the wall etc.

- a) 15 mm nominal outer dia pipes
- b) 20 mm nominal outer dia pipes
- c) 25 mm nominal outer dia pipes
- d) 32 mm nominal outer dia pipes
- e) 40 mm nominal outer dia pipes
- f) 50 mm nominal outer dia pipes

- 8.3.6 Providing and fixing Stainless Steel 316 L pipes confirming to EN 10312 complete with Press Type fittings with SC-Contur in accordance with DVGW regulation W534 such as sockets, bends, elbows, tees, reducers, unions, Flanges, clamps/structural steel supports, hangers etc. necessary adapters SS to CP fittings, jointing, sundries, cutting holes in walls/floors/slabs & making good including wrapping with polythene sheet tape etc. **(For drinking water purposes):**

- a) 15 mm OD
- b) 22 mm OD
- c) 28 mm OD
- d) 35 mm OD
- e) 42 mm OD

- 8.3.7 Providing and fixing G.I. Union in G.I. pipe including cutting and threading the pipe and making long screws etc. complete (New work) :

- a) 20 mm dia
- b) 25 mm dia
- c) 32 mm dia
- d) 40 mm dia
- e) 50 mm dia
- f) 65 mm dia
- g) 80 mm dia

- 8.3.8 Painting G.I. pipes and fittings with synthetic enamel white paint with two coats over a ready mixed priming coat, both of approved quality for new work :
- a) 20 mm dia
 - b) 25 mm dia
 - c) 32 mm dia
 - d) 40 mm dia
 - e) 50 mm dia
 - f) 65 mm dia
 - g) 80 mm dia
- 8.3.9 Providing and filling sand of grading zone v or coarser grade all-round the G.I. Pipe in external work
- a) 25 mm dia pipe
 - b) 32 mm dia pipe
 - c) 40 mm dia pipe
 - d) 50 mm dia pipe
 - e) 65 mm dia pipe
 - f) 80 mm dia pipe
 - g) 100 mm dia pipe
 - h) 150 mm dia pipe
- 8.3.10 Providing and Laying anti corrosive tape, 100 mm wide and 4 mm thick including an initial coat of primer for preventing the corrosion of buried pipes in trenches, complete in all respects as per the direction of engineer-in-charge.
- a) 25 mm dia pipe
 - b) 32 mm dia pipe
 - c) 40 mm dia pipe
 - d) 50 mm dia pipe
- 8.3.11 Providing and fixing forged brass lever operated ball valve of full flow with forged brass ball (Machined to mirror smooth finish with hard chrome plated) and spindle with setting and gland of superior quality having minimum working pressure of 16 kg/cm² etc. complete in all respect.

- a) 20 mm dia
- b) 25 mm dia
- c) 32 mm dia
- d) 40 mm dia
- e) 50 mm dia

8.3.12 Providing and fixing C.I butterfly valve, wafer end type class PN 1.6 as per I.S:13095 or BS:5155, including necessary nuts, bolts, gaskets etc., complete

- a) 65 mm dia
- b) 80 mm dia
- c) 100 mm dia
- d) 150 mm dia

8.3.13 Constructing masonry chamber 30x30x50 cm with cement based fly ash bricks, inside with brick work in cement mortar 1:4 (1 cement : 4 Coarse sand) for stop cock, with C.I. surface box 100x100x75 mm (inside) with hinged cover fixed in cement concrete slab 1:2:4 mix (1 cement: 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 mix (1 cement : 5 fine sand and 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design.
With cement based fly ash bricks of 1st class.Extra depth to be provided as per site condition if required

8.3.14 Constructing masonry Chamber 60x60x75 cm inside, in brick work in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100mm. top diameter, 160 mm bottom diameter and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1 cement :2 coarse sand : 4 graded stone aggregate 20mm nominal size) , i/c necessary excavation, foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design :
With cement based fly ash bricks of 1st class.Extra depth to be provided as per site condition if required.

8.3.15 Constructing brick masonry chamber for underground C.I. inspection chamber and bends with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover with frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg), R.C.C. top slab with 1:1.5:3 mix (1 cement : 1.5 Fine sand : 3 graded stone aggregate 20 mm nominal size), foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design:

Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets :

With cement based fly ash bricks of 1st class

8.3.16 Extra for depth beyond 45 cm of brick masonry chamber :

For 500x700 mm size

With cement based fly ash bricks of 1st class

8.3.17 Providing and placing on terrace (at all floor levels) polyethylene water storage tank, IS : 12701 marked, with cover and suitable locking arrangement and making necessary holes for inlet, outlet and overflow pipes but without fittings and the base support for tank.

8.3.18 Providing and Fixing of double flanged Water Flow Electromagnetic type Meter complete with digital display provision & including Pulse generator and Remote Totalizer complete in all respect as per the technical specifications.

a) 25 mm dia

b) 32 mm dia

c) 40 mm dia

d) 50 mm dia

8.3.19 Providing and Fixing Pressure Reducing station for cold water supply comprising of 2 Nos. of brass ball valves on outlet and bye-pass and ball valve with inbuilt strainers and a PRV (Diaphragm type) unit with out going pressure gauge with flanged or union connection including safety valve. The complete system is tested to a pressure not less than 15 Kg/Cm² and suitable to reduce the pressure from 3.5 Kg/Cm² to 1.0 Kg/Cm²(or as desired at site) including flanges/unions, nuts, bolts and washers complete as required for applications. (Horizontal or vertical as applicable).

a) 25 mm dia

b) 32 mm dia

c) 40 mm dia

d) 50 mm dia

8.3.20 Providing & fixing M.S. structural work fabricated from standard section e.g. M.S rounds, angles, channels, plates including cutting to size, drilling, welding fixing and welding to insert plates in RCC structural members as directed by engineer-in-charge including cutting and making good the walls, ceilings and floors.

8.4 SEWERAGE AND DRAINAGE SYSTEM AROUND THE BUILDINGS

- 8.4.1 Excavating trenches of required width for pipes, cables, etc., including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5m, including getting out the excavated soil, and then returning soil as required, in layers not exceeding 20cm in depth including consolidating each deposited layer by ramming, watering etc. and disposing of surplus excavated soil as directed within a lead of 50 m. All Kinds of Soil/Ordinary rock Pipes, cables etc., exceeding 80mm dia but not exceeding 300mm dia
- 8.4.2 Extra for excavating trenches for pipes, cables, etc. in All Kinds soil/ordinary rock exceeding 1.5 m in depth but not exceeding 3 m. All Kinds of Soil/Ordinary rock Pipes, cables etc., exceeding 80mm dia but not exceeding 300mm dia
- 8.4.3 Providing and laying non-pressure NP2 class R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete.
- a) 150 mm Dia
 - b) 200 mm Dia
 - c) 250 mm dia
 - d) 300 mm dia
- 8.4.4 Providing and laying cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) all-round the pipes of different dia for sewerline including bed concrete as per standard design.
- a) 150 mm dia.
 - b) 200 mm dia.
- 8.4.5 Providing and Laying Double wall corrugated (SN-8 class) Black pipes conforming to IS: 16098 Part -2, for Sewerage system with all required fittings including jointing by click ring & sealing ring/ solvent cement joint including testing of joints, setting right the leaking of joints etc. complete as per instructions of the Engineer-In-Charge.
- a) 150 mm dia..
 - b) 200 mm dia.
- 8.4.6 Providing and fixing square-mouth S.W. gully trap class SP-1 complete with C.I. grating brick masonry chamber with water tight C.I. cover with frame of 300 x300 mm size (inside) the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as per standard

design

::

150 x 100 mm size P type With cement based fly ash bricks of 1st class

- 8.4.7 Providing and fixing square-mouth S.W. gully trap class SP-1 complete with C.I. grating brick masonry chamber with water tight C.I. cover with frame of 300 x300 mm size (inside) the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as per standard design

::

180 x 150 mm size P type With cement based fly ash bricks of 1st class

- 8.4.8 Constructing brick masonry manhole in cement mortar 1:4 (1 cement : 4 coarse sand) with RCC Top slab with 1:2:4 mix (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size) foundation concrete 1:4:8 mix (1 cement :4 coarse sand: 8 graded stone aggregate 40 nominal size), inside plastering 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement and making channels in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) finished with a floating coat of neat cement complete as per standard design . Inside size 90x80 cm and 45 cm deep including C.I. cover with frame (Heavy duty) 455x610 mm internal dimensions, total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) .(Excavation of manhole and 12mm thick cement plaster at the external surface is included) With cement based fly ash bricks of 1st class

- 8.4.9 Constructing brick masonry manhole in cement mortar 1:4 (1 cement : 4 coarse sand) with RCC Top slab with 1:2:4 mix (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size) foundation concrete 1:4:8 mix (1 cement :4 coarse sand: 8 graded stone aggregate 40 nominal size), inside plastering 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement and making channels in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) finished with a floating coat of neat cement complete as per standard design . 'Inside size 120x90 cm and 90 cm deep including C.I. cover with frame (heavy duty) 560 mm internal diameter, total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg) .

(Excavation of manhole and 12mm thick cement plaster at the external surface is included)
With cement based fly ash bricks of 1st class

- 8.4.10 Extra depth of manholes Size 90x80cms With cement based fly ash Bricks with class designation75
- 8.4.11 Extra depth of manholes Size 120x90cms With cement based fly ash Bricks with class designation75

- 8.4.12 Constructing Brick Masonry circular type manhole 0.91 m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 (1 cement : 4 Coarse sand), inside cement plaster 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 40mm nominal size) and making necessary channel in Cement Concrete 1:2:4 (1 Cement : 2 Coarse Sand : 4 Graded Stone aggregate 20mm nominal size) finished with a floating coat of neat cement all complete as per standard design. External surface shall be finished with 15mm thick cement plaster 1:6 (1 cement : 6 Coarse sand) as per side conditions. 0.91 m deep with SFRC cover and frame (heavy duty, HD- 20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg., fixed in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete.(Excavation, foot rests and 12mm thick cement plaster at the external surface is included) : With cement based fly ash bricks of 1st class
- 8.4.13 Extra depth for circular type Manhole 0.91 internal dia with cement based fly ash Bricks class designation 75, depth beyond 0.91 m to 1.67 m
- 8.4.14 Constructing Brick Masonry circular manhole 1.22 m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 (1 cement : 4 Coarse sand), cement plaster 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in Cement Concrete 1:2:4 (1 Cement : 2 Coarse Sand : 4 Graded Stone Aggregate 20mm nominal size) finished with a floating coat of neat cement all complete as per standard design. External surface shall be finished with 15mm thick cement plaster 1:6 (1 cement: 6 Coarse sand) as per side conditions. 1.68 m deep with SFRC Cover and frame (heavy duty HD- 20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface is included in item) With cement based fly ash bricks of 1st class
- 8.4.15 Extra depth for Circular type Manhole 1.22 m internal dia (at Bottom) With cement based fly ash bricks class designation 75, Depth beyond 1.68 to 2.29 m.
- 8.4.16 Constructing Brick Masonry circular manhole 1.52 m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 (1 cement : 4 Coarse sand), inside cement plaster 12mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size) and making necessary channel in Cement Concrete 1:2:4 (1 Cement : 2 Coarse Sand : 4 Graded Stone Aggregate 20mm nominal size) finished with a floating coat of neat cement all complete as per standard design .External surface shall be finished with 15mm thick cement plaster 1:6 (1 cement : 6 Coarse sand) as per side conditions. 2.30 m deep with SFRC Cover and frame (heavy duty HD-20 grade designation) 560 mm internal diameter conforming to I.S. 12592, total weight of cover and frame to be not less than 182 kg. fixed in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) including centering, shuttering all complete. (Excavation, foot rests and 12 mm thick cement plaster at the external surface is included in item)
With cement based fly ash bricks of 1st class

- 8.4.17 Extra depth for circular type manhole 1.52 m internal dia (at bottom) beyond 2.30 m :
With cement based fly ash bricks of 1st class
- 8.4.18 Providing & fixing orange colour safety foot rest of minimum 6mm thick plastic encapsulated as per I.S:10910 on 12 mm dia steel bar conforming to I.S:1786 having minimum cross section as 23mm x 25mm and over all minimum length 263mm and width as 165mm with minimum 165 mm space between protruded legs having 2mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138mm as per standard drawing and suitable to with stand the bend test and chemical resistance test as per specifications and having manufacturer's permanent identification mark to be visible even after fixing, including fixing in manholes with 30x20x15cm cement concrete block 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20mm nominal size) complete as per design.
- 8.4.19 Constructing brick masonry road gully chamber 45x45x77.5 cm with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) with precast R.C.C. vertical grating complete as per standard design, .(Excavation of manhole and 12mm thick cement plaster at the external surface is included)
With cement based fly ash bricks of 1st class.

Extra depth of rgc up to 100 cm
- 8.4.20
- 8.4.21 Constructing brick masonry road gully chamber 50x45x60 cm with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) including 500x450 mm pre-cast R.C.C. horizontal grating with frame complete as per standard design, .(Excavation of manhole and 12mm thick cement plaster at the external surface is included)With cement based fly ash bricks of 1st class.

Extra depth of RGC up to 100 cm.
- 8.4.22
- 8.4.23 Constructing brick masonry road gully chamber 110x50x77.5 cm with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) including 500x450 mm precast R.C.C. horizontal grating with frame and vertical grating complete as per standard design,(Excavation of manhole and 12mm thick cement plaster at the external surface is included.)
With cement based fly ash bricks of 1st class.

Extra depth of RGC up to 120 cm
- 8.4.24
- 8.4.25 Construction of Grease trap of size 2 m x 1 m (Internal) with effective depth as required on site with Brick Masonry in Cement 1:4 (1 Cement: 4 Coarse sand) over a bed of 150 mm thick PCC 1:5:10 (1 Cement: 5 Coarse sand: 10 graded stone aggregate 40 mm nominal size) including a baffle wall of Brick work, covered with RCC slab of 150 mm thickness, of 1:2:4 mix (1 Cement: 2 Coarse sand: 4 graded stone aggregate of 20 mm nominal size) including centering, shuttering and reinforcement complete with providing and fixing Foot rests @300

mm C to C with Two 600x600 mm D.I. Manhole Covers with Lifting arrangement, including 150 mm dia Inlet & Outlet pipes complete . (Excavation of manhole and 12mm thick cement plaster at the external surface is included.)

- 8.4.26 Construction of Neutralization chamber of size 2000 mm x1000 mm (Internal) with effective depth as required on site with Brick Masonry in Cement 1:4 (1 Cement: 4 Coarse sand) over a bed of 150 mm thick PCC 1:4:8 (1 Cement: 4 Coarse sand: 8 graded stone aggregate 40 mm nominal size) including , covered with RCC slab of 150 mm thickness, of 1:2:4 mix (1 Cement: 2 Coarse sand: 4 graded stone aggregate of 20 mm nominal size) including centering, shuttering and reinforcement complete with providing and fixing Foot rests @300 mm C to C with two 610x455 mm DI Heavy duty Manhole Covers with Lifting arrangement, including 150 mm dia Inlet & Outlet pipes complete etc. in all respect as per direction of Engineering-in-charge. ,(Excavation of manhole and 12mm thick cement plaster at the external surface is included.)

Providing and laying cement concrete 1:5:10 (1 cement: 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) up to haunches for drainage pipes as per standard design as shown in drawing/specification to drainage pipes of different diameter including bed concrete.

- 8.4.27 a) 150 mm

8.5 MISCELLANEOUS

- 8.5.1 Providing and fixing 750 mm long hot dipped G.I. Puddle flanges for water tanks as per I.S. 1239 (Class C) with 6mm thick M.S. Plate of suitable size and welded around the pipe fixed in walls, beams and top slab of R.C.C tanks, complete with all details in all respects and as per drawing. (For overhead tanks & underground)
- a) 25 mm dia
 - b) 32 mm dia
 - c) 40 mm dia
 - d) 50 mm dia
 - e) 65 mm dia
 - f) 80 mm dia
 - g) 100 mm dia
 - h) 150 mm dia
- 8.5.2 Providing and fixing 80 mm dia insect-proof coupling to vent pipes of overhead tank with threaded or flanged joints, including M.S. flanges, nuts, bolts, 3mm thick rubber insertions complete.
- 8.5.3 Providing and fixing of wall hanging **drinking water fountain**, made by stainless steel top and heavy duty galvanized steel frame. ADA Compliant, size 472 mm Depth X 447mm width, flexible bubbler guard , operated between 50 to 120 PSI, Complete with all accessories which include MD-CU29, which is an EPA registered antimicrobial copper that fights off

microorganisms which include MRSA and e-coli on push pad. The water Fountain shall be certified by NSF-USA, Green building, TUN, UL, to be placed at different location of building. installing the Water Fountain for proper functioning and aesthetic view as directed by the engineer-in-charge without any extra cost.

TECHNICAL SPECIFICATIONS

ELECTRICAL WORKS

#	Section	Description
1.0	A	Special Conditions of Contract for Electrical Works
2.0	B	Technical Specifications
2.1	1	HT VCB Switchboard (33 kV)
2.2	2	Oil Cooled Transformer
2.3	3	HV Cables
2.4	4	MV Panels & Final Distribution Boards
2.5	5	Busduct / Rising Mains (Sandwich Type)
2.6	6	MV Cables
2.7	7	Cable Tray / Raceway / Under Floor Trunking
2.8	8	Earthing System
2.9	9	Lightning Protection System
2.10	10	Conduits
2.11	11	PVC Insulated FR-LSH Copper Wires
2.12	12	Switches, Socket Outlets & Receptacles
2.13	13	Lighting Fixtures, Ceiling Fans, Bracket Fans & Exhaust Fans
3.0	C	Technical Data Sheets
3.1	1 'a'	11kV Grid Power Distribution Panel
3.2	1 'b'	11kV Grid Power Isolation Panel
3.3	1 'c'	11kV Grid Power Panel
3.4	2 'a'	11/0.415kV, 2500kVA Oil Cooled Transformer
3.5	2 'b'	11/0.415kV, 2000kVA Oil Cooled Transformer
4.0	D	List of Makes Proposed by Contractor

Contents

1.0	A	Special Conditions of Contract for Electrical Works
2.0	B	Technical Specifications
2.1	1	HT VCB Switchboard (33 kV)
2.2	2	Oil Cooled Transformer
2.3	3	HV Cables
2.4	4	MV Panels & Final Distribution Boards
2.5	5	Busduct / Rising Mains (Sandwich Type)
2.6	6	MV Cables
2.7	7	Cable Tray / Raceway / Under Floor Trunking
2.8	8	Earthing System
2.9	9	Lightning Protection System
2.10	10	Conduits
2.11	11	PVC Insulated FR-LSH Copper Wires
2.12	12	Switches, Socket Outlets & Receptacles
2.13	13	Lighting Fixtures, Ceiling Fans, Bracket Fans & Exhaust Fans

SECTION-A

Special Conditions of Contract for Electrical Works

1. General

- The complete Electrical Installation shall be carried out in strict accordance with Regulations of Indian Electricity Act and Rules of Electricity Supply Authority, Relevant Indian Standards with particular reference to IS 1944/1960 (Personal Hazard Fire Safety of Buildings), IS 1646/1961 (Electrical Installation of Fire Safety of Buildings), IS 5216/1969 (Guide for Safety Procedures and Practices in Electrical Work), IS 5908/1970 (Electrical Installation in Buildings, Method of Measurements), National Electrical Code Of Practice 2005, National Building Code of India 2016 (SP 7 : 2005 Part IV) and Fire Insurance Company insuring the building.
- The Special Conditions of Contract are an extension of and are to be read in conjunction with the General Conditions of Contract. Should there be any contradictory requirements in the two, the requirement as per the Special Conditions of Contract shall prevail.
- The special conditions of contract are also meant to amplify the specifications, schedule of quantities & drawings. The most stringent of the above shall apply. Should there be any ambiguity or inconsistency, the Contractor should report the same to the PMC Consultant/ EIC/ Employer and obtain clarification before submitting his tender.
- All Equipment, Material, Switchgear and Cables etc. shall be adequately rated to suit the climatic conditions.
- Clause in this specification shall apply equally throughout.

2. Location of Site

- The site of works is located at Ballia, UP.

3. Site Conditions

- All equipment's shall be suitable for satisfactory operation at the following site conditions.
- Maximum +50° Celsius, 90% relative humidity.
- Minimum -5° Celsius, 90% relative humidity.

4. Scope of work

- The work to be carried out under this contract comprises the Construction of Autonomous State Medical College Ballia. The Contractor shall carry out & complete the said work under this contract in every respect in conformity with the current rules & regulations of the Local Electricity Authority, the Indian Standard Institution, Indian Electricity Rules & Act with the

directions of & to the satisfaction of the PMC Consultant/ EIC/ Employer. The Contractor shall furnish all labour & install all materials, appliances, equipment necessary for the complete provision and testing / commissioning of the Installation as specified herein and shown on the drawings. This also includes any material, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary & customary to make complete installation properly connected & in good working condition. The work shall include all incidental jobs/minor Electrical works connected with electrical installation such as excavation in trenches & back filling, cutting / drilling and grouting etc.

- Supply, Receiving, Storing, Handling, Installation, Testing and Commissioning of the following: -
 - I. 33 kV Metering Panel
 - II. HT Switch Board
 - III. Transformers
 - IV. Main LT Panel, Capacitor Bank Panel, MDBs, SDBs & DBs
 - V. Bus Duct, Rising Mains and Accessories
 - VI. Cables, Cable Terminations & Cable Trays
 - VII. Earthing & Lightning Protection
 - VIII. Point Wiring with PVC / MS Conduit & FR-LSH PVC Insulated copper wires, Switches & Receptacles
 - IX. Light Fixtures, Lamps & Tubes
 - X. GI Raceway, PVC / MS Conduit for Communication and Low Voltage System
 - XI. External Lighting comprising of Feeder Pillars, Cabling, Earthing, Light Fixtures & Poles.
- Sanction / Approvals including statutory approvals from the Local Authorities for the installation & load sanctions including energization of Electrical Installation (If required).
- Preparation of Shop Drawings, As-built Drawings in Autocad-2004 or Autocad-2009, completion documents, maintenance manuals & list of maintenance spares.
 - I. Shop Drawings in Autocad.
 - II. As-built Drawings in Autocad.
 - III. Completion Documents
 - IV. Maintenance Manuals
 - V. List of maintenance spares for various equipment's.
- Increase or decrease in scope of work
 The Owner reserves the right to increase or decrease the scope of work on any or all items or to change the nature of work involved in any or all items or to completely delete any items of the Work under the Contract. The Contractor shall not be entitled to claim for loss of anticipated profits, for mobilization of additional resources, or for any other such reasons on account of these change orders.

5. Stipulations and Deviations to Tender Clauses

Tenderers are advised to submit quotations strictly based on the terms and conditions and specifications contained in the tender documents & not to stipulate any deviations. No deviations from the given Specifications shall be accepted after the decisions are communicated by Owner. Tenderers are required to specify the list of makes proposed in the quotation.

6. Ordering

As soon as possible after receiving written notification of the acceptance of his tender, the Contractor shall order all the materials and equipment required to complete the contract. He shall submit to the PMC Consultant/ EIC/ Employer detailed summary of all orders placed. These should be submitted for approval before orders are placed and provided with the following details: name of supplier / vendor, make of equipment, date of order & forecast of delivery date at site.

7. Standard of Materials

- When the material and equipment is specifically described and named in the specifications, it is so named or described for the purpose of establishing a standard of materials & workmanship to which the Contractor must adhere. The Contractor may submit with his tender a list indicating any alternative make of equipment that he proposes to supply for the proposed installation only after approval & clearance of the PMC Consultant/ EIC/ Employer. Should the Contractor install the material or carry out the method in question before receiving approval from the proper authorities, the PMC Consultant/ EIC/ Employer may direct the Contractor to remove the material in question immediately. The fact that this material has been installed shall have no bearing or influence on the decision by the Owner / Architect/ Consultant. All materials, condemned by the PMC Consultant/ EIC/ Employer as not Approved for use are to be removed from the premises & suitable material delivered & installed in their place at the expense of the contractor. During the tender stage, the Contractor shall be deemed to have submitted his tender based on all materials & equipment specified or shown on the drawings & no alternative manufacturer or supplier of such material & equipment specified or shown shall be acceptable. If however, the material or equipment specified or shown on the drawings is not available due to any genuine reason, the Contractor shall get the written approval of the PMC Consultant/ EIC/ Employer for the particular material / equipment prior to order.
- The Contractor shall be responsible for the safe custody of all material including supplied by owner & shall insure them against theft, damage by fire, earthquake etc. A list of materials & equipment, together with a sample of each shall be submitted to the PMC Consultant/ EIC/ Employer as directed by him within 30 days of the award of the contract.
- All materials required for the works shall be new & the best of their respective kinds and shall be of uniform pattern. All materials are to be suitable for use in temperatures of 40-50 degree centigrade with comparative humidity.
- The protective finishes must be provided on all materials and apparatus used on this contract to ensure that no deterioration is caused by the local climatic conditions. All materials shall be inspected by the Contractor to ensure that finishes are in accordance with the specifications.

- All holes in Panels, Distribution Boards & similar equipment shall be blanked off to protect from dust & vermin. Where ventilation is necessary, holes are to be neatly covered. All cable entry holes on Switchgear and similar equipment shall be fitted with PVC / rubber bushing.

8. Workmanship

- The workmanship and method of installation shall confirm to the best Engineering and Standard Practice. All work shall be performed by skilled tradesman and to the satisfaction of the PMC Consultant/ EIC/ Employer . Helpers shall have qualified supervision.
- Any work that in the opinion of the PMC Consultant/ EIC/ Employer which does not confirm to the best standard practice, shall be removed and reinstated at the contractor's expense. Permits certificates & licenses must be held by all tradesman for the type of work in which they are involved & where such permits certificates and licenses exist under government legislation.

9. Safety Site

- Contractor shall install and maintain any and all temporary lighting, access ways, and/or safety precautions (such as guard rails, temporary coverings for holes in floors etc.) that are deemed necessary for the efficient & safe execution of the works. In the event of disagreement as to the type or extent of such temporary lighting, access way, and/or safety precautions, the Owner's decision shall be final and binding. Lack of any direction or instruction by the Owner's shall not release Contractor from his responsibilities and obligations under this clause.
- Contractor shall include cost for all items mentioned in clause 9.1.

10. Hoisting, Transportation and Scaffolding etc.

- Contractor shall include for his own unloading & hoisting of materials & equipment, own scaffolding, rigging and access equipment and clean up rubbish disposal.

11. Procedure

- Throughout all stages of work, the Contractor shall maintain a close liaison with the PMC Consultant/ EIC/ Employer and with all other contractors involved in the work.
- Site work shall commence immediately and shall proceed expeditiously and in harmony with the building work so as not to delay any particular agency in any way. All Plant / Equipment to be supplied and work to be done under this specification shall be manufactured and executed in the manner set out in the specification or where not so set out to the reasonable satisfaction of the PMC Consultant/ EIC/ Employer and all the contractors works on site shall be carried out in accordance with such reasonable directions as the PMC Consultant/ EIC/ Employer may give.

12. Permits

The Contractor shall obtain all necessary permits prior to work commencement for the excavation of Cable Trenches & Earth Stations etc. in areas where it is suspected that existing services are present. The Contractor shall carry out excavation work by hand. He shall also obtain the necessary permits from the respective authorities prior to working on major items of the High Side Installation. All application permits shall be made in writing with a copy to the PMC Consultant/EIC/ Employer.

13. Liasioning (if required)

- The Contractor shall be responsible for liasioning with the Local, State & Central authorities. Charges towards liasioning are deemed to be included in tender rates. Liaisoning shall include but not limited to following activities:
 - I. Submission of Application for load sanction and obtaining the principal load sanction (If required).
 - II. Arranging inspection of HT metering room by Supply Co. officials, installation of HT meter and allied electrical works (If required).
 - III. Arranging energization of installation with power from Supply Co (If required).
 - IV. Obtaining the final load sanction after submitting required documents (If required).
 - V. Obtaining approval from Electrical Inspectorate for Electrical Installation including pertaining to HVAC, Plumbing & Fire Fighting (If required).
 - VI. Any other statutory approvals as required.
 - VII. The Contractor shall be reimbursed on documentary proof, any statutory payments made in connection with carrying out above activities. The quoted rates shall be inclusive of carrying out all the above activities and nothing extra shall be payable on the above account.

14. Temporary and Trial Usage

- It shall be understood and agreed that temporary and trial usage by the employer of any device, machinery, apparatus, equipment or any other work or materials supplied under this contract shall be available before final completion. It is further understood and agreed that the Owner shall have the privilege of such temporary and trial usage as soon as the Contractor shall claim that the said work is completed & in accordance with the drawings & specifications & to the manufacturer's instructions and for such reasonable length of time as the PMC Consultant/ EIC/ Employer shall deem suitable for making a complete and through test of the apparatus, equipment or system under test.
- No claim for the damage will be made by the Contractor for the injury to or breaking of any parts of the works which have been placed under test whether this damage has been caused by weakness, flaw or inaccuracy of structural parts or by defective material or workmanship of any kind whatsoever.

15. Cleaning

- The contractor shall ensure that all parts of the building are left in clean and tidy condition during execution of works. Upon completion of the contract and before operating any of the systems, the Contractor shall also clean out rubbish and dirt from the entire area.

16. Setting Out of Works

- The Contractor at his own expense shall set out all his works and take all measurements and dimensions required for the erection of his equipment & materials on site. Modifications if any which may be found necessary during the progress of the work shall be submitted in detail to the PMC Consultant/ EIC/ Employer before proceeding with the works and Contractor must allow in his tender for all such modifications and for the provision of any sketches or drawings related thereto.

- The position of all Panels, DBs, Cable Routes, Cable Trays, Raceway / Trunking, Wiring Systems, Control Switches, Service Outlets and Fixtures etc. shown on the drawings are to be assumed as being correct for the purpose of tendering. Final positions of these must be agreed with the PMC Consultant/ EIC/ Employer & co-ordinated with all other agencies before installation.
- The data given here in and on the drawings is as exact as could be secured, but its complete accuracy is not guaranteed. The drawings are for the guidance of the contractor; exact locations, distances and levels shall be governed by the site conditions.

17. Drawings

- Contract Drawings duly signed by the Architect are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the structural, architectural & other services drawings and the direction of the PMC Consultant/ EIC/ Employer.
- Structural drawings shall take precedence over Architectural drawings, which in turn shall take precedence over Internal and External Electrical and Low Power Installation drawings and other services drawings in regard to all dimensions.
- The Contractor shall examine all architectural, structural, services drawings & verify all dimensions as built at the Site before start of work & bring to the notice of the PMC Consultant/ EIC/ Employer discrepancies if any. Any changes found essential to coordinate the installation of the Internal & External Electrical and Low Power Works with other installations shall be made with prior approval of the PMC Consultant/ EIC/ Employer only.

18. Reference Drawings

- The Contractor shall maintain on site one set of all Drawings issued to him for reference.

19. Conduit Layout

- Prior to fixing and laying of the conduits, the Contractor shall submit to the PMC Consultant/ EIC/ Employer detailed layout plans of the conduit network & get the same approved before proceeding with the works. The layout plan shall contain particulars regarding size and routes of these conduits, location of junction & inspection boxes provided along the routes of these conduits.

20. Revised Shop Drawings & Quantity Variation Statement

- For revised shop drawings whenever changes are indicated or shop drawings are made to indicate changes in layout, the particular drawing work shall be carried out within one week of approval of all the relevant shop drawings.
- Along with revised drawings the contractor shall also submit two copies of a comprehensive variation in quantity statement to the PMC Consultant/ EIC/ Employer.

21. Manufacturer's Instructions

Specific instructions furnished by the manufacturer's relating to the equipment and materials used in this project shall be followed strictly in case these are not mentioned in the document.

22. Guarantee

- At the close of the work and before issue of the final certificate of virtual completion, the Contractor shall furnish written guarantee indemnifying the PMC Consultant/ EIC/ Employer against defective equipment/ Material and workmanship for a period of 12 months. The Contractor shall hold himself fully responsible for reinstallation or replacement to owner, the following:
 - I. Any defective work or material supplied by the contractor.
 - II. Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

23. Safety of Materials

- The Contractor shall provide proper and adequate storage facilities to protect all materials and equipment, including those issued by the owner against damage from any cause whatsoever. The contractor shall also be responsible for making inventory of material supplied by the owner at the time of receiving the same. Any deficiencies in the material supplied by the owner shall be immediately brought to be notice of the PMC Consultant/ EIC/ Employer.

24. Security

- Contractor shall be held entirely responsible for the security and the protection of their works at all times inclusive of non-working hours. They shall be deemed to have included for all costs associated therewith. This clause shall enhance and complement clause of the General Conditions of Contract.

25. Completion Certificate

- On completion of the electrical installation, a certificate shall be furnished by the Contractor countersigned by the Site Engineer, under whose direct supervision the installation was carried out. The certificate shall be in the prescribed form as required by the Client Department. The Contractor shall be responsible for getting the whole electrical installation, inspected and approved by the local authorities concerned. Any drawings / documents required for this purpose shall be prepared & submitted to the concerned authorities by the Contractor. This is irrespective of the fact whether equipment is owner supplied, contractor supplied or supplied by any other agency.

26. Engineer and Foremen

- The Contractor shall employ competent, fully qualified full time Electrical Engineers & Licensed Foremen to direct the work of Electrical, Low Voltage & Extra Low Voltage Installation in accordance with drawings & specifications. The Electrical Engineers and Foremen shall be available full time on site to receive instructions from the PMC Consultant/ EIC/ Employer or his nominee in the day to day activities throughout the duration of the contract. The Electrical Engineers and Foremen shall correlate the progress of work in conjunction with all relevant requirements of the supply authorities. In case the Contractor needs to replace or change his Electrical Engineers or Foremen, he shall obtain prior approval of the PMC Consultant/ EIC/ Employer before doing so.

- As evidence of his intentions, the tenderer is required to submit with his tender manpower details with list of all Engineers, Foremen, Technicians & Electricians to be employed on this contract giving details of their qualifications and experience to the satisfaction of PMC Consultant/EIC/ Employer .
- The PMC Consultant/ EIC/ Employer may demand at any time during the contract the replacement of the contractor's personnel who fail to satisfy this requirement of competence.

27. Specifications and Schedule

- The specification and schedule of rates shall be considered as part of this contract & any work or materials shown on schedule & not called for in the specifications or vice versa, shall be executed as if specially called for in both. The drawings indicate the extent and general arrangement of the fixtures, controlling switches, wiring system etc. & are essentially diagrammatic and for guideline purposes.

28. Tools and Equipment

- The Contractor shall provide all necessary tools, portable power tools, test equipment etc. which will be required in order to carry out the electrical works. This shall also include scaffolding required for any particular purpose in the installation.

29. Site Conditions

- The Contractor shall take all necessary action to acquaint himself fully with site conditions. Any claim resulting from the Contractor not being aware of site conditions after tendering will not be accepted.
- After the contract is awarded, the Contractor shall acquaint himself fully with existing services and obtain all necessary information to avoid any damage to the services during excavation etc.

30. Labels' and Notices

- Identification name plates shall be fixed on all switch-gear. These will identify the sub-station and / or outgoing ways. The labels shall be made of indestructible not-deteriorating material with lettering engraved in black on white background except where otherwise specified. Fixing shall be by means of rivets or screws in addition to any adhesive employed. All labels shall be English / Hindi as directed by the PMC Consultant/ EIC/ Employer. All feeder pillars & mini feeder pillars in addition to identification labels shall have each way identified by a label to the same specification fitted in the feeder pillar. An indestructible "Danger 415 Volts" plates should be fitted externally with a double flash danger signal. The letters to be 12mm height minimum in signal red.
- In addition, each distribution board shall have a chart detailing particulars of the circuits controlled which shall be fixed to the inside of the door. The details shall include the circuit load, description, the type and rating of the protection device and cable size. A sheet of transparent rigid plastic shall be used to completely cover the chart to prevent damage.

31. Packing and Receipt of Material

- The Contractor shall take every possible measure including an appropriately strong packing, proper supervision of loading and off-loading and proper transportation by the most suitable route to ensure the safe delivery to site of plant and equipment. The Contractor shall keep on site up-to-date record of all materials received & fully annotated with details of the carrier and condition of equipment on arrival.

32. Recording of Work

- The Contractor shall keep a register and a set of drawings recording the progress of the works and details of all instruction received. These shall be available for the PMC Consultant/ EIC/ Employer upon request. The contractor's site representative will submit a written report every two weeks outlining the progress of the work including work completed to date.

33. Painting and Finishing

The following requirements shall be complied with unless otherwise specified :

- Machined surfaces of plant and equipment which are to be left bright shall be suitably protected against rust before dispatching from manufacturer's works. Metal parts which are to be painted, shall before painting commences, be cleaned of all rust, scale, oil and other foreign matter by sand paper / wire brushes and shall be subject to approval of the engineer.
- Before leaving manufacturer's work, all plant shall be treated to prevent rust special finishes, such as may be required on externally mounted and exposed equipment as described in the relevant clauses.
- After erection of equipment on site, any damaged or defaced paint finish and other surfaces prone to deterioration shall be suitably treated and / or restored to prevent further deterioration.
- The Contractor shall make sure that no salt, dust or other foreign matter comes into contact with base metal or freshly treated surfaces about to be painted and shall erect shelters or adopt such other approved measures as may be required by the PMC Consultant/ EIC/ Employer.

34. Marking Out

- Routes and positions of systems as well as positions of all electrical equipment's shall be marked out by the Contractor and approved by the engineer before such items are installed.
- These items shall be installed in the positions shown on the drawings but reasonable variations may be made on site with the consent of the PMC Consultant/ EIC/ Employer.

35. Fixing

- Screws fixing in brick, concrete or similar materials which necessitates plugging shall be made using steel wood screws into plugs in rotary drilled holes.
- Items of switch gear, cable racks and trays etc. shall be fixed using corrosion resistant steel bolts ritted with expanding collars, e.g. 'Raw bolts' set into rotary drilled holes of the correct size.

36. Contractor's Rates

- The contractor's rates must include the cost of transportation, freight and insurance of materials to the site, loading, unloading, handling, supplying, fixing, testing, commissioning as required & placing in position all items of work intended to be operated in the BOQ or otherwise.

37. Owner's / Architect's / Consultants Decisions

- Matters not covered by the specification given in the contract as a whole shall be covered by the relevant ISI codes. If such codes for a particular subject have not been framed, the decision of the PMC Consultant/ EIC/ Employer shall be final.
- The work shall be carried out under the direction and supervision of the Architects or their representative at site who shall guide the Owner from time to time. The Contractor shall intimate the name of his representative who would be supervising the construction & would be responsible for taking instructions for carrying out the work.
- The Architects or their representatives at site shall have access to the workshops of the successful tenderers so as to ensure themselves of the quality of material and workmanship.
- The PMC Consultant/ EIC/ Employer decision with regard to the quality of material & workmanship will be final and binding, any material rejected by the PMC Consultant/ EIC/ Employer shall be immediately removed by the contractor.

38. Defects Liability Period

- This period shall be in force from the date of "virtual completion" & minor defects if any shall be corrected / rectified within 24 hours and major defects within 3 days which shall develop during this period. However, if the same are not rectified by the Contractor within the period mentioned above the Owner with the concurrence of the PMC Consultant/ EIC/ Employer shall get the work done at the risk and cost of the contractor. The duration of defects liability period shall be 12 months.

39. Occupying Part Areas

- If the Owner wants to occupy areas in part, the Contractor shall have to complete the work of these areas in consultation with the owner and hand over the same to the Owner without affecting any of the clause of the contract agreement.

Format for Extra Items

#	Description	Rate (Rate analysis to be enclosed)	Qty	Authorized by	Special Remarks

- Enclosure
- Check list (All documents as per check list to be enclosed).

- Rate Analysis
- Supporting documents on which rate analysis is based.
- Photocopy of instructions issued by appropriate authority for executing the extra items.
- Check List for Extra item rate approval
- Photocopy of extra item clause for agreed overhead and profits.
- Photocopy of Invoice / Price List & discount valid on the date of LOI (Particular item to be highlighted)
- Reasons for executing the extra items. (Any items for which rate exists in the tender the same shall not be covered under extra item). This should be mentioned under the column of special remarks.
- Photocopy of instructions issued by authority instructing the execution of extra items.
- In case the rate for similar item exists in the tender, the same must be derived from the tender.

40. Site Instruction Book / File

- Contractor shall be required to maintain a site instruction book / file to enable the PMC Consultant/ EIC/ Employer or their representatives to record instructions given to contractor from time to time. Please note no drawings shall be issued for minor modifications / additions. Details shall be given in the form of instructions at site and shall be written in the site instruction book.

41. Professional Integrity and Team Spirit

- It is the intent of the Owner and the Architect / Consultant that this Project will be executed in a spirit of teamwork & full professional integrity. The Contractor shall fully co-operate with all agencies concerned to fulfill this objective.

42. Quality Assurance and Control Programmed

- The Contractor shall establish an effective quality control system at the Site & implement the same through an independent team consisting of the Contractor's Representative & qualified & experienced engineers and technical personnel to enforce quality control on all items of the Work and the Project at all stages.

43. Entry to the Site

- The Owner at his discretion has the right to issue passes to control the admission of the Contractor, his agents, employees and work people to the Site of the Work or any part thereof. Passes shall be returned at any time on demand by the Owner. The contractor shall follow all site related regulations especially concerning security and safety laid down by the Owner.

44. Fire Precautions

- The Contractor shall take all precautions and preventive measures against fire hazards at the Site and shall assume full responsibility for the same.

45. Accessibility

- The Contractor shall verify the sufficiency of the size of the shaft openings and suspended ceilings for proper installation of his piping. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same. The Contractor shall locate all equipment that must be serviced, operated or maintained in fully accessible positions.

46. Submittals by Electrical Contractor

I. SHOP DRAWINGS:

The Contractor shall prepare & submit to the PMC Consultant/ EIC/ Employer for his approval detailed shop drawings of all Equipment Layout, Cabling Layout, Conduit Layout, Distribution System, Circuit Details, Special Pull Boxes and any other requirement within 15 days of the signing of the contract or as agreed with Owner. Other requirements include the following :

- Shop Drawings for Lighting, Small Power, Cable Tray / Trunking and Voice/Data System layout.
- General Arrangement Diagrams.
- General Arrangement Diagrams of Panels shall include front, side, top & bottom view, sectional view, outline and dimensions, voltage, bus capacity, circuit breaker details and their arrangement / sizes.
- Typical control schematic diagram for each type giving designation to be referred on SLD.
- Terminal block details for all feeders for internal wiring connections.
- Bill of material giving make / rating / catalogue number of all components of the complete switch board.

II. Makes of Materials and their Samples

- List of make of materials proposed to be used from the approved options.
- Samples of material for approval.
- Technical Data Sheets of Materials

III. Inspection, Testing and Commissioning to be carried out by Electrical Contractor

- All testing/commissioning shall be carried out in accordance with the specifications & test results shall be submitted in proper formats. Please note if test results are not submitted, payments for this stage and beyond shall not be released.
- The Contractor shall also perform all such tests as may be necessary and required by the Owner / Architect / Consultant to ensure quality of the executed works and by local authorities to meet Municipal & other bye-laws, regulations in force. The Contractor shall provide all labour, testing equipment, materials etc. required for the performance of the tests. The contractor shall if so required by the PMC Consultant/ EIC/ Employer , get any material tested at the laboratories approved by the PMC Consultant/ EIC/ Employer at the cost of the contractor

IV. Commissioning Report with all Test Results as required by Owner / Consultant

- On completion of installation, all tests shall be carried out in accordance with details mentioned in the specifications and shall be recorded in proper formats.
- After successful completion of all tests, the commissioning report shall be duly signed by the Contractor / his representative as well the Site Manager and handed over to the PMC Consultant/ EIC/ Employer.

V. Progress Reports by Electrical Contractor

- The Contractor shall prepare weekly / monthly reports of planned and actual progress of the Work and the subsequent weekly / monthly scheduled work along with manpower details. These will also include material procurement status. These reports shall be submitted to Owner's Representative & shall be reviewed during the co-ordination meeting.
- The Contractor shall submit monthly report along with monthly bills.
- Further progress charts and schedules shall be prepared by the Contractor as directed by the PMC Consultant/ EIC/ Employer .

47. Completion Drawings

- At the completion of the works & before issuance of the certificate of virtual completion, the Contractor shall submit to the PMC Consultant/ EIC/ Employer layout drawings drawn at approved scale indicating the complete Electrical And Low Power System as installed. These drawings shall be complete in all respects as desired by the PMC Consultant/ EIC/ Employer and must provide the following information in particular :
 - Lighting, Small Power, Voice / Data and other misc. layouts giving details of location and rating of Switches / Receptacles along with necessary controls.
 - Conduiting / Raceway / Trunking Layouts along with details of run and size of conduits, inspection, junction and pull boxes.
 - Circuiting details in Lighting and Small Power drawings along with sizes of conductors.
 - Location of Distribution System Details / Charts for each individual DB / Panel in prescribed format.
 - Main & Sub-main Cable Layouts along with details of cable trays, location of all Panels, Distribution Boards and other particulars
 - Details of all single line diagrams and general arrangement diagrams.
 - Complete wiring diagram as installed & schematic drawings showing all connections in the complete Electrical and Low Power System.
 - External layouts, particulars of all Cables & their routes, details of Earth Stations, size of all earthing conduction and Manholes etc. along with all equipment layout.
 - No. of sets required shall be as follows :
 - Original Drawings - Coloured (A0 / A1 size): 1 Set
 - True Copies - Black & White (A0 / A1 size) : 3 Sets
 - CDs : 3 Sets
- All drawings shall be prepared on Acad Release 2004 / Acad Release 2009 / latest version. In addition to the above, Main SLD and Block diagram duly framed in A0 / A1 size to be mounted in LT Panel Room as required by consultant.

48. Completion Document / Manuals

All Completion Documents related to handing over shall be submitted before issuance of the certificate of Virtual Completion. Details of Completion Documents required shall be as follows :

As built Drawing along with final SLDs and GADs on ACAD Release 2004 / Acad Release 2009 / latest version (A0 / A1 size)

Commissioning Report duly filled and signed by Contractor.

Test Reports for all Electrical Equipment, Panels, Cables and Wires etc.

Electrical installation certificate duly signed by Contractor.

List of spares for two years maintenance along with necessary catalogues & addresses, telephone numbers and contact names of all particular vendors.

SLD Charts framed and fixed near all Panels as required by PMC Consultant/ EIC/ Employer .

Proper Balancing of system along with Records as soon as site is operational.

One original set & two photocopied sets of operating and maintenance manuals which shall include brief description of the entire Electrical & Lower Power system, maintenance & operating instructions along with necessary circuit diagrams as well as catalogues, manufacturer's drawings, performance data and warranty cards. These manuals are to be duly approved by the PMC Consultant/ EIC/ Employer before submitting them to the Owner.

49. Training of Owner's Personnel

- The Contractor shall train the Owner's Personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period.
- Training for major equipment shall be arranged by the Contractor at manufacturers' works at no extra cost.
- The period of training shall be adequate and mutually agreed upon by the Client and Contractor.
- The Owner's Personnel shall also be trained for routine maintenance work adjustments, testing, minor repairs and replacement.
- No extra charges shall be paid to the Contractor for training the Owner's personnel.

50. Requirement for LEED Certification

- A concept of Green Building with IGBC Gold / GRIHA rating is envisaged in the design. Contractor must submit the relevant test certificates / undertakings (relevant authorities' certification if and as applicable) for each individual equipment / material (as required for accredited agencies). The submittals would be regularly reviewed by Commissioning Agent to ensure adherence to the fulfillment of certification requirements.

Section – B

Technical Specifications for Electrical Works

Section – 01

Technical Specification for HT VCB Switchboard (33 kV)

1. General

- **Work Included**

- I. 33 kV HT VCB Switchboards

- **Related Work and Obligations**

- I. The general requirements apply to work specified in this section.

- II. Examine all the other sections of the specification for requirements, which may affect work of this section.

- **General Requirements**

- I. This specification covers the design, manufacture, testing, packing and supply of HT Indoor Air Insulated draw out type switchgear panel (Switchboard) up to 36 kV respectively incorporating Vacuum Circuit Breaker. The Switchboard shall be new which will be specifically manufactured against the enclosed detailed specification.

- **Codes and Standards**

- I. The switchgear shall be manufactured and tested in line with the latest revision of the following Indian as well as International Standards :

- IEC62271-200 (Internal arc withstand of 25KA till 1 sec. in all 3 HV compartments), IS13118, IS3427: High Voltage Switchgear & Control gear
 - IS5082 : Material for data for Aluminum bus bars.
 - IS9920 : Switches and Switch Isolators for voltages above 1000V
 - IS9921 : AC Disconnectors (Isolators) and Earthing switches for voltage above 1000V
 - IS9046 : AC Contactors of voltage above 1000V upto and including 11000V
 - IS13703 : Low voltage fuses
 - IS2705 : Current Transformers
 - IS3156 : Voltage Transformers
 - IS1248 : Electrical indicating instruments
 - IS3231 : Electrical Relays for power system protection
 - IS6875 : Control switches and push buttons
 - IS694 : PVC insulated cables for working voltages upto and including 1100V

In case of any conflict between the above standards and this specification, the requirements of the stringent will prevail.

- **Quality Assurance**

Only manufacturers regularly engaged in manufacturing of 33kV HT VCB shall be approved as required, whose products have been in satisfactory use in similar service for not less than 10 years. As minimum quality system adherence norms, the vendor shall have ISO 9001 Certification.

. Vendor to Confirm the following-

* That the offered Panel with all components i.e. Breaker, Cable and Bus Bar compartment is internal arc withstand tested design for desired current ratings

* That the Vacuum Circuit Breaker is maintenance free

* That the anti-pumping feature is available with confirmation whether the same is in-built feature or externally wired

* That the offered Breaker Mechanism is designed for the specific interrupter and is typed tested with that interrupter

* That all operations are carried out behind closed doors

- **Guarantee**

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and in lieu of all other liabilities which manufacturer may have by other provisions of the contract document.
- The HT VCB shall also be guaranteed against trouble free operation, defective workmanship and materials / parts for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period equipment / parts shall be replaced free of cost by the Vendor.

- **Submittals**

- Contractor to submit general arrangement diagrams with front, side, top & bottom view and inside view
- General arrangement diagrams shall include outline & dimensions, voltage, cable / bus capacity, circuit breaker details and their arrangement / sizes
- All drawings shall also indicate location / description of all operating / indicating components mounted inside VCB
- Typical Control Schematic Diagram
- Terminal block details for all power and control terminals provided for external as well as internal wiring connections
- Foundation details with necessary dimensions
- Bill of Material giving make / rating / catalogue number of all components

- **Delivery, Handling and Storage**

All equipment shall be inspected for the followings :-

* Damage

* Compliance with specifications

* Quality

This shall be protected from weather, fire or mechanical damage during storage / Shipment.

- The switchboard shall be suitable for installation and satisfactory operation in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The switchboard shall be designed to operate under site conditions as specified in particular specifications.

2. Products (General Requirements)

• Enclosure and Protection

- The Switchgear shall be metal clad and shall comprise of standard pre-fabricated cold rolled sheet steel units assembled (bolted) to form a rigid, free standing structure. The load bearing members shall be manufactured out of minimum 2 mm CRCA sheet steel. The non-load bearing members such as covers, partition, shutters, explosion covers can be made of 1.6 mm CRCA sheet steel. Wherever single core cables are used, the detachable gland plates shall be made of Aluminum sheet.
- The Switchboards shall be totally enclosed the vermin proof. If necessary, openings for natural ventilation such as louvers and ventilation box shall be provided with the wire mesh from inside. The switchgear panel shall have minimum degree of protection IP4X. Suitable measures such as gaskets shall be provided for doors if required.
- Each unit of the switchgear shall be divided into functional individual compartments such as:
 - * Bus Bar compartment
 - * LT compartment
 - * Circuit Breaker compartment
 - * Cable and instrument transformer compartment

All these compartments shall be segregated from each other by means of earthed metallic sheet steel. The shutters which are provided for safety purpose shall be also of earthed metallic sheet steel. Except the busbar compartment, all the compartments of each cubicle shall be independent from the similar compartment of the adjacent panels. The bus bar compartment shall run from end to end without any inter panel barriers so as in the event of internal arc inside the busbar compartment, the arc will travel along with the length of the switchboard.

- The complete switchgear shall be designed with full consideration with respect to the safety of the operating person in the event of internal arc. All the individual compartments as explained above shall have independent explosion vents. The Panel shall be type tested for 1 sec Internal Arc.
- The offered switchgear panel shall be with horizontal / vertical isolation and horizontal draw out Vacuum Circuit Breaker. The switching device shall be mounted on a truck, which will have distinct positions of Service and Test inside the compartment with the front door of the chamber closed. Each Circuit Breaker shall be provided with a truck so that a separate Circuit Breaker handling trolley is not required. All the operations of the switching device shall be with front door closed.
- Following minimum safety interlocks shall be provided so as achieve maximum operating personal safety :
 - * It will not be possible to rack out the withdrawable Vacuum Circuit Breaker trolley from Service to test position when the breaker is switched 'ON'. Similarly, it will not be possible to rack in the draw out mechanism from Test to Service position, if the Vacuum Circuit Breaker is switched 'ON'.
 - * Any attempt to rack out Circuit Breaker from Service to Test position will not result in

switching 'OFF' of the circuit Breaker. Instead the breaker Service position will be locked till VCB is 'ON'.

* It will not be possible to rack in or rack out Vacuum Circuit Breaker trolley when the front Vacuum Circuit Breaker chamber door is open. However, a suitable defeat interlock mechanism shall be provided for emergency purpose.

* It will not be possible to rack in Vacuum Circuit Breaker trolley from test to service position when the low voltage control plug is not in position and locked on the trolley itself.

* It will not be possible to switch 'ON' the earthing switch if provided, when the withdrawable truck is in Test position. This ensures physical isolation between the truck, busbar and the cables.

* It will not be possible to rack in Vacuum Circuit Breaker trolley from test to service position in case the cable earthing switch is 'ON'.

* Additional electro-magnetic interlock shall be provided for cable earthing switches in incomers and tie feeders.

* Alternately earthing trolleys can be also supplied. Electro-magnetic interlock to be provide on earthing trolley for incomers and tie feeders.

* Automatic metallic safety shutters shall be provided covering the opening for busbar and cable chambers. The movement of these shutters shall be interlocked mechanically with the movement of the truck so that these will open only when the movement of the truck is from service to test position. These automatic safety shutters shall be individual for cable and busbar openings and also shall be provide with the facility for padlocking. Suitable danger name plates shall be provided on these safety shutters.

- All hardware shall be of zinc passivated, high quality steel. For busbar connections, Belleville washers shall be used while for structure bolting, contact washers shall be used.
- The complete switchgear from inside as well as from outside shall be powder coated. The powder shade shall be pebble light grey.
- Wherever maintenance is envisaged such as tightening of busbar joints, the design shall allow easy access for the same. The busbar shall be accessible either from rear or from top for maintenance purpose. A suitable sheet steel partition shall be provided between the busbar compartment and the rear cover so that after removing the rear cover a direct access to live busbars will be prevented. A suitable viewing inspection window shall be provided for cable compartment.

- **Busbar Connections, Supports and Busbar Design**

- The switchgear shall comprise of 3 Phase busbars, which shall extend through all the units of the switchgear line up. All phases of busbars shall be uniform cross section throughout the switchgear and shall be sized to carry continuously the current specified in the Single Line Diagram with respect to site conditions. Busbars shall be housed in a separate chamber and shall be accessible for inspection only with tools.
- Busbar shall be made of electrolytic aluminium / copper. The clearance between the live busbar and the nearest earth partition / member shall be suitably arranged so as to withstand the 1 minute power frequency withstand voltage and impulse withstand voltage as specified in IEC62271. The clearance be meant for air insulation.
- Busbar shall be suitable at regular intervals by means of cast resin bus support insulators. The whole system be designed so as to withstand the specified short circuit level without permanent deterioration.

- The busbar shall be prominently marked with phase identification.
- **Cable Connections**
 - The incomer as well as outgoing power connections shall be through XLPE cables and from bottom unless and until otherwise stated. Ample space / termination height shall be provided in the cable chamber so as to terminate 3 core aluminium cables as specified in the Single Line Diagram. The power as well as control cable shall enter the switchgear panel from the bottom. Detachable undrilled glands plates shall be provide for cables, also the same shall be non- magnetic in case of single core cables.
 - Auxiliary Wiring & Terminals
 - Inside the cubicles, the wiring for control, signaling, protection and instrument circuits shall be done with PVC insulated conductors. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. The CT wiring shall be of minimum 2.5 sq mm and the other control as well as PT wiring shall be of 1.5 Sq mm. The same shall be multi stranded copper. Each wire shall be identified at both ends by PVC ferrules. All spare contacts of auxiliary relays timers etc. shall be wired upto terminals, 10% spare terminals shall be provided on each terminal block. Shorting links shall be provided for all C.T. terminals.
 - All inter-panel control wiring including wiring within the same shipping section shall be done by the switchgear vendor. For difference shipping sections, wires in rolls of the required length and loose ferrules shall be provided.
- **Earthing Connections**
 - All cubicles shall be connected to an earth busbar running throughout the length of the switchboard. All non-current carrying metallic parts shall be earthed to the main busbar effectively through structure. The movable Vacuum Circuit Breaker truck shall be provided with scrapping earth connection so that the earthing is done before the power contacts are engaged and break after the power contacts are dis-engaged. The main earthing busbar shall run in cable chamber. All doors and movable parts shall be connected to earth bus with braided copper of suitable size.
- **Name Plates**
 - Equipment name plates / shall be provided, Suitable danger warning name plates / shall be provided wherever necessary.
- **Vacuum Circuit Breaker**
 - The switching device shall be Vacuum Circuit Breaker. The Vacuum Circuit Breaker shall be maintenance free for a minimum life level of 10,000 electrical operations. The mechanism shall be of Motor Spring Reserve Drive (MSRD) with gear box shall be sealed for the lifetime. A suitable mechanical detaching facility shall be provided for the spring charging mechanism so that in the event of failure of spring charge limit switch, the drive mechanism will get automatically decoupled. An anti-pumping auxiliary contactor shall be integral part of the circuit breaker operating mechanism itself. The VCB auxiliary contacts shall be also mounted in VCB operating mechanism compartment itself. Shunt Release & Closing Coil shall be suitable for 24VDC control Voltage. Mechanical ON/OFF push buttons shall be provided for emergency purpose so that the same can be operated in the event of control supply failure without opening the VCB compartment front door. Mechanical indication shall be provided for ON/OFF, spring charge indication along with a mechanical operation counter. CBs of same rating shall be interchangeable however; CBs of different rating shall not be interchangeable.

- **Instrument Transformers**

- Instrument Transformers such as current and voltage transformers shall be cast resin insulated. The current transformers shall conform to IS2705, while the voltage transformers shall conform to IS3156. The CTs and PTs shall be designed suitable for required metering and protection equipment. The bus as well as PTs shall be in single pole version. The draw out bus PT shall be mounted in a separate panel while the Line PT shall be provided in the breaker panel.

- **Measuring and Recording Instruments**

- Ammeters, Voltmeters and other meters shall be provided as indicated in the Single Line Diagram. The same shall be of 96x96 mm flush mounted digital type.

- **Protective Relays**

- All protective relays shall be back-connected, draw out type, suitable for flush mounting and fitted with dust tight covers. Alternatively, "Plug-in" type relays will also be acceptable. The relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent wiring. It shall be possible to short the CTs through the test plug. Non-protection relays can be in fixed execution. Numerical relays shall be preferred over electromechanical relays.
- All relays shall be mounted on the panel front unless otherwise specified. The current & voltage coils shall be rated as specified on the relevant approved schematic drawings.
- Protective relays shall have hand reset facilities and clear operating indication eg flags for mechanical type relays or light emitting diodes for static type relays. It shall be possible to reset the flag without opening the relay case. Anti fungus treatment shall be provided for all relays.

3. Testing

- **Type Tests**

- Certificates to be provided by HT Switchboard Vendor for the following:
 - * Power frequency withstand
 - * Short time withstand
 - * Duty cycle
 - * Impulse withstand
 - * Degree of protection

- **Routine Tests**

- Following Routine tests in line with IEC62271 shall be carried out at HT Switchboard manufacturer's factory & tests certificates for the same shall be supplied with dispatch documents:
 - * High Voltage test on LT Circuit
 - * Opening and Closing Time of VCB
 - * Secondary Injection Test for Protective Relays
 - * General Functional Checks

- **Recommended Tests at Site and Examination of Work**

- Vendor to list all recommended tests to be conducted at site.
- Upon completion of installation of HT VCB and after building circuitry has been energized, commissioning agency shall apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance, otherwise, remove and replace with new units and proceed with retesting. In case commissioning assistance is required, vendor shall depute **their engineer for supervision of commissioning and guidance.**

4. Packing and Transport

- The switchboard shall be shipped to site packed in wooden crates. They shall be wrapped with polythene sheets before being placed in crates to prevent damage to the finish. Crates shall have skid bottoms for handling. Base channels required for base frame shall be dispatched 3 months in advance to the dispatch of panels, so that these can be buried and grouted in the concrete floor.

5. Measurement

- Equipment shall be enumerated.

Section – 02

Technical Specification for Oil Cooled Transformer

I. General

1 Work Included

- Oil Cooled Transformer
- Supervision during Testing & Commissioning of Oil Cooled Transformer

2 Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect **work of this section.**

3 General Requirements

- This specification covers the Design, Manufacture, Testing, Packing and Supply of Oil Cooled Transformer with On Load Tap Changer / Off load Tap Switch as per BOQ. The Transformer shall be new which will be specifically manufactured against the enclosed detailed specification.

4 Codes And Standards

- The Transformer shall be manufactured & tested in line with the latest revision of the following Indian as well as International Standards :
- IS10028 : Code of Practice for Selection, Installation & Maintenance of Transformers
- IS6600 : Guide for Loading of Oil Immersed Transformers
- IS335 : Insulating Oil
- IS8468 : On Load Tap Changer
- IS1271 : Thermal Evaluation and Classification of Electrical Insulation
- IS3637 : Gas Operated Relays
- IS2099 : Bushing (AC – 1000 Volt and above)
- IS3347 : Dimensions of Porcelains Transformer Bushing
- IS3639 : Fittings and Accessories
- IS5 : Painting
- IS1180- Losses in Distribution Transformer(Level 2 Minimum)
- IS2026- Temperature rise Power Transformer- Insulation level & (Part III) dielectric tests
- In case of any conflict between the above standards and this specification, the requirements of the stringent will prevail.

5 Quality Assurance

- The Vendor shall ensure that all equipment furnished by him under the contract shall meet the requirements of relevant Indian standards Manufacturers regularly engaged in manufacture of 11/0.415 kV Oil Cooled Transformer with On Load Tap Changer/ Off load Tap Switch (as per BOQ) respectively shall be approved as required, whose products have been in satisfactory use in similar service for not less than 10 years. As minimum quality system

6 Guarantee

- Manufacturer shall provide guarantee for supply of equipment under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer may have by other provisions of the contract document.
- The Transformer shall be guaranteed against trouble free operation, defective workmanship and materials / Parts for a period of 18 months from the date of supply or 12 months from the date of erection & commissioning, whichever is earlier. In case of any defects during this period equipment / parts shall be replaced free of cost by the Vendor.

7 Delivery, Handling and Storage

- All equipment shall be inspected for the followings :-
- Damage
- Compliance with specifications
- Quality
- This shall be protected from weather, fire or mechanical damage during storage.
- The Transformer shall be suitable for installation and satisfactory operation in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The Transformer shall be designed to operate under site conditions as specified in the data sheets.

I Distribution Transformer (General Requirements)

1 Design Criteria

- Transformer is intended to step down incoming 33kV power supply to 0.415 kV (as per BOQ) for feeding power supply to further distribution network.
- The transformer will be installed in hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- The transformer shall be capable of withstanding the short circuit stresses due to terminal fault on one winding with full voltage maintained on the other winding for minimum period of three seconds.
- The transformer shall be free from annoying hum or vibrations. The design shall be such as not to cause any undesirable interference with radio or communication circuits.
- The safety clearances of all live parts of equipment shall be as per relevant standard.

2 Specific Requirements

a. Oil Tank

- Oil Tank shall be of all welded construction and fabricated from good commercial grade low carbon steel of adequate thickness. All seams shall be properly welded.
- The tank wall shall be reinforced by stiffener to ensure rigidity so that it can withstand without any deformation, mechanical shock during transportation and during oil filling by vacuum.

- Transformer tank shall be provided with one set of bi-directional flanged wheels for rolling the transformer in both directions. adherence norms, the vendor shall have ISO 9001 Certification.
- First Filling of oil shall be furnished for each transformer. Oil shall be supplied in non- returnable containers for outdoor storage.

b. Core & Coils

- The transformer shall be of core type. The core shall be built up with high grade, non-aging, low loss, high permeability, grain oriented, cold-rolled silicon steel laminations specially
- suitable for core material.
- The coils shall be manufactured from electrolytic copper conductor & fully insulated for rated voltage
- Insulating material shall be proven design. Coils shall be insulated such that impulse and power frequency voltage stresses are Minimum.
- Coil assembly shall be suitably supported between adjacent sections by insulating spacers and barriers. Bracing and other insulation used in assembly of the winding shall be arranged to ensure a free circulation of the air and to reduce the hot spot of the winding.
- All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used where practicable.
- Core shall be procured from one of these reputed Manufacturers
- The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000V for one minute

c. Radiators

- Radiators shall be made from pressed steel.
- Radiators shall be detachable and interchangeable type. Top and bottom shut off valve shall be provided for each radiator.
- Each radiator shall be provided with air release plug, drain valve and lifting lugs.

d. Insulating Oil

- The transformer tank shall be filled with mineral insulating oil suitably inhibited to prevent sledging.
- First Filling of oil shall be furnished for each transformer. Oil shall be supplied in non- returnable containers for outdoor storage.

e. Terminal Arrangement

- HV side shall be provided with cable terminal box and LV side shall be suitable for Bus Duct / Cable connection as per Bill of Quantity (BOQ) / SLD.
- Cable end box shall be self - supporting, weatherproof type with sufficient space inside for termination and connection of cables as detailed in the particular specifications. In case of Busduct, same would also be self - supporting, weatherproof type with sufficient space inside for termination.
- Cable end box wherever applicable shall be furnished complete with removable gland plate.

In general, the arrangement shall be such as to permit removal of the transformer without dismantling the bus duct / cable installation.

A separate L.V. neutral bushing shall be provided for connection to station ground mat. Necessary insulators shall be provided on transformer body for bringing down the Conductor.

f. Marshalling Box

- A sheet steel, weatherproof, marshalling box shall be provided for each transformer. The box shall contain all auxiliary devices except those which must be located directly on the transformer.
- All terminal blocks for Owner's cable connection shall be located in this box. The terminal blocks shall with minimum size of 4 sq mm.

g. Wiring

- All control, alarm & indication devices provided with the transformer shall be wired upto the terminal blocks.
- Wiring shall be done with PVC wires in MS Conduit or PVC insulated copper conductor armoured cable. Minimum wire size shall be 2.5 sq.mm. copper. No more than two wires shall be connected to a terminal. 10% spare terminals shall be provided.
- All devices & terminal blocks within the marshalling box shall be identified by symbols corresponding to those used in applicable schematic or wiring diagram.

h. Grounding

- Two grounding pads, located on the opposite sides to the sheet steel enclosure, shall be provided for connection to station ground mat.
- Grounding pad shall have clean buffed surface with two tapped holes, M10-G.I. bolts and spring washers for connection with G.I. flat.
- Ground terminals shall also be provided on marshalling box to ensure its effective earthing.

i. Fittings And Accessories

- Each transformer shall be equipped with fittings and accessories as listed below:-
- Oil Temperature Indicator with Alarm and Trip contacts (for one or all three windings)
- Winding Temperature Indicator with Alarm and Trip contacts (for one or all three windings)
- Oil Conservator with filler cap, drain plug and magnetic oil level gauge
- Silica gel breather with connecting pipe and oil seal
- Air Release Plugs
- Pressure Release Device, Explosion Vent (Double Diaphragm type)
- Thermometer Pockets
- Double Float Buchholz Relay with gas release cock, shut-off valve on either side or separate sets of contacts for Trip & Alarm
- Filter Valve with threaded adopter (top and bottom)
- Drain Valve with threaded adopter

- Sampling Valve
- Marshaling Box for housing control equipment and terminal connections
- Neutral Bushing
- HV Cable Box / LV Cable Box or HV Cable Box / LV Busduct Terminal
- On load Tap Charger with +5% and -15% tapping on H.T. Side
- Earthing Lugs / Studs
- Lifting Hooks
- Diagram and Rating Plates
- Base Channels (skid type) with Bi-directional Rollers suitable for mounting on Floor and Plinth.
- Suitable Enclosure

j. Painting

- All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required, to produce a smooth surface free of scales, grease and rust.
- The external surfaces, after cleaning, shall be given a coat of high quality red oxide or yellow chromate primer followed by filler coats.
- The transformer shall be finished with two coats of Siemens Grey Shade RAL 7032 synthetic enamel paint, oven baked or powder coated.

k. Voltage Control (On Load in case of Tap Changer)

- The transformers shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio while the transformers are on load and without producing phase displacement.
- Equipment for 'local' and 'remote' electrical and 'local' manual operation shall be provided and shall comply with the following conditions (Local/remote switch may be housed in remote control panel or in tap changer drive mechanism) :
- It shall not be possible to operate the electric drive when the manual operating gear is in use.
- It shall not be possible for any two electric controls to be in operation at the same time.
- The equipment suitable for supervisory control and indication on a multi way switch, make before break having one fixed contact for each tap position, shall be provided and wired to the tap changer drive gear. This switch shall be provided in addition to any, which may be required for remote tap change position indication purpose. Supervisory indication shall also be provided in the form of contacts to close on. 'Tap change incomplete' condition. All other components of the supervisory gear, if required be specified separately
- Operation from the local or remote-control switch shall cause one tap movement only. The control switch shall be returned to the 'neutral' position between successive operations.
- All Electrical control switches on the local operation gear shall be clearly labeled in a suitable manner to indicate the direction of tap changing.

- The local control switches shall be mounted in the drive gear housing.
- The equipment shall be so arranged as to ensure that when a tap change has commenced, it shall be completed independent to the operation of the control relays or switches. In case of failure of the auxiliary supply while the tap change is in progress or any other contingency such as stuck tap changer, adequate means shall be provided to safe guard the transformers and its auxiliary equipment.
- Suitable apparatus shall be provided for each transformer to give indications as follows:
 - i. To give indication, mechanically at the transformer and electrically at the remote control cubicle of the position of tap in use .
 - ii. To give an indication at the remote- c o n t r o l cubicle that a tap change is in progress, by means of an illuminated lamp.
 - iii. For remote control, the switches, tap position indicator, etc. shall be supplied duly mounted on remote control cubicle.
 - iv. All relays and operating devices shall be operated correctly at any voltage between the limits specified in the relevant IS.
 - v. The tap changing mechanism shall be mounted in the oil tank or compartment mounted in an accessible position on the transformer.
 - vi. Any non-oil filled compartment shall be adequately ventilated, thermostatically controlled heaters shall be provided in the driving mechanism chamber and in the marshalling box. All contactors & auxiliary relay coils or other parts shall be suitably protected against corrosion or deterioration due to condensation, fungi etc.
 - vii. The tap changer contacts which are not used for making or breaking current like separate selector switch contacts inside main transformer tank where tap changer construction permits such arrangement. In case of on load tap changer having separate compartment for selector contacts, the oil in such compartment shall be maintained under conservator head by means of pipe connection from the highest point of the chamber to the conservator. Such pipe connection shall be controlled by suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas oil actuated relay. A separate Buchholz relay may be provided for this compartment.
 - viii. It shall not be possible for the oil in these compartments of the tap change equipment which contain contacts used for making or breaking current, to mix with the oil in the compartments containing contacts and not used for making or breaking current.
 - ix. Any 'DROP DOWN' tanks associated with the tap changing apparatus shall be fitted with guide rods to control the movement during lifting or lowering operations. The guide rods shall be so designed as to take support of the associated tank when in the fully lowered position with oil. Lifting gear fitted to 'Drop Down' tanks shall include suitable device to prevent runaway during lifting & lowering operations.
 - x. They shall be provided with adequate breathing arrangement. The tap changer shall be mounted in such a way that the cover of the transformer can be lifted without removing connections between windings and tap changer.
- Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil gauge.

- The alternating supply for electrical operation of the control and indicating gear shall be standard 415 Volts, three-phase, 3 Wire, 50 HZ. along with 240 Volts single phase, 2 wire 50HZ, subject to a variation of + 5 percent so that the equipment offered can withstand variation in AC.
- Limit switches shall be provided to prevent over-running of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stopper or other approved device shall be provided to prevent overrunning of the mechanism under any condition.
- Limit switches may be connected in the control circuit of the operating motor provided that a mechanical de clutching mechanism is incorporated.
- Thermal devices or other means like motor circuit breakers with shunt trip coil shall be provided to protect the motor and control circuits. All relays, switches, fuses, etc. shall be mounted in the marshalling box or driving gear housing. These shall be clearly marked for purpose of identification. They shall withstand the vibration associated with tap changer gear operation.
- The whole of the apparatus shall be of robust design and capable of giving satisfactory service under conditions to be met in service including frequent operation
- A five-digit counter shall be fitted to the tap changing mechanism to indicate the number of operations completed by the equipment
- A permanently legible lubrication chart shall be fitted within the driving mechanism chamber, where applicable.
- The indigenous make (internal/external) OLTC shall be duly type tested from CPRI or other Govt. Test House or reputed lab abroad to the extent the facilities of Type test available in CPRI.

I. Tests Routine Tests

During manufacturing and on completion, all transformer shall be subjected to the routine tests as per relevant Indian Standard.

- **Type Test**

Following type test shall be performed on transformer in accordance with relevant Indian Standards:

- Temperature rise test.
- Cost of such test, if extra, shall be quoted separately by the Bidder.
- Test Witness
- Tests shall be performed in presence of Owner's representative, if so desired by the Owner. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

Section – 03

Technical Specification for HV Cables

I. General

1. Work Included

- HV Cables
- The cable installation shall include laying, testing & commissioning all trench work, sleeves, ducts and all necessary fixing and cable terminations at both ends of the cable.
- Ducts and sleeves shall be provided at road crossings, under paved roads and footpaths. The duct crossings shall include 25% spare capacity to cover possible future requirements. Ducts / sleeves shall also be installed for future use as indicated in the drawings.

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements which may affect work of this section.
- Co-ordinate work with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying, laying, testing and commissioning of PVC insulated cables for High Voltage system. All cables shall be of the approved make.
- Cable sizes shall be as shown on the drawings. Sizes smaller than those specified shall not be accepted.

4. Codes And Standards

- The cables shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
- IS 7098 (Part-II) : Cross-linked Polyethylene insulated PVC sheathed HV XLPE cables: Part II for working voltages from 3.3 kV up to and including 33 kV.
- IS 8130 : Conductors for insulated electric cables & flexible cords
- IS 5831 (1984) : PVC insulated and sheath of electrical cables.
- IS 1554 (Part-II) : PVC insulated (heavy duty) electric cables - Part II for working voltages of 3.3 kV, 6.6 kV and 33 kV.

- IS 3975 : Mild steel wires, strips and tapes for armoring of cables.
- IS 3961 (Part-II) : Recommended current ratings for cables: Part II PVC insulated and PVC sheathed heavy duty cables.
- IS 1753 : Aluminum conductors for insulated cables.

5. Quality Assurance

- Manufacturers regularly engaged in manufacture of cables, whose products have been in satisfactory use in similar service for not less than 5 years. Vendor to provide necessary excise duty gate pass (as applicable) along with test certificates, if required by the Owner.
- Installation shall be carried out by a firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The HV Cables shall be guaranteed against trouble free operation, defective workmanship and materials for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period cables shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- All cables shall be carefully transported to site to avoid damage during transit. While on site all cables shall be stored in a proper manner to prevent damage or moisture ingress at the ends.

II. Products

1. General Construction

- The cables shall be brand new and in good condition. These shall be suitable for laying in cable turnings, trays (Ladder type), trenches, ducts, conduits and underground buried installation with uncontrolled backfill and possibility of flooding by water.

1.01 Core Identification

- The cores shall be identified by different colours as follows :
- Single core : Black
- Two core : Red and Black
- Three core : Red, Yellow, Blue
- Four core : Red, Yellow, Blue, Black
- Three and half core : Red, Yellow, Blue and reduced neutral core in Black

1.02 Laying Up

- In multicore cables, cores shall be laid up as per the above colour scheme, interstices shall filled wherever necessary to make the laid up cores circular.

1.03 Inner Sheath

- Laid up cores shall be provided with Inner Sheath with LSZH Polymer which shall as bedding for Steel Wire / Strip Armoring.

1.04 Insulation

- Conductor shall be insulated with suitably compounded polymer to bear thermal and thermos-mechanical stresses safety at continuous normal and short circuit temperature conditions.

1.05 Armouring

- Armouring shall be provided over the inner sheath to guard against mechanical damage. Armouring shall be generally of galvanized steel wires or strips, (In single core cables used in AC system armouring shall be by non-magnetic hard Aluminium wires/strips). Round steel wires shall be used where the diameter over the inner sheath does not exceed 13 mm; above 13 mm, flat steel strip armour shall be used.

1.06 Outer Sheath

- Specially formulated LSZH material shall be extruded to form the outer sheath.

1.07 Product Code

- As per IS : 7098 : Part I, the codes as under shall be followed :

Constituent	Code
Aluminium conductor	- A
XLPE insulation	- 2X
Steel round wire armour	- W
Steel strip armour	- F
Steel Double round wire armour	- WW
Steel Double strip armour	- FF
Non-magnetic (Al.) round wire armour	- Wa
Non-magnetic (Al.) strip armour	- Fa
PVC outer sheath	- Y

2. XLPE Cables

- Power Cables for 3.3 kV up to & including 33 kV system shall be with aluminum / copper conductor (as per BOQ), XLPE insulated & Fire Resistant having thermo stating insulation for low emission of smoke & corrosive gasses when affected by fire.
- The construction of the conductor shall be stranded and compacted circular for all cables.

- The core insulation shall be with cross linked polyethylene unfilled insulation compound. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.
- The conductor screen, XLPE insulations & insulation screen shall all be extruded in one operation by “triple Extrusion” process to ensure perfect bonding between layers. The core identification shall be by coloured strips.
- For multicore cables, the armouring shall be by galvanized steel strips.
- The dimension of the insulation, armour and outer sheathing materials shall be governed by values given in Tables 1, 3 and 4 of IS 7098 Part-II.

III. Installation, Testing and Commissioning

1. Erection

- All cable routes shall be carefully measured & cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable drums shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable BOQ is approximate.
- The Contractor shall ascertain the exact requirement of cable for a particular equipment by measuring at site and avoiding interference with structure, foundation, pipe lines or any other works.
- Cables shall be laid in complete, uncut lengths from one termination to the other.
- Cables shall be neatly arranged in the trays (Ladder type) / trenches / underground in such a manner so that crisscrossing is avoided and final take off to the C.B. Panel / Transformer is facilitated. Arrangement of cables within the trays / trenches / underground shall be responsibility of the Contractor.
- All cables shall be identified close to their termination points by cable numbers / identification as per details mentioned in SLD. Cable tags shall be used for this purpose.
- Each underground cable shall be provided with identity tags securely fastened at each end before the cable enters the ground.
- All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape along with cable caps.
- Removal of concrete covers from RCC cable trenches for purposes of cable laying and restating them in their proper positions after the cables are laid shall be done by the Electrical Contractor at no extra cost.
- Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protecting cover until such times the final termination to the equipment / C.B. Panel is completed.
- At all changes in direction in horizontal and vertical places, the cable shall be bent smooth with a radius of bent not less than 12 times the diameter of the cable.
- Insulation tapes of appropriate voltage and in red, yellow and blue shall be wrapped just below the lugs for phase identification.
- Minimum depth of buried cable trench shall be 900 mm (3.3 to 11 kV Cables) and 1200 mm (33 kV Cables) to the highest point of cables laid in undeveloped ground /

cultivated ground or where crossing below road / path ways. The depth & the width of the trench shall vary depending upon the number of layers of cables.

- Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the cables & sand shall be lightly pressed. A protecting cover of 75 mm thick second-class red bricks shall then be laid flat. The remainder of the trench shall be back filled with soil, rammed & leveled.
- Before covering the cables with sand every cable shall be given an insulation test in the presence of Consultant's representative. Any cable which proves defective shall be replaced.
- At road crossing and other places where cables enter pipe / sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- Where the cables shall be laid in overhead cable trays the same shall be ladder type and galvanized.
- Cables laid in vertical / horizontal run of cable trays shall be suitably clamped by means of GI saddles/ clamps.

2. Examination of Work

- No work shall be covered by backfilling or otherwise put out of view without the approval of the Consultant / Engineer-in-charge. The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination & the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such work.

3. Tests

- PVC insulated cables shall be subjected to tests as required by IS : 1554 Part I.
- XLPE insulated cables shall be subjected to test as required by IS : 7098 Part II.

3.01 Type Tests

- Certificates to be provided by Cable Manufacturer for the following :
 - Tests on Conductor:

Annealing Test for Copper, Tensile & Wrapping Test for Aluminum, Measurement of Resistance

- Test for Thickness of Insulation and Sheath
- High Voltage Test
- Insulation Resistance Test
- Test for Armouring Wires / Strips
- Flammability Test

3.02 Routine Shop Tests

- The following routine shop tests shall be carried out at Cable manufacturer's factory:
 - Acceptance Tests for Conductor and Insulation
 - High Voltage Test

- Conductor Resistance Test

3.03 Routine Tests during Installation at Site

- The following routine tests shall be carried out during Installation at site :
 - A general visual check shall be carried out for overall dimension.
 - Insulation Resistance Test
 - High Voltage Test
- All cables furnished under the contract shall be tested by the Contractor in the presence of the Consultant / Engineer-in-charge to ensure and prove satisfactory performance and for same the Contractor shall provide all test equipment required.
- The Contractor shall test all cables using DC voltage injection equipment (Digital type).
- The insulation resistance of all cables when tested with 1000 volt DC Meggar shall not be less than 100 Mega Ohm.

IV. Measurement

- I. Cable shall be measured by length.

Section – 04

Technical Specification for MV Panels and Final Distribution Boards

I. General

1. Work Included

- Panel Board Enclosures, Switch Gear and Accessories
- Internal wiring, control terminal blocks, name plates / labels and painting

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect work of this section.
- Co-ordinate works with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for Supply, Erection, Testing & Commissioning of MV Panel Boards. The equipment offered by the Contractor shall be complete in all respects. Any material and component not specifically stated in this specification but which is necessary for trouble free operation of the equipment and accessories specifically excluded. All such equipment / accessories shall be supplied without any extra cost. Also, all similar components shall be interchangeable and shall be of the same family type and rating for easy maintenance and low spare inventory.

4. Codes and Standards

- Compliance with all applicable Indian / International standards, Indian Electricity Act and Indian Electricity Rules

- IS 5 : Colors for ready-mixed paints and enamels.
- IS 375 / 1963 : Making & arrangement for switchgear, Busbars, main connections & auxiliary wiring
- IS 694 : PVC insulated cables for working voltages up to & including 1100V
- IS 13779 : A.C. Static Electricity Meters
- IS 1248 : Electrical Indicating instruments
- IS 1567 / 1960 : Metal clad switches (Current rating not exceeding 100A)
- IS 1951 / 1916 : Polyvinyl chloride sleeving for electric purposes
- IS 2147 / IS 12063 : Degree of protection provided by enclosures for low voltage switchgear and control gear.

- IS 2675 / 1966: Enclosed distribution fuse boards & conduits for voltage not exceeding 1000 Volts
- IEC 60947 / IS 13947 (Part-2) : A.C. Circuit Breakers
- IS 8828 : Miniature Circuit Breakers
- IEC 61641 : Internal Arc
- IS 12640 : Residual Current Operated Circuit Breakers
- IS 2448 / 1962 : Adhesive insulating tapes
- IS 2551 : Danger Notice Plates
- IS 2705 : Current Transformers
- IS 2208 / 1962 : HRC Cartridge fuses links up to 650 Volts
- IEC 60947 / IS 13947 (Part-4, Sec-1) : Contactors & motors starter for voltages not exceeding 1000 V AC or 1200 V DC
- IS 13947 (Part-5, Sec-1) : Control Circuit Devices and Switching Elements
- IS 13947 (Part-1 & 5) : Actuators, Indicators
- IS 13947 (Part-1 & 5) : Timers
- IEC 60947 / IS 13947 (Part-3) : Switch Disconnectors Fuse, Changeover Switches
- IS 3043: Code of practice for earthing
- IS 3072: Installation and Maintenance of switchgear
- IS 3202: Code of practice for climate proofing of electrical equipment
- IS 3231/ IS 8686 : Electrical relays for power system protection
- IS 4237: General requirements for switchgear & control gear for voltages not exceeding 1000 V
- IS 5082: Wrought Aluminum & Al alloy for electrical purposes
- IS 6875: Switches and push-buttons
- IS 8623 (Part-1) : Specification for factory built assemblies of switchgear and control gear for voltages up to & including 1000 V AC
- IEC 439 – 1 : Requirements for Type Tested & Partially Type Tested Assemblies
- IS 61439 : Requirements for Type Test Report
- IS 13703 (Part-2) : HRC Cartridge fuses
- IS 10118 : Code of practice for selection, installation and maintenance of switchgear and control gear
- IS 11353 : Guide for uniform system of marking & identification of conductors and apparatus terminals
- IS 12021 : Specification of control transformers

- Equipment in line with any other authoritative / internationally recognized standards such as IEC, British, USA and German etc. shall also be considered if it ensures performance equivalent or superior to Indian Standards. Prior approval shall be obtained from Consultant for use of this equipment / material. In such cases, the decision of Consultant shall be final and binding

5. Quality Assurance

- Manufacturers regularly engaged in manufacture of panel boards and enclosures of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years
- Installation shall be carried out by a firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The Panel Boards shall be guaranteed against trouble free operation, defective workmanship, materials and design for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. Any defects during this period shall be rectified free of cost

7. Submittals

- Contractor to submit general arrangement diagrams with front, side, top & bottom view and inside view
- General arrangement diagrams shall include outline and dimensions, voltage, main bus capacity, circuit breaker details and their arrangement / sizes
- All drawings shall also indicate location / description of all operating / indicating components mounted on the front / rear of the panel for all feeders / starters
- Typical control schematic diagram for each type giving designation to be referred on Single Line Diagram
- Terminal block details for all feeders / starters power and control terminals provided for external as well as internal wiring connections
- Panel board foundations with necessary dimensions
- Details of shipping sections along with all dimensions
- Bill of material giving make / rating / catalogue number of all components of the complete switch board
- Shop drawings to scale of the room layout indicating the panel location

8. Delivery

- All panels shall be carefully packed to avoid damage during transit. Panel boards shall be wrapped in polyethylene sheets for local shipment; whereas for outstation

delivery, in addition to polyethylene sheet, the panels shall be packed in wooden crates to prevent damage to the finish.

II. Products

A. Panel Board Enclosures and Accessories

1. Constructional Details of Panel Boards

- All Panel Boards shall be metal enclosed, indoor, floor / wall mounted, free-standing type.
- The Switch board shall have a rated short time withstand current of 50kA for 1 second and a fault withstand classification of class 3 for a supply voltage of 415V AC between phases at 50Hz with Impulse withstand of 12 kV
- All Switchboards frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed & shaped CRCA sheet steel of thickness not less than 2.0mm. Frames shall be enclosed in CRCA sheet steel of thickness not less than 2.0mm. Doors and covers shall also be of CRCA sheet steel of thickness not less than 1.6mm. Stiffeners shall be provided wherever necessary. Rear doors shall made of min 2.00 mm thick CRCA, sheet steel and provided with three pin handle and lock.
- All panel edges & cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that these do not permanently bulge / bend by the weight of maintenance personnel working on it.
- The complete structures shall be rigid, self-supporting and free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.
- All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 52 as per IS: 2147.
- The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree pf enclosure protection to be maintained even with Fans
- All cutouts shall be provided with synthetic rubber gaskets. The gaskets, wherever specified, shall be of good quality synthetic rubber with good aging, compression & oil resistance characteristics suitable for panel applications. Preference shall be given to Heat resistant – EPDM Gaskets.
- All Switchboards shall be of uniform height not exceeding 2300 mm unless otherwise mentioned / approved in general arrangement diagrams submitted by Contractor during detailed engineering.
- Internal Arc withstand of 50kA for 0.3 sec.
- The minimum and maximum operating height shall be 400 mm and 1800 mm respectively. Height of Indicating instruments shall not be more than 1900 mm. Measuring devices requiring visual supervision shall not be mounted above 1600 mm from floor level.
- Tested for Internal Arc Performance as per IEC 61641
- Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary provision for fixing to foundation / floor as required. The

base frame height shall be such that floor finishing to be done by Owner after erection of the switchboards does not obstruct the movement of doors and cover etc.

- All Panel Boards shall be divided into vertical section, comprising of various compartments as mentioned below. However, these compartments may be combined in case of Sub- Distribution Board.
- The LV main switchboards shall be type tested assemblies (TTA) all type tests as defined in IEC 61439-1 or EN 61439-1, built up from compartments housing circuit breakers, Control gear, relays, bus bars, controls and other items of equipment.
- The switchboard shall be identical in mechanical construction to the LV Switchboard which had been type-tested by an acceptable, accredited and independent testing laboratory for the fault conditions, temperature rise limits.
- ACB shall have vertical terminal adaptor connectors
- The switchboard along with ACBs and connections should have been be type tested design at CPRI/ ERDA / Independent international test house for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required .
- Main LT Panel shall be enabled with a DIN rail wireless sensor capable of monitoring the system and generate three-levels of alerts on overheating wire connections or overheating cables depending on the severity of the detected situation.

Each column of the electrical switchboard shall include one wireless sensor at the top, to help user to prevent electrical switchboards from being damaged, by analyzing gas and particles in the air and sending alerts before any smoke or insulator browning occurs.

Sensor shall be able to analyze gases and microparticles inside the switchboard, by concentrating air into the sensor (with the help of an aspiration fan), applying a smart algorithm to sort internal cable issues from overheating, and sending alerts via email or notification to a smart phone application, enabling the switchboard's digital management.

- Temperature and humidity inside the switchboard should be measured by the wireless sensor and values to be communicated through the network. Sensor device should be able to be tested during commissioning and within the first 30 minutes after powering on. Device can also be tested whenever needed, after the 8-hour environment-learning period. All testing shall be made with an accessory provided only by the sensor manufacturer. Device shall also be capable to run self- diagnosis and provide two types of results. Sensor device should not replace any fire protection device of the installation.
- ENERGY MANAGEMENT SYSTEM (To be provided in Main LT Panel for all communicable meters)

a) Software - General:

The Energy Monitoring System shall have specialized data acquisition, visualization, analysis and reporting tools specifically designed for Energy Management.

b) Dashboards-

Flexibility for the operator to create engaging dashboard displays of the energy monitoring system information and easily share information with anyone in the facility.

c) ISO 50001 Compliant

It should be certified software in compliance with the requirements of ISO50001 & support compliance with EN 16247-1 for energy audits.

d) Cyber Security:

The Software Platform shall be designed to comply with cyber security standard IEC62443 at the component level: IEC62443-4-1 and IEC62443-4-2 (SL1).

e) Integration with third party software

f) The Software Platform shall support OPC DA Client 2.01 real-time data interoperability.

1.01 Busbar Compartment

- A completely enclosed bus bar compartment shall be provided for the horizontal & vertical Busbars. Bolted covers shall be provided for access to horizontal & vertical Busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. All Busbars shall be in separate compartment. Covers shall be provided with name plates indicating “Danger - Bus Bars” on it. Color of the plate shall be White with letters in Red of danger name plates shall be inscribed with 6 mm size lettering.
- Shrouding shall be provided for Bus Bar with current rating above 2000 A. These shrouds located near conductors shall be made using nonmagnetic materials.
- Main Horizontal bus bar 'Neutral should be in the same compartment'

1.02 Switchgear / Feeder Compartment

- All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides. The front of the compartment shall be provided with the hinged single leaf door with “Master Key” lock. The feeders compartment door shall have two number anodized inscription plates. One inscription plate shall bear the feeder number & feeder rating and fixed to the door with rivets. The other inscription plate shall bear the feeder name and shall be fixed by screws. The feeder name plates shall be interchangeable.

1.03 Harmonic Filter Compartment

- Space shall be provided LT Panel for installing Harmonic Filter. The Filter shall be selected at a later stage after the building is occupied & Harmonic analysis is done by competent agency.

1.04 Cable Compartment or Cable Alley

- A full-height vertical cable alley of minimum 300mm width shall be provided for power & control cables. Cable alley shall have no exposed live parts and shall have no communication with Busbar compartment. Cable terminations located in cable alley shall be suitably shrouded to prevent accidental contact by falling of tools etc. It shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination. The Contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged. Cable alley door shall be provided with name plates indicating “Cable Alley” on it.

1.05 Control Compartment

- A separate compartment shall be provided for relays and other control devices associated with a circuit breaker
- Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboards, except for the horizontal Busbar compartment. Synthetic rubber gasket shall be provided between the panel sections to avoid ingress of dust into panels. Each shipping section shall have full metal sheets at both ends for transport and storage.
- After isolation of power and control circuit connections, it shall be possible to safely carryout maintenance in a compartment with the Busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit
- All 415 V switchgear (circuit-breaker) panels shall be of single-front type. All Panels shall also be of single-front construction. All single-front switchboards shall be provided with single-leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with 'Danger' labels. All panel doors shall open by 90deg. or more. The panel door shall be openable only after switching of the incoming power supply
- Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the Busbar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live
- All equipment and components shall be neatly arranged & shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to Consultants approval and shall be provided with Bakelite shrouding.
- The tentative power and control cable entries (top/bottom) required are indicated in the "Bill Of Quantity". However, the Owner / Consultant reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.
- Each switchboard shall be provided with un-drilled, removable type gland plate, which shall cover the entire cable alley. Contractor shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall be provided with gasket to ensure enclosure protection.
- The switchboards fed from indoor transformers will be flange connected to the same and shall be located as close as desirable to the transformers. The switchboards fed from outdoor transformers shall be connected through cables as indicated in the "Bill of Quantity". Busduct connections wherever applicable shall be preferably in a straight-line alignment. The Centre line of the Busduct will be finalized during detailed engineering.

1.06 DC Control Bus & Power Pack

- Irrespective whether specified in the BOQ or not DC copper control bus minimum 4 sq mm in size shall be provided with a dedicated power pack if DC control circuits are required in the panel. The power pack shall have 300-watt output. 150 watt of this

output shall be backed with a battery for 15 minutes. Balance 150 watts shall be without battery back up

- The vendor shall calculate the burden of DC components. In case the burden of DC control components as envisaged in the scheme is more than the minimum specified, he shall provide power pack accordingly. If the control scheme requires more than one DC voltage, each DC voltage shall be provided through a separate control bus and dedicated power pack.

1.07 Gland Plates

- Gland plates for 2 Core, 3 Core, 3½ Core, 4 Core Cables shall be 2.5 mm thick CRCA zinc passivated. Thickness of zinc passivation shall be 100 microns. Wherever the size of gland plates exceeds 600 mm, same shall be split into two parts & provided with adequate supporting arrangement. Earth continuity between cable armour & panel body shall be maintained
- For Single core cables 3.00 mm thick, Aluminum gland plates shall be provided. These shall be adequately supported to avoid any distortion or bulging while doing terminations

2. Clearances

- The minimum clearance in air between phases and earth for the entire run of horizontal and vertical Busbars and bus-link connections at circuit-breaker shall be 25mm. For all other components, the clearance between “two live parts” shall also be twenty-five (25) mm throughout. For a live part and an earthed part, the clearance shall be twenty (20) mm minimum. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal & vertical Busbars, the clearances specified above should be maintained even when the Busbars are sleeved or insulated. All connections from the Busbars up to MCCB / SFU / FSU shall be fully shrouded / insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits.

3. Power Busbars and Insulators

- All 415 V Panel Boards, SDBs and MCCs shall be provided with three phase and neutral Busbars as specified in BOQ. Entire Busbar system shall be insulated with color coded, heat shrinkable PVC sleeves.
- All Busbars & jumper connections shall be of high conductivity aluminum alloy / copper of adequate size as specified in SLD / BOQ.
- The cross-section of the Busbars shall be uniform throughout the length of switchboard & shall be adequately supported & braced to withstand the stress due to the specified short circuit currents. Neutral Busbar short circuit strength / cross section shall be same as main Busbars up to 400Amps .
- All Busbars shall be adequately supported by non-hygrosopic, non-combustible, track-resistant and high strength sheet molded compound or equivalent type polyester fiber glass molded insulators. Separate supports shall be provided for each phase and neutral Busbar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Bakelite / Hiram shall not be accepted. The Busbar insulators shall be supported on the main structure.

- All Busbar joints shall be provided with steel bolts, Belleville / spring washers and nuts so as to ensure good contacts at the joints. Non-silver plated Busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the Busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the Busbar
- All copper to Aluminum joints shall be provided with suitable bi-metallic washers. Alternatively direct Bus Bar joints can be made between copper and Aluminum Bus Bar if tinned copper Bus Bars are used.
- All Busbars shall be color coded as per IS : 375 .All Busbars shall have PVC sleeves (not tapes) wherever called for in the specification.

4.00 Earth Bus and Earthing

- A galvanized steel / aluminum earth bus of suitable size shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar
- The earth bus shall have sufficient cross section (150 sq. mm. minimum) to carry the momentary short circuit and short time fault current to earth, without exceeding the allowable temperature rise.
- Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through at- least two bolts and taps by proper lug and bolt connection.
- All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.
- All metallic cases of instruments and other panel-mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire / braids. Insulation color code of earthing wires shall be green.
- CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit can be removed without disturbing the earthing of other circuit
- All hinged doors having potential carrying equipment mounted on it, shall be earthed by flexible wire / braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges / hinge pins of proven design may also acceptable. The Contractor shall establish earth continuity at site also.
- Interlocking: Electrical, Mechanical or both interlocking in panels shall be provided as per single line diagram. Wherever extension of panels for future is indicated on the single line diagram, necessary provision of interlocking as a composite scheme shall be made. These contacts including spare contacts of switchgear shall be connected to plug in type terminal block at one end of the panel. The arrangement should be such that when in future extension panel is connected, no shut down of panel in use is required
- Interlocking as required shall be provided both through shunt trip and closing coil in case of electrically operated circuit breakers.

- In case of manual draw out breakers, interlocking shall be provided through under voltage coil with supply from dedicated power pack.

4.00 Construct ruction Form

- As specified in the BOQ the switchboard shall be form 3b. For form of separation only metallic covers shall be used. Hylem / PVC sheets shall not be allowed.

Switchgear

1.00 Air Circuit Breakers

- The ACB shall confirm to latest IS 13947 (Part – 2) and IEC – 60947-2. The ACB shall comply with the isolation function requirement of IEC 60947-2 Section 7.12 & marked as suitable for isolation and disconnection to facilitate safety of operating personnel while the breaker is in use.
- The ACB shall have a rated service short circuit breaking capacity (Ics) not less than 40kA / 50kA / 65ka / 80kA rams at 415V, 50 Hz AC / as specified in SLD's and BOQ. The Service breaking capacity (Ics) shall be equal to ultimate breaking capacity (Ice) unless otherwise specified. The withstand capacity (Icw) shall be specified by the manufacturer for one second.
- ACB's shall be suitable for rated operational voltage up to 690 V AC, 50 Hz and insulation voltage up to 1000 V AC, 50 Hz.
- There should be no de-rating @ 50 degree C.
- Circuit breakers shall be three / four pole, air break, horizontal draw out / fixed type as indicated in SLD/BOQ.
- ACBs shall be single frame till 3200A to save the inventory. ACB shall have minimum Mechanical life of 20000 operations.
- Draw out type Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.
- There shall be "SERVICE", "TEST" & "FULLY WITHDRAWN" positions for the breakers. In "TEST" position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLY WITHDRAWN" position.
- Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE", "TEST", and "SPRING CHARGED" positions.
- All circuit breakers shall be provided with "2 NO" & "2 NC" potential free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker and should be directly operated from breaker operating mechanism.
- All circuit breakers shall be provided with the following interlocks :
 - Movement of circuit breaker between "Service" and "Test" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exist between the fixed and draw out contact at the time of

breaker trip, so that no arcing takes place even with the breaker carrying its full rated current

- Closing of circuit breaker shall not be possible unless it is in “Service” position, “Test” position or in “Fully Withdrawn” position.
- Closing of circuit breaker shall not be possible till all interlock is checked and found OK.
- Safety interlock shall be provided to prevent the ACB from falling out in a fully withdrawn position
- It shall be possible to close the door in “TEST ” position
- ACB supplied with both side rotatable terminal adaptors
- Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.
- A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.
- There should be a provision of positive earth connection between fixed & moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts must be provided on the cradle or body of fixed ACB.
- It should be possible to bolt the draw out frame not only in CONNECTED position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- Circuit breakers shall be provided with castle key / electrical interlocking devices, as specified in “Bill Of Quantity”.
- Access to accessories shall be prevented with ACB in ON condition. Circuit breaker trip unit shall have a display for measurement of current and voltage. It shall be possible to view last 5 trip cause on trip unit.
- Mechanical tripping shall be possible by means of front mounted Red “trip” push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation. It shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network.
- The manufacturer shall provide details of opening time duration to ensure discrimination and proper selection for feeder protections. All ACBs upto 3200A shall be a single ACB unit. The manufacturer shall also indicate the mechanical and electrical life of circuit breaker and their rating inside cubical at 50°C.
- Circuit breaker shall be provided with the following mechanisms, protection and accessories as specified in “Bill Of Quantity”. Separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip unit failure) shall be available on the trip unit which shall function even if the display fails.
- ACB shall have ready to close contact

1.01 Manually Operated Mechanism

- Manually operated mechanism shall be of manual spring charging stored energy type.
- The circuit breaker shall have a spring charging handle and push-button for closing the breaker mechanically after the spring has been charged. However,

closing by spring charging handle after the spring has been fully charged shall also be acceptable, provided the movement of contacts does not take place with the movement of handle and the contacts operate only when the spring stored energy is released. Overcharging of spring shall not be possible.

- The closing action of the circuit breaker shall charge the tripping spring, thus making it ready for tripping.
- The circuit breaker shall be provided with the interlocks so that it shall not close unless the spring is fully charged.
- The mechanism shall be suitable for addition of motor mechanism at site if required for future upgrade without the need of any special accessories.

1.02 Power Operated Mechanism

- Power operated mechanism shall be provided with a universal motor suitable for operation on 240 AC / DC Control supply, with voltage variation from 70% to 110% rated voltage. Motor insulation shall be class “E” or better
- The motor shall be such that it requires not more than 10 seconds for fully charging the closing spring at minimum available control voltage
- Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring
- The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operation shall be possible. After failure of power supply at least one open- close-open operation shall be possible
- Provision shall be made for emergency manual charging & as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled
- Provision for mechanical closing of the breaker only in “TEST” and “WITHDRAWN” positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds

1.03 Protection

- The integral self-powered Solid state release / Microprocessor based unit as specified in BOQ / SLD's shall be provided on circuit breaker for over load, short circuit and earth fault protection with adjustable dials for current and time setting. Specific LED indications should be provided for short circuit, over current and earth fault operation for faster fault diagnosis and reduced down time. The trip indication shall not need any external supply for display.
- Solid state / microprocessor releases as specified in BOQ / SLD shall be EMI / EMC compatible while fitted inside breaker. Microprocessor releases shall be provided with integral LCD Display of Load Current, Voltage on the display of release and individual loading / bar graph of all the three phases. Microprocessor release shall also be suitable for zone selective interlocking (ZSI) without the need of auxiliary power supply to ensure dependable and faster protection. Microprocessor releases shall also have I^2t ON/OFF time delay protection for short circuit and Earth fault at absolute value.
- Relays wherever specified, shall be CT operated and these shall trip the breaker through shunt trip release / under voltage trip release for desired protection.

- Four Pole ACB shall have 4th Pole / Neutral protection adjustable at site as 0%, 50%, 100%.
- Wherever earth fault release has been asked for in 3 Pole breakers, additional CT shall be provided on the neutral bus link. This CT shall have characteristics matching to the CT's installed in the ACB for the purpose.
- ACBs shall be able to communicate on/off/trip/ready to close status to EMS/BMS
- Microprocessor Releases shall have Thermal Memory i.e. when the breaker shall re-close after tripping on overload, then the thermal stress caused by the overload if not dissipated completely, shall get stored in the memory of releases and this thermal memory shall ensure reduced tripping time in case of subsequent overloads and earth fault. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system

1.04 Accessories

- All accessories like shunt release, under voltage, motorized mechanism etc. shall be front mounted, requiring no adjustments and can be fitted at site.
- All circuit breakers shall be provided with closing and trip coils as per BOQ. The closing coil shall operate correctly at all values of voltage between 70% to 110% of rated control voltage. The trip coil shall operate satisfactorily at all values of voltage between 40% to 110% of rated control voltage and shall be of continuous duty cycle.

2.00 Moulded Case Circuit Breakers (MCCBs)

- The Moulded case circuit Breaker (MCCB) shall conform to the latest IS 13947 (Part-2) and IEC 60947-2. The MCCB shall comply with the isolation function requirement of IEC 60947-2 Section 7.12 & marked as suitable for isolation and disconnection to facilitate safety of operating personnel while the breaker is in use.
- The MCCB shall have a rated service short circuit breaking capacity (Ics) not less than 25 / 40 / 50 / 65 / 80 KA rams at 415V, 50 Hz AC / as specified in SLDs & BOQ. The Service breaking capacity (Ics) shall be equal to ultimate breaking capacity (Ice) unless otherwise specified.
- MCCBs shall be suitable for rated operation voltage up to 690 V AC, 50 Hz and rated insulation voltage up to 690 V AC, 50 Hz.
- MCCBs shall be of triple pole / four pole construction as per enclosed BOQ. Operating mechanism shall be quick-make, quick-break and trip-free type. The "ON", "OFF" and "TRIP" positions of the MCCBs shall be clearly indicated and visible to the operator when mounted as in service. Front of door operating handle shall be provided with pad lock and door interlock. Front of door operating handle shall be provided with door interlock defeat mechanism to facilitate inspection of the MCCB during 'ON' position.
- The MCCB shall be current limiting type. MCCB shall have Arc extinguishing device contained in a compact, high strength, heat resistance, flame retardant, halogen free insulating molded case with high withstand capability against thermal and mechanical stresses.
- The trip command of releases in MCCB shall over ride all the other commands. The MCCB shall employ maintenance free double break contact system to minimize the let through energies and capable of achieving Discrimination up to the full short

circuit capacity of the downstream MCCB. The MCCB shall not be restricted to line / load connections. MCCB shall be provided with test trip Push Button to check the proper function of tripping mechanism.

- MCCBs shall be capable of withstanding the thermal stresses caused by overloads & locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short-circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 8 milliseconds.
- MCCB shall have continuous rated shunt release.
- Where mechanical interlocking is called-for between two Incomer and Bus Coupler or between two Incomers without Bus Couplers, proper arrangement for built-in Ronis / Coded key interlocking shall be provided.
- MCCB terminals shall be shrouded and designed to receive Bus Bar Links / cable lugs for cable sizes relevant to circuit ratings.
- MCCBs shall be single frame till 250A to save the inventory
- MCCB shall have ambient Temperature at 45° C without deration.

2.01 Protection

- MCCBs shall be provided with Thermo-Magnetic / microprocessor type releases as indicated in SLD / BOQ.
- The MCCBs above 250 Amps shall be provided with fully interchangeable thermo-magnetic / microprocessor-based overload and short circuit release & MCCBs below 250A shall be with thermal magnetic release. Load indication LED shall be integral part of electronic releases. All electronic releases shall be EMI / EMC compatible.
- All Microprocessor Based MCCBs shall have inbuilt earth fault protection & fault trip history with neutral protection as standard.
- All Thermal Magnetic based MCCBs shall have earth fault protection through external earth fault module with fault differentiation (through indication on panel) between overcurrent & earth fault.
- Microprocessor Releases shall have Thermal Memory i.e. when the breaker shall re-close after tripping on overload, then the thermal stress caused by the overload if not dissipated completely, shall get stored in the memory of releases and this thermal memory shall ensure reduced tripping time in case of subsequent overloads and earth fault. Realistic Hot / Cold curves shall take into account the integrated heating effects to offer closer protection to the system.
- Where Earth fault protection are indicated in drawings / BOQ they shall be integral with MCCBs & have adjustability from 10% to 60% of rated current with adjustable time delays to aid discrimination on earth faults. The integrated system shall be immunized against nuisance tripping as per IEC 61000-4 standards.
- In case of 4 Pole MCCB the neutral shall be defined and capable of offering protection up to full rating (0/50/100% value of phase current). In case of critical supply feeder, neutral protection shall also be given.
- MCCB with Thermal Magnetic Release shall be capable for distinguishing with the Trip condition i.e. Short Circuit or Over Load.

2.02 Accessories

- The MCCB shall have common field fittable snap-on auxiliaries for entire range & above 160 Amps the accessories like tin plated spreaders and phase Barriers shall be integral part of MCCBs.
- The trip coil shall operate satisfactorily at all values of voltage between 50% to 110% of rated control voltage and shall be of continuous duty cycle.

3. Miniature Circuit Breaker (MCBs)

- Miniature Circuit Breaker shall comply with IS 8828 – 1996 / IEC 898 – 1995.
- Miniature Circuit Breaker shall be quick make & break type for 230 / 415 V AC & 50 Hz application. The housing of MCBs shall be heat resistant and having a high impact strength. The breaking current of MCBs shall not be less than 10000 Amps, at 230 V / 415 V. The MCBs shall be flush mounted & shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications. MCBs shall be suitable for isolation function and line load reversibility.
- MCBs shall be current limiting type class – 3. MCBs shall be classified as B, C, and D as per standard Ref. IS as per the Tripping characteristics curves defined by all the manufactures. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS / IEC and the manufactures shall publish the value.
- MCBs shall be calibrated at an ambient temperature of 40 degree.
- The MCB contacts shall be silver nickel alloy and contact tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCBs shall be provided with magnetic coil releases for short circuit protection and thermal release for over load protection. The over load or short circuit devices shall have a common trip bar in the case of DP, TP, TPN and FP Miniature Circuit Breakers & shall have 20000 electrical operations up to 63A. The terminals shall be protected against finger contact to IP 20 Degree of protection.
- MCBs shall have a facility to accommodate accessories like auxiliary contacts, trip alarm contact, shunt trip and under voltage add-on blocks.

4. EL + MCB / RCCB / ELCB

- The RCCB / ELCB should comply with IEC 1008 & shall be suitable for use with pure AC/AC with DC off set, for frequency range of 50 Hz to 400 Hz. The RCCB / ELCB shall be protected against nuisance tripping by a protective device, limiting such tripping to a peak value of 250 A according to the 8/20 wave for instantaneous devices. RCCBs / ELCBs shall be suitable for isolation function and line load reversibility.
- EL + MCB / RCCB shall have Earth leakage, over load and short circuit protection where as ELCB shall have Earth leakage protection only. RCBO / RCCB wherever provided in UPS systems / DB shall be super immunized / equivalent.
- EL + MCB / RCC B / ELCB shall be quick make & break type. The housing shall be heat insulated & having a high impact strength. The moving contacts of the Phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism for closing / opening of all the three phases simultaneously. The neutral moving contact shall be so mounted on the common bridge that at the time of closing, the neutral makes contact first before the phases and at the time of opening, the neutral breaks last after allowing the phases to open first.

- The core balance transformer ensures positive detection of earth leakage currents. The incoming current shall pass through the toroidal core transformer. As long as the current in the phase & the neutral shall be the same, no electromotive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which will cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. The device shall be current operated independent of the line voltage, current sensitivity of 30mA/100mA/300mA at 240 / 415V AC.
- EL + MCB / RCCB / ELCB shall have trip free nature of mechanism ensuring that it cannot be closed when an earth leakage fault persists.
- Test device shall be there to check the integrity of earth leakage detection system and the tripping mechanism. It shall have box type terminals & capture screws ensuring easy connection of cables and protected against finger contact to IP 20 Degree of Protection.

5. Motor Protection Circuit Breakers (MPCB)

- The Motor Protection Circuit Breaker shall be used for DOL / STAR-DELTA starting of motors up to 110.0 KW shall offer protection to motors against overload, short circuit and phase failure. The MPCBs shall be suitable for Type 2 co-ordination. It shall have quick make, quick break mechanism suitable for AC 3 duty and shall be capable of operating in temperatures up to 55 degree centigrade and temperature compensated. The MPCBs shall have a minimum breaking capacity of 50 KA at 415 V 50 Hz. The MPCBs shall have rotary door operating mechanism handle and shall have a facility to accommodate auxiliary contact, short circuit signaling contact, under voltage release and shunt trip.

6. MCB Isolator

- MCB Isolator shall be quick make and break type. The housing shall be heat resistant and having
- high impact strength. The overall dimensions and fixing arrangement of Isolator shall be same as that of MCB. MCB Isolator shall not be provided with any protection.

7. Indicating Instruments (Digital Type)

- All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96mm. Square size Digital Type with Built-in Selection, and shall have an accuracy class of 1.0 or better. The covers & cases of instruments and meters shall provide a dust & vermin proof construction. Digital meters to be provided for single phase Panels shall not incorporate Built in Selector Switch.
- All instruments shall be compensated for temperature errors and factory calibrated.

8. Instrument Transformers

- All current transformers shall be tape insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the

switchboard is operating at its rated condition & the specified ambient temperature. The class of insulation shall be 'E' or better.

- All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block where star point formation and earthing shall be done.
- CT shorting links are to be provided to avoid burning / damage of CTs in case of opening of CT terminals.
- Current transformers may be multi or single-core type. All CTs shall be provided with supports independent of Busbar / Busbar supports.
- The CTs shall be located in such a way that they can be easily approached for maintenance without necessitating shut down of adjacent feeders.

9. Selector Switches

- Selector switches shall be of rotary type, with plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.
- Contacts of switches shall be spring assisted & shall be of suitable material to give a long trouble free service.

10. Push Buttons

- Push-buttons shall be of spring return, push-to-actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 240 V AC and 1 A (inductive) at 220 V DC.
- All push-buttons shall have one normally open (1 NO.) and one normally closed (1 NC) contact, unless specified otherwise. The contact faces shall be of silver alloy.
- All push-buttons shall be provided with integral plates marked with its function.
- The color of the button shall be as follows :
 - Green for motor START / breaker CLOSE.
 - Red for motor STOP / breaker OPEN.
- All push-buttons on panels shall be located in such a way that Red push-buttons shall always be to the left of Green push-buttons.
- All emergency push-buttons shall have mushroom knobs.

11. Indicating Lamps

- Indicating lamps shall be of the panel mounting, LED type and low watt consumption. The LED lamps shall have plates marked with its function, wherever necessary
- Lamps shall have translucent lamp-covers of the following colors, as warranted by the application :
 - Red for R-Phase / MCCB "ON" / Contactor 'ON'
 - Yellow for Y-Phase
 - Blue for B-Phase
 - Green for Contactor 'OFF'
 - Amber for Breaker / Starter 'TRIP'
- Lamp cover shall be easily replaceable from the front of the cubicle.

- LED indicating lamps should be located just above the associated push-button / control switches. Red lamps shall invariable be located to the right of green lamps.
- When associated with push-buttons, red lamps shall be directly above the green push-button and green lamp shall be directly above the red push button.
- All LED indicating lamps shall be suitable for continuous operation at $\pm 25\%$ of their rated voltage.

12. Control Circuit MCBs

- Miniature Circuit Breakers for Control Circuits shall comply with IS 8828-1996 / IEC 898-1995. MCBs shall be quick make and break type for 230V / 415V AC/DC applications.
- The housing of MCBs shall be heat resistant and having a high impact strength. The breaking current of MCBs shall not be less than 6000 Amps, at 230 V / 415 V. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications. MCBs shall be suitable for isolation function and line load reversibility.
- The MCB contacts shall be silver nickel alloy and contact tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCBs shall be provided with magnetic coil releases for short circuit protection and thermal release for over load protection. The terminals shall be protected against finger contact to IP 20 Degree of protection.

13. Control Transformers

- The control transformers shall be 415 V / 240 V or 415 / 110 Volt as specified in SLD / BOQ with Centre point earthed, dry type and insulation class 'B' or better. The sizing of control transformers shall be reconfirmed by Contractor during approval of GADs considering the actual load of power contactors, auxiliary contactors, indicating lamps & other equipment in the module circuit. Contractor shall also ensure that control transformers are adequately designed for meeting the momentary loading requirements & the voltage drop during this condition shall not be more than 5%.

14. Power Factor Improvement LT Capacitors

- The capacitors shall conform to IS 13340 / IS 13341 / IEC 831. The capacitors shall be delta connected suitable for 415 V 3 phase 50 Hz AC supply. Metalized Polypropylene (MPP) capacitors of suitable KVAR as mentioned in BOQ/SLD shall be provided to improve power factor, reduce voltage drop and reduce power costs.
- The capacitors shall be suitable for a continuous overcurrent of 1.5 times of rated current combined with overvoltage and presence of harmonics as per IEC clause 21. The capacitor shall be tropicalized for an ambient of 55 degrees centigrade as per IEC 831. The capacitors shall be self-healing type and provided with pressure sensitive disconnecter safety device. The impregnation shall be non-PCB biodegradable type or Inert gas, so as not to have any degenerated properties and shall be non-oxidizing. The watt loss per KVAR shall not exceed 0.5 watts. The capacitor shall be provided with suitable discharge resistor. The expected life of

capacitors shall not be less than 1,00,000 continuous hours. The capacitors shall be provided in M.S. sheet steel container.

15. Contactors for Controlling Capacitor Banks

- Contactors provided for switching on & switching off the capacitor banks through Automatic Power Factor Relay shall be suitable for Capacitor duty.

16. Automatic Power Factor Control Relay

- Automatic power factor control relay shall be solid state / microprocessor based that automatically can manage capacitor banks compensate for the reactive power absorbed by the load. The relay shall control the power factor of the installation by giving signals to switch "ON" or "OFF" power factor correction capacitors
- When the power factor falls below the setting, the relay shall switch the capacitor "ON" in sequences i.e. first in first out or first in last out
- Relay shall have built-in digital power factor meter with 3½ digit steady display and LED indicators for various indications. Relay shall be provided with Dead Band facility to prevent the system from overcorrection and hunting. Relay shall have under current blocking system to shut down the relay by the switching off all capacitors one by one in sequence when load current is below setting. Relay shall also have built-in Auto / manual control, special timing sequence and preferably facility for No voltage / Over voltage / Over temperature protection
- Relay shall have RS 232 port interface protocol or RS 485 port with MODBUS

17. Battery Charger

- Battery Charger shall be capable of Charging 24 volt DC or 12 volt DC batteries as specified. Charger shall have 16 Amps current output. The battery charger shall have facility for trickle / boost charging of the batteries on auto mode. The charger shall be housed in MS sheet steel enclosure and placed inside the Panel at a convenient and easily accessible position.
- The Charger shall have the following indications:
- Battery Charger tripped Batteries Charging Batteries Charged Batteries Low
- The terminal for all above indications shall be brought out to a terminal strip for remote wiring these indications to lamps located on Panel door.

C Internal Wiring, Control Terminal Blocks, Name Plate / Labels and Painting

1. Internal Wiring

- All switchboards shall be supplied completely wired internally up to the terminals, ready to receive external cables.
- All intercubicle & inter panel wiring & connections between panels of same switchboard including all bus wiring shall be provided by Contractor.
- All auxiliary wiring shall be carried out with 1100 V grade, single core, stranded copper conductor, color coded, PVC insulated wires. Conductor size shall be 1.5 mm² (min.) for control circuit wiring & 2.5 mm² (min.) for CTs.

- PVC insulated, standard copper wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the door shall be properly sleeved or taped.
- All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and blocks.
- All internal wiring terminations shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible.
- Engraved core identification ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The ferrule shall be of self-locking type. The wire identification marking shall be in accordance with IS : 375.
- Wiring for equipment, which are to be supplied by the Owner and for which the Contractor has to provide mounting arrangement in his panels, shall also be provided by the Contractor, up to the terminal blocks.
- All connections from vertical Busbars for individual modules above 100 A shall be made with Copper / Aluminum links only. The cable connections for module up to 100 A shall be selected in such a way that there will not be any melting / shorting in case of a short circuit inside the module and the cable shall have current rating to carry the let through energy of the corresponding breakers in case of a fault. For power wiring color coded wire insulation / tapes shall be provided.

2. Control Terminal Blocks

- All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size up to 2.5 mm² each.
- All terminals shall be numbered for identification and grouped according to the function. Engraved white-in-black labels shall be provide on the terminal blocks.
- Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.
- Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm.

3. Name Plates and Labels

- All Panel Boards shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation.
- All name plates shall be of anodized aluminum with white engraved lettering on black background.

4. Painting

- All sheet steel work shall be pretreated, in tanks, in accordance with IS : 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Finishing paint on Panels shall be Powder Coated, Siemens Grey, shade RAL-7032 throughout Orange Peel Finish with Electrostatic method or as approved by the Owner's / Consultant while approving the shop drawings.

D Final Distribution Boards

1. The distribution boards shall be fabricated from 16 / 18 SWG CRCA sheet steel as called for in particular specifications / BOQ. Intermediate plate shall be provided so that no live parts are accessible even when the door is open. The door shall be earthed with braided copper wire. The door shall be openable up to 120 degree. The hinges shall be so provided that door can be completely removed if required. The hinges shall be robust in nature. The protection shall be minimum IP 43. Configuration whether 4 tier, 2 tier, horizontal or vertical shall be as described in the BOQ. Generous wiring space shall be provided for ensuring space for wire loops and ease of connections. Distribution boards to be used for distribution of UPS supply shall have provision for insulated links for dedicated earthing.
 - The neutral, dedicated earth and earth links shall be adequately sized to receive the cable i.e. incomers up to 16 sq mm and outgoing up to 6 sq mm. Neutral link for distributing neutral from incomer to individual phases shall be capable of receiving 16 sq mm cable incoming as well as outgoing. Chrome plated panel locks or finger operated opening knob shall be provided as per approved GA drawings. All Busbars shall be high conductivity electrolytic grade copper insulated type. Din channels shall be provided with end closer to lock the MCBs.
 - The distribution board shall be suitable for surface mounting or recess mounting as required
2. **Painting**
 - All sheet steel work shall be pretreated, in tanks, in accordance with IS : 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Finishing paint on Panels shall be Powder Coated, Siemens Grey, shade RAL-7032 throughout Orange Peel Finish with Electrostatic method or as approved by the PMC/ Employer while approving the shop drawings.

III. Testing

1. Type Tests

- Certificates to be provided by Panel Manufacturer for the following including all test certificates as per IEC 61439-1 & 2 for the project ratings. Failure to do so can impact approval process.
 - Temperature Rise Limits
 - Dielectric Properties
 - Short Circuit Withstand Test
 - Effectiveness of Protective Circuit
 - Clearance and Creepage Distance
 - Mechanical Operation of Switchgear
 - Degree of Protection
 - Seismic withstand Test

2. Routine Shop Tests

- The following routine shop tests shall be carried out at Panel manufacturers factory :
 - A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number & type of devices, terminal boxes, connection of terminals and Phase Sequence etc.
 - Verification of Wiring and Control Circuits shall be carried out.
 - Manual operation of all Circuit breakers shall be checked.
- Dry insulation test with power frequency voltage for the main & auxiliary circuits shall be conducted as follows :
 - Power Circuits - 2500 Volt (for one minute)
 - Control Circuits - 1500 Volt (for one minute)
 - Control Circuits Aux. Circuits connected to Sec. of CT's - 2000 Volt (for one minute)

Painting

All sheet steel work shall be pretreated, in tanks, in accordance with IS : 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Finishing paint on Panels shall be Powder Coated, Siemens Grey, shade RAL-7032 throughout Orange Peel Finish with Electrostatic method or as approved by the PMC/Consultant while approving the shop drawings.

Testing

Type Tests

Certificates to be provided by Panel Manufacturer for the following including all test certificates as per IEC 61439-1 & 2 for the project ratings. Failure to do so can impact approval process.

- Temperature Rise Limits
- Dielectric Properties
- Short Circuit Withstand Test
- Effectiveness of Protective Circuit
- Clearance and Creepage Distance
- Mechanical Operation of Switchgear
- Degree of Protection
- Seismic withstand Test

Routine Shop Tests

The following routine shop tests shall be carried out at Panel manufacturers factory :

A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number & type of devices, terminal boxes, connection of terminals and Phase Sequence etc.

Verification of Wiring and Control Circuits shall be carried out.

Manual operation of all Circuit breakers shall be checked.

Dry insulation test with power frequency voltage for the main & auxiliary circuits shall be conducted as follows :

Power Circuits - 2500 Volt (for one minute)

Control Circuits - 1500 Volt (for one minute)

Control Circuits Aux. Circuits connected to Sec. of CT's - 2000 Volt (for one minute)

- Insulation resistance of the main and auxiliary circuits shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.

3. Routine Tests during Installation at Site

- The following routine tests shall be carried out during Installation at site :
 - A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, connection of terminals & Phase Sequence etc.
 - Verification of Wiring and Control Circuits shall be carried out.
 - Manual operation of all Circuit breakers shall be checked.
 - Dry insulation test with power frequency voltage for the main & auxiliary circuits shall be conducted as follows :
- Power Circuits
- Control Circuits
- Aux. Circuits connected to Sec. of CTs
- Insulation resistance of the main and auxiliary circuits shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.
- Electrical Operational Test and Relay / Release Setting.

Section - 05

Technical Specification for Busduct / Rising Mains (Sandwich Type)

- I. General
- 1. Work Included

- Metal enclosed Busduct / Rising Mains (Sandwich Type)
- Accessories

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect work of this section.
- Co-ordinate works with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supply, erection, testing and commissioning of metal enclosed Busduct / Rising Mains (Sandwich Type)

4. Codes and Standards

- The Bus Duct Riser (Sandwich Type) shall comply with all applicable Indian / International Standards, Indian Electricity Act and Indian Electricity Rules :-
 - IS 5082 : Wrought Aluminum and aluminum alloys for electrical purposes
 - IS 8623 (Part-2) : Specification for factory-built assemblies of Switchgear and Control gear for voltages up to and including 1000 V AC and 1200 V DC
 - IEC 61439-6 : Particular Requirements for Busbar Trunking Systems (Busway)
 - IS 5 : Colours for ready-mixed paints and enamels
 - IS 2147 : Degree of protection provided by enclosure for low voltage switch gear and control gear
 - IS 2551 : Danger notice plates
 - IS 3072 : Code of practice for installation and maintenance of switch gear / Busduct.

5. Quality Assurance

- The Contractor shall ensure that all materials furnished and installed by him under the contract shall meet the requirements of relevant Indian standards.
- Manufacturers regularly engaged in manufacture of Busduct / Rising Mains (Sandwich Type), whose products have been in satisfactory use in similar service for not less than 5 years.
- Installation shall be carried out by a firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which

manufacturer and Contractor may have by other provisions of the contract document.

- The Busduct / Rising Mains (Sandwich Type) shall be guaranteed against trouble free operation, defective workmanship and materials for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period cables shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- Busduct / Rising Mains (Sandwich Type) shall be carefully transported to site to avoid damage during transit. While on site the same shall be stored in a proper manner to prevent damage from moisture / rusting / mechanical damage.
- Busduct / Rising Mains (Sandwich Type) and accessories shall be inspected for the followings: -
 - Damage
 - Compliance with specifications
 - Quality
- Busduct / Rising Mains (Sandwich Type) shall be protected from weather, fire or mechanical damage during storage.

II. Products

1.00 Metal Enclosed Busduct / Rising Mains (Sandwich Type)

- Busduct / Rising Mains (Sandwich Type) shall have aluminum / copper conductor suitable for 4P+2E 440Volt AC, 50 cycles distribution system in accordance with material and ratings as defined in enclosed BOQ.
- Busduct / Rising Mains (Sandwich Type) shall have a rated insulation voltage of 1000 V and rated frequency of 50 Hz. Bus Bar Riser shall have rated operating voltage of 690 V.
- Busduct / Rising Mains (Sandwich Type) shall be suitable for short time withstand current equal to as specified in BOQ.
- Busduct / Rising Mains enclosure shall be made from minimum 1.6 mm thick CRCA Sheet steel / Al. Enclosure with powder coated epoxy polyester structured paint Siemens Grey shade RAL 7032 or as called for in BOQ.
- Busduct / Rising Mains (Sandwich type) shall be suitable for degree of protection IP-54 for Indoor & IP - 65 for outdoor installation while conforming to IEC - 61439-6(including tap off box)
- The design shall be compact type with low impedance.
- Standard accessories like end feed units, bends, elbows, flanges, tee junctions, expansion joints, tap- off boxes shall be provided as called for in BOQ. Busduct / Rising Mains shall be available in standard lengths.
- Riveted construction shall be adopted to make it tamper proof.
- Tap off outlets shall be provided at every 500/600 mm intervals to accommodate flexibility for any changes that may be required.
- At tap-off points, proper shrouding shall be provided to avoid accidental contacts with live parts. While inserting and removal of plug-in boxes, earth contact shall first make and be last to break. It shall be possible to position the plug in boxes on the Busduct / Rising Mains without using tools.

- Neutral bus shall be of section not less than half or equal to the phase cross-section as specified in enclosed BOQ.
- All the insulating & plastic materials (shutters etc.) that are used shall have improved fire behavior.
- Individual bus bars shall be covered with min B-Class insulation material in multilayers. Higher Class insulation material shall be preferred.
- All contact on joint and plug-in opening should be tin plated copper
- All accessories like bends, tee, Junctions expansion joints, reducers, fire proof barriers shall be deemed to be included in the quoted rates unless specified separately.

III. Installation

1. Erection

1.01 Busducts / Rising Mains

- All steel structures require for Busduct / Rising Main supports shall be MS (painted). Termination of bus bars at transformer and PCC / Main Panel shall be done through flexible copper links. Termination of Bus Bar at Alternator end of DG Set shall be done with Rubber bellows to minimise the vibrations.
- Proper sealing arrangement shall be provided with Fire Retardant Mortar at the wall / cutout where Busduct / Rising Mains enter the Panel / switch gear room.
- Proper alignment and co-ordination regarding phase sequence etc. between the Busduct / Rising Mains, Transformer, PCC / Main Panel termination etc. shall be the Contractor's responsibility.
- Various sections of the Busduct / Rising Mains shall be joined by special insulated clamps, which can be tightened by single screw turning. Bus bars shall not be drilled anywhere. Inspection covers shall be provided where clamps can be approached to check tightness when required. System shall be maintenance free.
- Proper brackets shall be provided to support trunking to structure for Horizontal / Vertical installation. The rising mains shall be aligned plumb vertically and horizontally before final tightening of all joint hardware.
- The busbar trunking system should pass seismic tests with actual physical product and being certified complying with UBC seismic Zone 4 condition by an international recognized earthquake research body eg. ANCER
- If work is suspended during installation due to any reason, the ends of connecting sections shall be protected against water & dust by keeping the riser covered with polythene or similar material.

2. Examination of Work

- Prior to installation of Busduct / Rising Mains (Sandwich Type), the Contractor shall carefully examine the drawings indicating the layout. All installation shall be carried out as per manufactures instruction manual.
- The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination and the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary

and advises the Contractor accordingly, attend for the purpose of examining and measuring such work.

- No work shall be covered or otherwise put out of view without the approval of the Consultant / Engineer-in-charge.
- The insulation resistance shall be checked before and after installation.

IV. Testing

1. Type Tests

- Certificates & test reports to be provided by Bus Duct / Rising Main Manufacturer for the following):
 - Temperature Rise Limits
 - Dielectric Properties
 - Short Circuit Withstand Test
 - Clearance and Creepage Distance
 - Verification of Resistance and Reactance
 - Verification of Structural Strength
 - Degree of Protection
 - Additional Certificates as per IEC61439-6 shall also be provided

2. Routine Shop Tests

- The following routine shop tests shall be carried out at Manufacturer's factory
 - A general visual check shall be carried out. This shall cover measurement of overall dimension, number and type of devices, terminal boxes, alignment of assemblies, connection of terminals and phase sequence etc.
 - Dry insulation test with power frequency voltage shall be conducted.
 - Insulation resistance shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.

3. Routine Tests during Installation at Site

- The following routine tests shall be carried out during Installation at site :
 - A general visual check shall be carried out. This shall cover measurement of overall dimension, number and type of devices, terminal boxes, connection of terminals and phase sequence etc.
 - Dry insulation test with power frequency voltage shall be conducted.
 - Insulation resistance shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.
 - Electrical Operational Test and Relay / Release Setting

V. Measurement

1. Busduct / Rising Mains shall be measured by length. Cost of any steel structure, angles, GI rods and dash fasteners etc. required for fixing / suspension shall be included in the erection rate and nothing extra shall be paid for the same.

Technical Specification for MV Cables

I. General

1. Work Included

- MV Cables (PVC insulated / XLPE Cables)
- The cable installation shall include laying, testing & commissioning, all trench work, sleeves, ducts and all necessary fixing and cable terminations at both ends of the cable.
- Ducts and sleeves shall be provided at road crossings, under paved roads and footpaths. The duct crossings shall include 25% spare capacity to cover possible future requirements. Ducts / sleeves shall also be installed for future use as indicated in the drawings.
- The contractor shall work out the control cabling schedule between HT Panel and Transformer, Transformer & Regulator (In case of AVR), Main LT Panel & DG Sets, HT Panel & Main LT Panel and other equipments not specified herein but forming scope of work for installation testing and commissioning. The control cabling schedule made by Contractor shall be subject to Consultants approvals. Any delay due to non-procurement of control cables shall be sole responsibility of the contractor.

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements which may affect work of this section.
- Co-ordinate work with all other trades affecting, or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying, laying, testing and commissioning of PVC insulated / XLPE cables for medium voltage system. All cables shall be of the same make as specified in the list of approved Make Of Materials.
- Cable sizes shall be as shown on the drawings. Sizes smaller than those specified shall not be accepted.

4. Codes and Standards

4.01 Applicable to PVC Insulated Cables

- The cables shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
 - IS 1554 (Part-I) : PVC insulated (heavy duty) electric cables - Part I for working voltages up to and including 1100 Volts
 - IS 5959 (Part-I) / 1970 : Polythene insulated & PVC sheathed (Heavy duty) electrical cable
 - IS 1596 / 1960 : Terms for Electrical cables and conductors

- IS 1596 / 1970 : Polythene insulated and PVC sheathed cable
- IS 8130 : Conductors for insulated electric cables and flexible cords
- IS 3975 : Mild steel wires, strips and tapes for armouring of cables
- IS 3961 (Part-II) : Recommended current ratings for cables : Part II PVC insulated and PVC sheathed heavy duty cables
- IS 5831 (1984) : PVC insulated and sheathing
- IS 1753 : Aluminum conductors for insulated cables
- IS 694 : PVC insulated cables for working voltages up to & including 1100V

4.02 Applicable to XLPE Insulated Cables

- The cables shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
 - IS 5959 (Part-I) / 1970 : Polythene insulated & PVC sheathed (Heavy duty) electrical cable
 - IS 1596 / 1960 : Terms for Electrical cables and conductors
 - IS 8130 : Conductors for insulated electric cables and flexible cords
 - IS 3975 : Mild steel wires, strips and tapes for armouring of cables
 - IS 8130 : Aluminum / copper conductors
 - IS 7098 (Part-I / 1988) : Product code for XLPE cables

5. Quality Assurance

- Manufacturers regularly engaged in manufacture of cables, whose products have been in satisfactory use in similar service for not less than 5 years.
- Installation shall be carried out by a firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The MV Cables shall be guaranteed against trouble free operation, defective workmanship and materials for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period cables shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- All cables shall be carefully transported to site to avoid damage during transit. While on site all cables shall be stored in a proper manner to prevent damage or moisture ingress at the ends.

II. Products

1. General Construction

- The cables shall be brand new and in good condition. These shall be suitable for laying in cable trunkings, trays, trenches, ducts, conduits and underground buried installation with uncontrolled backfill and possibility of flooding by water.

1.01 Core Identification

- The cores shall be identified by different colors as follows :
 - Single core : Black
 - Two core : Red and Black
 - Three core : Red, Yellow, Blue
 - Four core : Red, Yellow, Blue, Black
 - Three and half core : Red, Yellow, Blue and reduced neutral core in Black

1.02 Laying Up

- In multicore cables, cores shall be laid up as per the above color scheme, interstices shall filled wherever necessary to make the laid up cores circular.

1.03 Inner Sheath

- Laid up cores shall be bedded over with thermoplastic material for protection against mechanical and electrical damage.

1.04 Armouring

- Armouring shall be provided over the inner sheath to guard against mechanical damage. Armouring shall be generally of galvanized steel wires or strips, (In single core cables used in AC system armouring shall be by non-magnetic hard Aluminum wires/strips). Round steel wires shall be used where the diameter over the inner sheath does not exceed 13 mm; above 13 mm, flat steel strip armour shall be used.

1.05 Outer Sheath

- Specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-198 shall be extruded to form the outer sheath. Specially formulated Flame Retardant Low Smoke compound (FRLS) for outer sheath shall be provided of XLPE Cables.

1.06 Product Code

- As per IS : 7098 : Part I, the codes as under shall be followed :

Constituent	Code
Aluminum conductor	- A

XLPE insulation	-	2X
Steel round wire armour	-	W
Steel strip armour	-	F
Steel Double round wire armour	-	WW
Steel Double strip armour	-	FF
Non-magnetic (Al.) round wire armour	-	Wa
Non-magnetic (Al.) strip armour	-	Fa
PVC outer sheath	-	Y

2. **PVC Insulated Cables**

- All power / control cables for use on MV systems shall be heavy duty type, 1100 V grade with Aluminum / copper conductor, PVC insulated inner sheathed, armoured / unarmoured and overall PVC Sheathed.
- The construction of the conductors shall be “Stranded” for Aluminum cables as well as for Copper cables.
- The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of IS : 5831.
- For multicore cables, if the armouring is specified in the specification / BOQ the same shall be single round galvanized steel wires / galvanized steel strips.
- The outer sheath for the cables shall be applied by extension and shall be of PVC compound conforming to IS : 5831. To protect the cables against rodent and termite attack, suitable chemicals shall be added into the PVC compound of the outer sheath. The chemicals of the insulation, armor and outer sheath materials shall be governed by values given in Section-VI of IS : 1554 (Part-I).

3. **XLPE Insulated Cables**

- XLPE cables shall consist of low-density polyethylene molecules of carbon and hydrogen in form of long flexible chains. Slippage between long chains is prevented by cross linking them & heating to temperatures 250 deg. C to 300 deg. C. This strengthens cables against stress cracking and gives them greater resistance to fight ageing in hot air.

4. **Site Inspection**

- All cables shall be inspected upon receipt at site and checked for any damage during transit

5. **Tests**

- PVC insulated cables shall be subjected to tests as required by IS : 1554 Part I.
- XLPE insulated cables shall be subjected to test as required by IS : 7098 Part I.

5.01 **Type Tests**

- Certificates to be provided by Cable Manufacturer for the following :
 - Tests on Conductor : Annealing Test for Copper, Tensile and Wrapping Test for Aluminum, Measurement of Resistance
- Steel strip armour - F

- Steel Double round wire armour - WW
- Steel Double strip armour - FF
- Non-magnetic (Al.) round wire armour - Wa
- Non-magnetic (Al.) strip armour - Fa
- PVC outer sheath - Y

2. PVC Insulated Cables

- All power / control cables for use on MV systems shall be heavy duty type, 1100 V grade with Aluminum / copper conductor, PVC insulated inner sheathed, armoured / unarmoured and overall PVC Sheathed.
- The construction of the conductors shall be "Stranded" for Aluminum cables as well as for Copper cables.
- The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of IS : 5831.
- For multicore cables, if the armouring is specified in the specification / BOQ the same shall be single round galvanized steel wires / galvanized steel strips.
- The outer sheath for the cables shall be applied by extension and shall be of PVC compound conforming to IS : 5831. To protect the cables against rodent and termite attack, suitable chemicals shall be added into the PVC compound of the outer sheath. The chemicals of the insulation, armor and outer sheath materials shall be governed by values given in Section-VI of IS : 1554 (Part-I).

3. XLPE Insulated Cables

- XLPE cables shall consist of low density polyethylene molecules of carbon and hydrogen in form of long flexible chains. Slippage between long chains is prevented by cross linking them & heating to temperatures 250 deg. C to 300 deg. C. This strengthens cables against stress cracking and gives them greater resistance to fight ageing in hot air.

4. Site Inspection

- All cables shall be inspected upon receipt at site and checked for any damage during transit

5. Tests

- PVC insulated cables shall be subjected to tests as required by IS : 1554 Part I.
- XLPE insulated cables shall be subjected to test as required by IS : 7098 Part I.

5.01 Type Tests

- Certificates to be provided by Cable Manufacturer for the following :
 - Tests on Conductor: Annealing Test for Copper, Tensile and Wrapping Test for Aluminum, Measurement of Resistance
 - Test for Thickness of Insulation and Sheath
 - High Voltage Test
 - Insulation Resistance Test
 - Test for Armouring Wires / Strips
 - Flammability Test

5.02 Routine Shop Tests

- The following routine shop tests shall be carried out at Cable manufacturer's factory :
 - Acceptance Tests for Conductor and Insulation
 - High Voltage Test
 - Conductor Resistance Test

5.03 Routine Tests during Installation at Site

- The following routine tests shall be carried out during Installation at site :
 - A general visual check shall be carried out for overall dimension.
 - Insulation resistance test

III. Installation, Testing and Commissioning

1. Erection

- Cable network shall include Power, Control, lighting and communication cable which shall be laid in trenches, cable trays, cable trunking or conduits. Erection of cable trays / trunking as required shall be the responsibility of the Contractor. All tray / trunking levels shall be checked after erection and marked in as built drawings. Cable routing layout shall be checked at the site to avoid interference with structures, heat sources, drains, piping and air-conditioning duct etc.
- and necessary adjustment shall be done to suit the site conditions.
- All cable routes shall be carefully measured & cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels / drums shall be carefully selected to prevent undue wastage of
- cables. The quantity indicated in the cable BOQ is approximate.
- The Contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipe lines or any other works.
- Cables shall be laid in complete, uncut lengths from one termination to the other. Where joints are unavoidable, the location of such joints shall be got approved by consultant.
- Cables shall be neatly arranged in the trays / trunkings / trenches in such a manner so that criss- crossing is avoided and final take off to the panel / equipment / motor is facilitated. Arrangement of cables within the trays / trunkings / trenches shall be responsibility of the Contractor.
- All cables shall be identified close to their termination points by cable numbers / identification as per details mentioned in Single Line Diagram. Cable tags shall be used for this purpose.
- Wherever cables / earthing tapes are crossing the walls / floors appropriate size of GI sleeves shall be provided. The sleeves in walls shall slope outwards to avoid moisture travelling along the cable length. After the cables have been pulled through sleeves the gaps shall be properly sealed to avoid ingress of moisture.
- Each underground cable shall be provided with identity tags securely fastened at each end before the cable enters the ground.

- All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be taped with an approved PVC or rubber insulating tape.
- Removal of concrete covers from RCC cable trenches for purposes of cable laying & restating them in their proper positions after the cables are laid shall be done by the Electrical Contractor at no extra cost.
- Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protecting cover until such times the final termination to the equipment / Panel is completed.
- At all changes in direction in horizontal and vertical places, the cable shall be bent smooth with a radius of bent not less than 12 times the diameter of the cable.
- If required insulation tapes of appropriate voltage & in red, yellow, blue and black shall be wrapped just below the lugs for phase / neutral identification. No insulation tape is to be provided on the thimbles / lugs, these shall be shrouded with proper shrouds.
- Where the cable is pulled through conduits, to prevent damage to the cable approved cable lubricant shall be used for this purpose.
- At road crossing and other places where cables enter pipe / sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- Cables laid in vertical run of cable trays / trunking shall be suitably clamped by means of GI saddles / clamps with GI bolts, nuts and washers, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords / cable ties / GI clamps as directed.

2. Cable tags and Route Markers

- Route Markers: Route markers shall be provided wherever cables are laid in soft soil. These shall be provided near the cable entrance to rooms and at the turning points, the distance between two route markers shall not exceed 30 meters. The route markers shall be at 100 mm dia, cast iron, minimum 10 mm thick. The route marker shall convey the voltage grade and depth of the cable laid. Height of the alphabets shall be minimum 12 mm. These shall be fixed by grouting 40x40x5 mm angle appropriate length in the ground.
- Cable Tags: Cable tags indicating the cable identification by means of cable number or description shall be provided near the end terminations. Cable tags shall also be provided where cable crosses room / enclosed space enroute. These shall be provided at distance of 15-20 meters (Minimum one tag shall be provided in each such room) or as directed by Project Manager / Site Engineer.
- The cable tags shall be of anodized Aluminum plate and tied to the cable properly after the cables have been laid and dressed. Wherever cables are laid in hume pipes cable tags shall be provided in the manholes.
- Temporary cable tags shall be provided before laying of cables. The layers of ABRO Tape 50- 65 mm wide shall be wrapped along the circumference of the cable and cable identification marked with permanent marker in neat hand writing. After writing the ABRO tape shall be covered with transparent cello tape. The temporary

tags shall be provided at 5 meters from ends and additional at every 15 to 20 meters.

3.00 Examination of Work

- No work shall be covered by backfilling or otherwise put out of view without the approval of the Consultant / Engineer-in-charge. The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination & the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such work.

4.00 Field Tests

- All low voltage cables furnished under the contract shall be tested by the Contractor in the presence of the Consultant / Engineer-in-charge to ensure and prove satisfactory performance and for same the Contractor shall provide all test equipment required.
- The Contractor shall test all cables using DC voltage injection equipment (Digital type).
- Immediately upon the installation of all main and sub-main cables, these shall be pressure tested. The insulation resistance of all cables when tested with 500 volt DC Meggar shall not be less than 100 Mega Ohm.

IV. Measurement

1. Cable shall be measured by length.

Section – 07

Technical Specification for Cable Tray / Raceway / Under Floor Trunking

I. General

1. Work Included

- Ladder type GI cable tray (Hot Dip Galvanized)
- Perforated MS / GI cable tray
- MS Trunking / Raceway and Junction Boxes
- GI Trunking / Raceway and Junction Boxes
- Supporting devices

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all other sections of the specifications for requirements which may effect work of this section.
- Co-ordinate work with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under this Contract.

3. General Requirements

- This specification covers requirement for supplying and fixing of cable tray / trunking for various services in accordance with the specifications and as indicated in the drawing.

4. Codes and Standards

- Compliance with all applicable Indian standards, Indian Electricity Act and Indian Electricity rules.

5. Quality Assurance

- Cable tray and cable trunking shall only be purchased from manufacturers specializing in the manufacture of the type of cable trays mentioned herein.
- Manufacturers may be asked to provide proof of supply of similar types of cable tray and cable trunking to know users.
- Cable tray and cable trunking shall generally be to manufacturer's standard for construction and materials. Where this contradicts any part of this specification, the manufacturers shall state this at the time of tender.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The cable tray and cable trunking shall be guaranteed against trouble free operation, defective workmanship, materials and design for a period of 18 months

from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. Any defects during this period shall be rectified free of cost.

7. Delivery, Handling and Storage

- The cable tray and cable trunking shall be inspected for the following :
 - Damage
 - Compliance with specification
 - Quality
- Store cable tray & trunking in factory installed coverings in a clean, dry indoor space which provides protection against weather.

II. Products

1. Ladder Type Cable Tray (Hot Dip Galvanized)

- Cable tray shall be supplied and installed in accordance with the details shown on the drawings. The design and general arrangement of all ladder type cable trays shall be neat with adequate supports and shall be to the approval of the Consultant.
- Main Channels / Runners / Rungs used for ladder type cable tray shall be prefabricated type of minimum 2.5mm thick CRCA sheet steel hot dip galvanized. The width of cable tray and Rung's spacing shall be as specified in BOQ / Drawings.
- Ladder type cable tray accessories (Bends, Tees, Cross & Down) shall be hot dip galvanized. All accessories like Tees, Bends – Vertical / Horizontal shall be factory fabricated only. No extra charges shall be paid to Electrical Contractor for accessories and these shall be measured in length along with cable tray for payment purpose.
- SAMPLE OF CABLE TRUNKING / RACEWAY SHALL BE SUBMITTED FOR APPROVAL BY PROJECT MANAGER / CONSULTANT.

2. GI / MS Perforated Cable Tray

- Cable tray shall be supplied and installed in accordance with the details shown on the drawings. The design and general arrangement of all trays shall be neat with adequate supports and shall be to the approval of the Consultant.
- Cable tray shall be prefabricated perforated type of minimum 2.0mm thick CRCA sheet steel, enamel painted or Galvanized sheets (for trays) as specified in enclosed BOQ.
- Perforated type cable tray accessories (Bends, Tees, Cross & Down) shall be minimum 2.0mm thick CRCA sheet steel, enamel painted or galvanized. All accessories like Tees, Bends – Vertical / Horizontal shall be factory fabricated only. No extra charges shall be paid to Electrical Contractor for accessories and these shall be measured in length along with cable tray for payment purpose.
- SAMPLE OF CABLE TRUNKING / RACEWAY SHALL BE SUBMITTED FOR APPROVAL BY PROJECT MANAGER / CONSULTANT.

3. GI Cable Trunking / Raceways

- Cable trunking / raceways shall be supplied and installed in accordance with the details shown on the drawings. The design and general arrangement of all trunking shall be neat with adequate supports and shall be to the approval of the Consultant.
- Cable Trunking / Raceways for use above false ceiling & Under Floor GI Cable Trunking / Raceway shall be manufactured with 1.6 mm thick galvanized sheets and proper edge for secure lid fixing by means of screws at not more than 600mm centers. The top covers for trunking / raceway shall be as specified in BOQ / Drawings. The total sectional area of the cable installed in trunking shall not exceed 45% of the internal cross-sectional area of the trunking.
- SAMPLE OF CABLE TRUNKING / RACEWAY SHALL BE SUBMITTED FOR APPROVAL BY PROJECT MANAGER / CONSULTANT.

4. Colour Coding For Cable Tray / Trunking

- Colour coding for cable tray / trunking shall be as follows :
- Galvanised Ladder Type Cable Tray for Power cables in Main Plant Rm / LT Rm Area.
- Galvanised Perforated Cable Trays in Basement for areas other than Main Plant Room

/ LT Room.

- Orange MS Perforated cable tray for Power / Sub-main cables in other areas (wherever applicable).
- Orange MS Trunking for power wiring (wherever applicable).
- Blue MS Trunking above false ceiling for computer cables (wherever applicable).
- Grey MS Trunking above false ceiling for telephone cables (wherever applicable).
- Galvanized Trunking above false ceiling for Power / Sub-main cable, computer, telephone & other low power cables.
- Galvanised under floor trunking for voice and data cables.

5. Painting with Synthetic Enamel paint

- Preparation of Surface: The surface shall be thoroughly cleaned and dusted off. All rust, dirt scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is commenced. The primer shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.
- The primer shall be applied with brushes, worked well into the surface & spread even and smooth. The painting shall be done by crossing and laying off.
- Application: The number of coats including the under coat shall be stipulated in the item.
- Under Coat: One coat of the specified ordinary paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.
- Top Coat: Top coat of synthetic enamel paint of desired shade shall be applied after the under coat is thoroughly dry. The number of coats shall be as stipulated in the item. The paint will be applied in the usual manner with brush, or spray. Additional

finishing coats shall be applied if found necessary to ensure properly uniform glossy surface. On painting steel work, care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

- Baking: After applying two coats of enamel paint the cable tray / trunking shall be placed in suitable oven and dried at the proper temperature as recommended by the Paint Manufacturer (130 to 140 degree centigrade) to obtain proper bonding of the paint to the mild steel surface. The cable tray / trunking can be alternatively powder coated.

III. Installation

1. Cable Tray

- Cable trays shall be coupled by means of rigid edge bars and fish plates and care shall be taken to eliminate dangerous bolt ends projecting through the flanges.
- Effective continuity between sections of trays shall be ensured by separate bonding strips bolted across each coupling point. The contact surfaces shall be thoroughly cleaned prior to bonding.
- Cable tray for horizontal runs suspended from the ceiling shall be installed with flanges facing downwards and the tray shall be supported with purpose made round mild steel rods (threaded at both ends) or other such supporting devices as approved by the Consultant at sufficient centers to prevent the tray from sagging and to provide an overall rigid construction. Cable tray fixed to walls or ceiling soffits shall be installed with flange outwards or downwards respectively & shall be fixed with an approved fixing with spacing washers such that the tray is at least 10mm from the surface of the wall or ceiling.
- The complete installation shall be free from burrs and sharp edges.
- Where exact sizes of cable trays are not detailed, then the Electrical Contractor shall ensure that all cable trays are liberally sized to suit the installation.
- For requirements of larger than 1000 mm width two trays shall be run side by side.
- Maximum support span for cable trays shall not exceed 1200 mm unless design is approved for larger span. The maximum support span shall however be decided by Consultant / Site Engineer in accordance with site conditions. This may be reviewed as per site conditions and reduced to 1000 mm or 900 mm as required.
- Where two lengths of cable trays are coupled together additional supports shall be provided on either side to ensure proper alignment. These supports shall be provided less than or 300 mm on either side.
- Dash fasteners used for fixing cable trays shall be Hilti / Cannon make or equal. Size of dash fasteners shall vary between 6 mm to 12 mm depending on size and weight of cable tray. Arrangement for structural supporting system for cable trays shall be responsibility of the contractor and subject to approval of the consultant / Site Engineer. Shop drawings wherever necessary shall be prepared and submitted for approval by the Contractor.
- Proper sealing arrangement shall be provided where cable tray passes through wall / cutout with fire retardant motor.

2. Cable Trunking

- Where cutting or slotting of trunking is carried out, all sharp edges and burrs shall be removed. Where cables pass through slots in trunking the perimeter of the slot shall be shrouded with continuous PVC sleeving.
- All trunking and accessories shall be finished, externally and internally, with enamel paint as indicated in BOQ to prevent the formation of rust, unless otherwise specified. Cables installed in the trunking shall, wherever practicable, be laid with the larger size of cables at the bottom.
- Dash fasteners utilized in horizontal / vertical trunking runs, shall be installed at distances not exceeding 750 mm. All cables bound to the supporting MS flats / straps inside the trunking shall be at a maximum spacing of 600mm.
- Where trunking terminates at electrical apparatus, a suitable flanged coupling shall be provided.
- Sealing end pieces shall be used to blank off the end of all trunking.
- Where trunking is installed with the open side down, suitable cable retaining straps shall be installed in each compartment of the trunking at a maximum spacing of 600mm.
- Where conduit / flexible conduit terminates on trunking, the connection to the trunking shall be by means of separate couplings / checknuts.
- Where the paint has been damaged or removed from trunking, the metal work shall be repainted.
- Particular care must be taken when carrying out the trunking installation to ensure that effective earth continuity is achieved. At each joint in the trunking, e.g. between straight lengths, tee units, angle units etc., a proper bonding strip shall be connected across the joints. The Contact surfaces of the trunking shall be thoroughly cleaned and the bonding strips fixed by two M4 round head screws and nuts on each side, connected with suitable locking washers.
- Where trunking passes through fire division walls, floors, ceilings or partitions, internal fire division barriers shall be provided.
- Where two lengths of cable trunking are coupled together or where cable trunking is terminated into junction boxes additional supports shall be provided on either side to ensure proper alignment. These supports shall be provided less than or 300 mm on either side.
- Dash fasteners used for fixing cable trunking shall be Hilti / Cannon make or equal. Size of dash fasteners shall vary between 6 mm to 12 mm depending on size and weight of cable trunking. Arrangement for structural supporting system for cable trunking shall be responsibility of the contractors and subject to approval of the consultant. Shop drawings wherever necessary shall be prepared and submitted for approval by the Contractor.
- Proper sealing arrangement shall be provided where cable tray passes through wall / cutout with fire retardant motor.

IV. Measurement

1. Cable tray / trunking shall be measured by length.

Section – 08

Technical Specification for Earthing System

I. General

1. Work Included

- Installation, Testing and Commissioning of Earthing System
- Earthing Stations
- Electrolytic Grade Copper Earthing Tapes
- Electrolytic Grade Copper Earthing Plates / Pipes / Rods
- GI Earthing Tapes
- GI Earthing Plates / Pipes / Rods
- Earth Test Links

2. Related Work and Obligations

- To meet the general requirements apply to work specified in this section.
- To examine all the other sections of the specification for requirements, which may affect work of this section.
- To co-ordinate works with all other trades affecting or affected by activities of this section; Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- The intent of this specification is to define the requirement for the supply, installation, testing and commissioning of the Earthing system.
- All non-current carrying metal parts of equipment including the metal case of all Panels shall be earthed by means of Copper Tape / GI Tape in accordance with particular specifications. Copper Tape used for Neutral shall always be provided with heat shrunk PVC sleeves.

4. Codes and Standards

- The earthing system shall comply with all applicable Indian Standards (IS 3043 : 1987 - Code of Practice for Earthing) as well as IEEE 80 : 2000. The installation shall also comply with Indian Electricity Act and Indian Electricity rules as well as relevant international standards.

5. Quality Assurance

- The Contractor shall ensure that all materials furnished & installed by him under the contract shall meet the requirements of relevant Indian & International Standards. The Contractor shall also verify all test results and ensure that these are in accordance with the requirements as mentioned in the specifications.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

7. Delivery, Handling and Storage

- The earthing material shall be inspected for the followings :-
 - Damage
 - Compliance with Specification
 - Quality
 - Storage of Material at Site to Prevent Rusting

II. Products

1. General Details

- The earthing material shall be brand new and in good condition. Earthing Strips / Earthing Plate / Earthing Pipes / Earthing Rods shall be GI / Copper / Copper Bonded Steel as called for in particular specifications / BOQ. GI Tapes / Copper Tapes / PVC insulated green earth wires shall also be in- accordance with details as mentioned in the SLD / BOQ.

2. Earthing Stations

a. General Earthing

- Earth Electrode (Plate / Pipe / Rod) shall be driven to a sufficient depth to reach permanently moist soil.
- Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.
- In case of Plate Earthing, the earthing electrode shall consist of a tinned copper plate not less than 900 mm x 900 mm x 6 mm thick or GI plate 900 mm x 900 mm x 10 mm thick unless otherwise specified. The earth plate shall be set vertically & surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level & shall be provided with a funnel and a mesh for watering the earth through pipe.
- In case of Pipe Earthing, the earthing pipe shall be minimum 50 mm dia 14 SWG for GI Pipe and minimum 38 mm dia 16 SWG for Copper Pipe. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through pipe.
- Earth electrode / funnel shall be covered with heavy duty cast iron cover housed on a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The covers shall have sturdy locking arrangement. They shall also be provided with stumbling free, non-protruding lifting arrangement.
- In case of Rod Earthing, the earthing electrode shall be minimum 32 mm dia Galvanized MS Rod for Sub-Stations & 25 mm dia Galvanized MS Rod for LT Panels. The earthing rod shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture as specified in respective drawings.

b. Maintenance Free Earthing

- In case of Rod Earthing, the Earthing Electrode shall consist of Copper Rod of suitable dia for achieving desired surface area. In case of use of Copper Bonded Steel Rod, the thickness of molecularly bonded copper coating shall not be less than 250 micron. The earthing electrode & bonding material shall comply with UL 467 for Grounding and Bonding Equipment. The earthing electrode arrangement shall be provided with ground enhancing material complying with IEEE 80: 2000 clause 14.5'd'.
- The Ground enhancing material in its set form shall have a resistivity of not more than 20 Ohm- cm. the Proposed Material shall not dissolve or decompose or otherwise pollute the soil or the local water table. The earthing stations shall be guaranteed for minimum 25 years for restricting earthing resistance as mentioned in BOQ. The necessary Calculation for achieving the guaranteed Earthing resistance value shall be submitted by vendor for approval.
- The electrodes shall have a clean surface, not covered by paint, enamel, grease or other material of poor conductivity.

III. Installation, Testing and Commissioning

1. Erection

- The earth continuity resistance shall not exceed the specified values as per testing in BIS regulations.
- A removable test link shall be provided as near as possible to the earth electrode for isolating of the earth electrode /earth pits to check their resistance periodically. Wherever tape is fixed to the building structure, it shall be by means of purpose made saddles. Fixing shall be made by using purpose made plugs and clamps. Fixings requiring the drilling of the hole through the strip shall not be used. Joints in tapes shall be tinned before assembly and riveted with a minimum of two rivets severed solid. A drawing showing the proposed arrangement shall be submitted by the contractor for approval before any work is carried out at site. Care shall be taken that the excavations for earth electrode may not affect the column footings or foundation of the building.
- The Earth Pit for lightning conductors shall be at least 7M away from Earth Pits for Body Earthing of equipment's & at least 10M away from Earth Pits for dedicated / clean earth. The Earth Pits for Body Earthing of equipment shall be at least 10M away from Earth Pit for dedicated / clean earth.
- The Contractor shall visit the site during the tender stage for purpose of ascertaining ground condition as well as soil resistivity value regarding main / auxiliary earths & no extra charges shall be entertained after the contract is awarded.
- The exact location of earth conductors, earth electrodes and earthing points shall be determined at the site by the Contractor in consultation with the Consultant & the same shall be indicated in as built drawings.
- Earthing Conductor shall be GI or Copper tapes or Copper wires with PVC insulation as specified in BOQ. The Copper tape shall have more than 85% conductivity.

- All Tapes shall be jointed to ensure earth continuity. GI Tapes shall be jointed by welding and painting the same with zinc rich paint. All Copper Tapes above surface level shall be tinned and riveted at the joints with minimum two rivets for 20 / 25 mm wide tapes and four rivets for 32 mm wide & above tapes. All Copper Tape buried in soil shall be joint with exothermic welding to ensure proper connection & low contact resistance.

2. Examination of Work

- No work shall be covered by backfilling or otherwise put out of view without the approval of the Consultant / Engineer-in-charge. The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination and the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such work.

3. Field Tests

- Each electrodes shall be tested for earth resistance by means of standard DIGITAL EARTH TEST METER. The tests shall be carried out preferably after a protracted dry spell. The distance between two electrodes shall not be less than twice the length of electrode.
- No Earth Station shall have a ohmic resistance more than 2 ohms for equipment earthing as measured by a DIGITAL Earth testing apparatus.
- No Earth Station shall have a ohmic resistance more than 1 ohm for dedicated / clean earthing as measured by a DIGITAL Earth testing apparatus.

IV. Measurement

- 1. Earthing stations shall be enumerated and Earthing Tapes / PVC insulated copper wires shall be measured by length.**

V. Submittals

- 1. Following Test Certificates / Submittals shall be furnished by Vendor during Tender submission :**

- Compliance of Earthing Electrode to UL 467 - Grounding & Bonding Equipment / KEMA83C : 1990 (in case of maintenance free earthing)
- Confirmation of Eco friendliness of ground enhancing material & compliance to IEEE 80 : 2000 clause 14.5 'd' (in case of maintenance free earthing)
- Necessary Calculations for achieving the guaranteed Earthing resistance value for approval.
- Guarantee of restriction of maximum ohmic value of earth station as per specifications for at least 25 years (in case of maintenance free earthing)

Section – 09

Technical Specification for Lightning Protection System

I. General

1. Work Included

- Installation, Testing and Commissioning of Lightning Protection System
- Earthing Stations
- Electrolytic Grade Copper Earthing Tapes
- Electrolytic Grade Copper Earthing Plates/Pipes/Rods
- GI Earthing Tapes
- GI Earthing Plates/Pipes/Rods
- Earth Test Links

2. Related Work and Obligations

- To meet the general requirements apply to work specified in this section.
- To examine all the other sections of the specification for requirements, which may affect work of this section.
- To co-ordinate works with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- The intent of this specification is to define the requirement for the supply, installation, testing and commissioning of the Lightning Protection System.
- All Lightning Down Conductors shall be earthed by means of Copper Tape / GI Tape / Copper Cable / Screened Cable in accordance with particular specifications. The earth continuity resistance shall not exceed the value specified in the ISI regulations.

4. Codes and Standards

- The Lightning Protection System shall comply with all applicable Indian Standards (IS / IEC 62305 - 1 : 2010 - Code of Practice for Protection of buildings and allied structures against lightning) and French Standards (NFC 17-102 : 1995) as applicable. The installation shall also comply with Indian Electricity Act and Indian Electricity rules as well as relevant international standards. The major components shall be compliant to UL-96 Lightning Protection Standards.

5. Quality Assurance

- The Contractor shall ensure that all materials furnished and installed by him under the contract shall meet the requirements of relevant Indian & International Standards. The Contractor shall also verify all test results and ensure that these are in accordance with the requirements as mentioned in the specifications.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

7. Delivery, Handling and Storage

- The earthing material shall be inspected for the followings :-
 - Damage
 - Compliance with Specification
 - Quality
 - Storage of Material at Site to Prevent Rusting

II. Products

1. General Details

- The earthing material shall be brand new and in good condition. Earthing Strips / Earthing Plate / Earthing Pipes / Earthing Rods shall be GI / Copper / Copper Bonded Steel as called for in particular specifications / BOQ. GI Tapes / Copper Tapes / Copper Cables shall also be in- accordance with details as mentioned in particular specifications / BOQ.

2. Earthing Stations

a. General Earthing

- Earth Electrode (Plate / Pipe / Rod) shall be driven to a sufficient depth to reach permanently moist soil.
- Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.
- In case of Plate Earthing, the earthing electrode shall consist of a tinned copper plate not less than 600 mm x 600 mm x 3 mm thick or GI plate 600 mm x 600 mm x 6 mm thick unless otherwise specified. The earth plate shall be set vertically & surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level & shall be provided with a funnel and a mesh for watering the earth through pipe.

- In case of Pipe Earthing, the earthing pipe shall be minimum 50 mm dia 14 SWG for GI Pipe and minimum 38 mm dia 16 SWG for Copper Pipe. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through pipe.
- Earth electrode / funnel shall be covered with heavy-duty cast-iron cover housed on a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The covers shall have sturdy locking arrangement. They shall also be provided with stumbling free, non-protruding lifting arrangement.
- In case of Rod Earthing, the earthing electrode shall be minimum 32 mm dia Galvanized MS Rod for Sub-Stations & 25 mm dia Galvanized MS Rod for LT Panels. The earthing rod shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture as specified in respective drawings.

b. Maintenance Free Earthing

- In case of Rod Earthing, the Earthing Electrode shall consist of Copper Rod of suitable dia for achieving desired surface area. In case of use of Copper Bonded Steel Rod, the thickness of molecularly bonded copper coating shall not be less than 250 micron. The earthing electrode & bonding material shall comply with UL 467 for Grounding and Bonding Equipment. The earthing electrode arrangement shall be provided with ground enhancing material complying with IEEE 80 : 2000 clause 14.5 'd'.
- The Ground enhancing material in its set form shall have a resistivity of not more than 20 Ohm- cm. the Proposed Material shall not dissolve or decompose or otherwise pollute the soil or the local water table. The earthing stations shall be guaranteed for minimum 25 years for restricting earthing resistance as mentioned in BOQ. The necessary Calculation for achieving the guaranteed Earthing resistance value shall be submitted by vendor for approval.
- The electrodes shall have a clean surface, not covered by paint, enamel, grease or other material of poor conductivity.

3. Air Terminal

- Air terminal shall be designed upon emission streamer technology. It shall have no external power requirement for its operation & shall be compliant to UL-96 Safety Standards for Lightning Protection Components.

4. Down Conductor

- Down Conductor shall be 70 sq.mm. insulated copper cable as Down Conductor with necessary saddles & fixing hardware unless otherwise specified in BOQ. The cable shall also be provided with necessary factory fabricated kits for termination of the same with Air terminal & Earthing Pit / Test Link.
- In case of use of Multi Layered Stranded & Screened Cable, the electrical parameters shall be as specified in the BOQ. The said cable shall be compliant to UL-96 Safety Standards for Lightning Protection Components. The cable shall be provided with necessary saddles & fixing hardware as well as necessary factory fabricated kits for termination of the same with Air terminal & Earthing Pit / Test Link.

III. Installation, Testing and Commissioning

1. Erection

- The Air Terminal Mast shall be suitably designed to be fixed on top of the highest point of building & robust enough to support the terminal against wind.
- A removable test link shall be provided as near as possible to the earth electrode for isolating of the earth electrode / earth pits to check their resistance periodically. Wherever tape is fixed to the building structure, it shall be by means of purpose made saddles. Fixing shall be made by using purpose made plugs and clamps. Fixings requiring the drilling of the hole through the strip shall not be used. Joints in tapes shall be tinned before assembly and riveted with a minimum of two rivets severed solid. A drawing showing the proposed arrangement shall be submitted by the contractor for approval before any work is carried out at site. Care shall be taken that the excavations for earth electrode may not affect the column footings or foundation of the building.
- The Earth Pit for lightning conductors shall be at least 7M away from Earth Pits for Body Earthing of equipment's & at least 10M away from Earth Pits for dedicated / clean earth. The Earth Pits for Body Earthing of equipment shall be at least 10M away from Earth Pit for dedicated / clean earth.
- The Contractor shall visit the site during the tender stage for purpose of ascertaining ground condition as well as soil resistivity value regarding main / auxiliary earths and no extra charges shall be entertained after the contract is awarded.
- The exact location of earth conductors, earth electrodes and earthing points shall be determined at the site by the Contractor in consultation with the Consultant & the same shall be indicated in as built drawings.
- Earthing Conductor shall be GI or Copper tapes or Copper wires with PVC insulation as specified in BOQ. The Copper tape shall have more than 85% conductivity.
- All Tapes shall be jointed to ensure earth continuity. GI Tapes shall be jointed by welding and painting the same with zinc rich paint. All Copper Tapes above surface level shall be tinned and riveted at the joints with minimum two rivets for 25 mm wide tapes and four rivets for 32 mm wide & above tapes. All Copper Tape buried in soil shall be joint with exothermic welding to ensure proper connection & low contact resistance.

2. Examination of Work

- No work shall be covered by backfilling or otherwise put out of view without the approval of the Consultant / Engineer-in-charge. The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination and the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such work.

3. Field Tests

- Each electrode shall be tested for earth resistance by means of standard DIGITAL EARTH TEST METER. The tests shall be carried out preferably after a protracted dry spell. The distance between two electrodes shall not be less than twice the length of electrode.

- No Earth Station shall have a ohmic resistance more than 10 ohms for lightning protection earthing as measured by a DIGITAL Earth testing apparatus.

IV. Measurement

- 1. Earthing stations shall be enumerated and Earthing Tapes / Cables shall be measured by length.**

V. Submittals

- 1. Following Test Certificates / Submittals shall be furnished by Vendor during Tender submission :**

- Compliance of Lightning Protection Components to UL 96 (Safety Standard for Lightning Protection Components)
- Compliance of Earthing Electrode to UL 467 - Grounding & Bonding Equipment / KEMA83C : 1990 (in case of maintenance free earthing)
- Confirmation of Eco friendliness of ground enhancing material & compliance to IEEE 80 : 2000 clause 14.5 'd' (in case of maintenance free earthing)
- Necessary Calculations for achieving the guaranteed Earthing resistance value for approval.
- Guarantee of restriction of maximum ohmic value of earth station as per specifications for at least 25 years (in case of maintenance free earthing)
- List of Installations

Section – 10

Technical Specification for Conduits

I. General

1. Work Included

- MS Conduits
- PVC Conduits
- Flexible, Bends, Junction Boxes and Accessories
- Installation

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements which may affect work of this section.
- Co-ordinate work with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying & fixing concealed / surface mounted conduits for various services in accordance with the specifications and as indicated in the drawings. All conduits shall be ISI marked.

4. Codes and Standards

- The conduits shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
- IS 9537 (Part-I, 1980) : Specification for Conduits for Electrical Installations (General Requirements)

- IS 9537 (Part-II, 1981) : Specification for Conduits for Electrical Wiring (Rigid Steel Conduit)
- IS 9537 (Part-III, 1983) : PVC conduit pipes
- IS 3072 / 1965 : Flexible steel conduits for electrical wiring
- IS 2667 / 1966 : Fittings for rigid steel conduits for electrical wiring

5. Quality Assurance

- The Contractor shall ensure that all materials furnish and installed by him under the contract shall meet the requirements of relevant Indian standards.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

7. Delivery, Handling and Storage

- Conduit and accessories shall be inspected for the followings :-
 - Damage
 - Compliance with specification
 - Quality
- The conduits shall be protected from weather, fire or mechanical damage during storage.

II. Products

1. General Detail

- The MS conduits /PVC conduits, bends, flexible, boxes and accessories shall be brand new and in good condition.

2. MS Conduits

- MS Conduits shall be ISI marked, ERW type (Electric Resistance Welded), black stove enameled inside and outside, manufactured by High Frequency Induction Welding process and shall conform to all relevant Indian standards.
- Minimum wall thickness of MS conduits shall be 1.6mm (16 SWG) up to 32mm & 2.0mm (14 SWG) for 38mm and 50mm dia. The conduits shall be delivered to the site in original bundles and each length of conduit shall bear the label of the manufacturer. The number of insulated copper wires that may be drawn into the conduits of various sizes shall be in accordance with relevant Indian standards and space factor shall not exceed 40%.

3.00 PVC Conduits

- PVC Conduits shall be ISI marked, manufactured by Extrusion Process and shall conform to all relevant Indian standards.
- PVC Conduits shall be heavy gauge, high impact PVC smooth inside & outside. The polyvinylchloride conduit and accessories shall be of one manufacturer and the

manufacturers installation instructions shall be deemed to form part of the specification.

- Minimum wall thickness shall be 1.8/2.0 mm for all conduits up to 50mm dia.
- The conduits shall be delivered to the site in original bundles and each length of conduit shall bear the label for the manufacturer. The number of insulated copper wires that may be drawn into the conduits of various sizes shall be in accordance with relevant Indian standards and space factor shall not exceed 40%.

4. GI / PVC Flexible

- GI Flexible shall be used along with MS Conduits wherever necessary and PVC Flexible with PVC conduits unless otherwise mentioned in the particular specification.
- GI / PVC flexible conduits where applicable shall be used only to items of equipment which are withdrawable or subject to vibration or adjustment. The flexible conduits shall have a minimum length of 300mm & have sufficient length to allow the full range of withdrawal adjustment or movement necessary, terminated at each connection with proper couplers and checknuts. All earth conductors shall be taken internally through the conduit and fixed to the earth terminal of the light fixtures & switch boxes etc.

5. Bends, Junction Boxes and Accessories

- Bends, Junction Boxes & accessories shall be MS / PVC as required. Bends shall not have radius less than $2\frac{1}{2}$ times the outside diameter of the conduit & junction boxes shall be one / two / three / four way as necessary during installation at site.
- Circular inspection boxes shall be of minimum 50 mm dia rust proof, manufactured from sheet steel with smooth external and internal finish. These boxes shall be provided to facilitate removal and replacement of wires when required.
- Termination to accessory boxes shall be carried out with proper checknut in case of MS Conduits along with rubber bushes which shall be provided both for MS as well as PVC conduits.

III. Installation

1. Erection

- Conduits shall be concealed, wherever possible unless stated otherwise, by chasing into walls, installation in ceiling spaces or trunking or direct burial within poured concrete. No chases will be cut without approval of the consultant. Conduits shall be securely fixed to reinforcement or shuttering to prevent displacement. All boxes & conduits shall be fitted covers or plugs to prevent ingress of moisture or rubble & shall remain sealed until ready for wire pulling. No conduits shall be installed in screed or plaster unless such is of ample thickness & prior approval is obtained. All conduits must be checked where run in floor screeds before the floor screed is laid.
- Conduits shall have drawn in boxes every 10M of straight run or 7.5 M of lengths containing bends or every third bend. Conduit shall not have more than two right angle bends in any run without provision of draw in box / junction box.
- In case of MS Conduits, joints between conduits & accessories shall be securely made to ensure earth continuity & positive mechanical connection.

- Conduits shall be installed in such a manner that all cables / wires can be drawn in after erection with ease by means of a pull wire.
- Conduits connections for MS conduits shall be screwed to metal and all conduits joints shall be painted with approved metallic paint. The threads and sockets shall be free from grease and oil. Connections between screwed conduits and sheet metal boxes shall through a coupler through the conduit.
- When necessary, bends and diversions may be achieved by means of bends and / or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly screwed and flushed with the finished wall surface.
- Surface conduits shall be fixed by means of space bar saddles at intervals not more than 750 mm. The saddle shall be galvanized mild steel flat, and properly treated, securely fixed to support by means of screws. Where circular inspection box / inspection bends are mounted for necessary bends and diversion. All conduits shall be provided with saddles within 150 mm on either side of the inspection box / bend.
- All conduits shall be installed neatly and as unobtrusively possible parallel to general building lines where run on the surface of walls and ceilings. Laid in a straight line from point to point when concealed. Care must be taken where run in floors to prevent damage to the finish until floor screeds are laid.
- Cables shall not draw until the conduiting is complete. Conduits shall not be installed in contact with steel, water, gas or heating pipe work. A distance of 150 mm shall be maintained from other services wherever possible. Conduits shall not be left with any untreated rust patches on surfaces or installed by fixing nails.
- All screws used to secure cover plates, ceiling roses, batten type lamp holders, fan controllers or surface mounted luminaries to circular shall be galvanized and have a m4 thread. These screws shall have a pin head, countersunk head or raised head as required by the particular item to be fixed. Screws shall be of sufficient length to fully engaged the threaded lugs of the conduit box. Self- tapping screws shall not be used for the above purposes under any circumstances.
- All flush conduit boxes shall be installed with the front face level with the finished surface; where necessary extension sections shall be added. All circular conduit boxes shall be drilled and screwed with a minimum of one fixing; adaptable boxes and rectangular boxes for socket outlets, light switches and spur units etc., with a minimum of two fixings.
- All joints between PVC conduit and PVC accessories shall be glued by a solvent welding process. Conduit of not less than 25 mm shall be used throughout unless otherwise specified in particular specifications / BOQ.
- They shall be protected from weather and all mechanical damage during installation and at the same time protected by means of wooden plugs, plastic plugs or plastic caps to prevent the entrance of plaster or foreign matter during erection.
- The conduit work shall be concealed in floors, walls & roof slabs. The wiring shall be continuously and effectively protected along its whole length, with conduits mechanically continuous throughout. Cable capacities to be drawn in the conduit shall be as laid in the ISI regulations for the size of the conduit to be used. The

number of cables shall include separate earth wires in accordance with the standard regulations.

- PVC conduits shall not be used where not approved by IEE wiring regulations including hazardous locations and areas of high ambient temperature / above false ceiling. PVC conduit installation shall be generally in accordance with requirements specified for steel conduits except that they shall be installed with plastic fitting boxes and sets, with bends and sets formed with the help of helical spring fitted internally with the conduit warmed sufficiently of it to move without deformation of the bore and without avoidable wall thinning on the outside of the bend. With length coupled together by means of PVC socket jointed by solvent solution. For the above separate earth wire shall be used to ensure earth continuity.

2. Examination of Work

- Prior to laying and fixing of conduits, the Contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number & sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Consultant. Any modifications suggested by the Contractor shall be got approved by the Consultant before the actual laying of conduits is commenced / completed.

IV. Measurement

1. Conduits shall be measured by length or form part of the enumerated items in case of point wiring etc.

Section – 11

Technical Specification for PVC Insulated FR-LSH Copper Wires

I. General

1. Work Included

- PVC insulated FR-LSH copper conductor wires (1100 Volt grade) ISI marked

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect work of this section.
- Co-ordinate works with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying, laying, testing and commissioning of PVC insulated FR-LSH copper conductor wires, 1100 volt grade in existing MS / PVC conduits in accordance with the specifications and as mentioned in the drawings. All PVC insulated FR- LSH copper conductor wires shall be ISI marked.

4. Codes and Standards

- The wiring shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
 - IS 694 / 1990 : Wiring as well as flexible cords (metric)
 - IS 2448 / 1962 : Adhesive insulating tapes.
 - All tests should comply with ASTM Standards.

5. Quality Assurance

- Manufacturers regularly engaged in manufacture of wires, whose products have been in satisfactory use in similar service for not less than 5 years.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities, which manufacturer and Contractor may have by other provisions of the contract document.
- The wires shall be guaranteed against trouble free operation, defective workmanship and materials for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period cables shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- All wires shall be carefully transported to site to avoid damage during transit. While on site all wires shall be stored in a proper manner to prevent damage or moisture ingress.

II. Products

1. General Detail

- All copper conductor wires shall be PVC insulated, FR-LSH, unsheathed, solid / stranded annealed electrolytic grade copper conductor.
- 1100 volt grade in accordance with IS 694 / 1990 and ISI marked.
 - sq. mm. PVC insulated FR-LSH copper wires shall be solid conductor.
 - sq. mm. PVC insulated FR-LSH copper wires and above shall be stranded conductor. Multi stranded copper conductors can be used with approval of Consultant.

2. Colour Codes

Red, Yellow & Blue coloured PVC wires for three phase, Black for Neutral, White for 'Off' wire & Green for Body Earth shall be used. Dedicated Earth Wire wherever required shall be Yellow + Green.

3. Co-Axial Cables

Coaxial cables for TV, CCTV shall be solid annealed bare electrolytic grade copper conductor with gas injected physical foam PE dielectric, poly laminated Aluminum tape followed by copper braiding, jelly filled and overall PVC sheathed.

4. Maximum Capacity of Conduits for Drawing in PVC Insulated Wires / Cables to IS:694 / 1990

	Size of Conduit Wire Size in sq. mm.	20 mm	25 mm	32 mm	40 mm	50 mm
		Number of Wires / Cables				
•	1.5	4	8	12	-	-
•	2.5	3	6	10	-	-
•	4.0	2	5	8	-	-
•	6.0	-	4	7	-	-
•	10.0	-	3	5	6	-
•	16.0	-	2	3	5	7
•	25.0	-	-	2	3	6
•	35.0	-	-	-	2	5
•	50.0	-	-	-	-	3

- The table shows maximum capacity for simultaneous drawing of Cables manufactured in accordance with IS : 694 / 1990. This table applies to all type of conductors

5. Circuit Details

- Lighting / Fans Points – 10 Points or 800 Watts on each Circuit whichever is less
- 6 Amps Switched Socket Outlet (Raw Power) – 10 Points or 800 W on each Circuit whichever is less
- 6 Amps (Twin) Switch Socket Outlet (UPS) – 4 Sets on each Circuit
- 6 Amps (Triple) Switch Socket Outlet (UPS) – 2 Sets on each Circuit
- 16 Amps Switch Socket Outlet (Raw Power / UPS) – 2 Nos. on each Circuit
- A/C Outlet – 1 No. on each Circuit

6. Tests

- PVC insulated wires shall be subjected to tests as required by IS : 694.

6.01 Type Tests

- Certificates to be provided by Wire Manufacturer for the following :
 - Tests on Conductor : Annealing Test for Copper, Measurement of Resistance
 - Test for Thickness of Insulation and Sheath
 - High Voltage Test
 - Insulation Resistance Test
 - Flammability Test

6.02 Routine Shop Tests

- The following routine shop tests shall be carried out at Cable manufacturer's factory:
 - Acceptance Tests for Conductor and Insulation
 - High Voltage Test
 - Conductor Resistance Test

III. Installation

1. Erection

- The system of internal wiring shall consist of PVC insulated FR-LSH copper conductor solid / stranded wires 1100 volt grade in PVC / MS conduits as called for. Conduits shall be concealed or surface mounted as required.
- Prior to laying & fixing of conduits, the contractor shall examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of architect / consultant before the commencement of the work. Any modifications suggested by the contractor shall be got approved by the architect / consultant before the actual laying of the conduits. Maximum capacity of conduits for drawing in PVC insulated FR- LSH wires shall be as per IS 694/77.
- Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phase shall not run in the same conduit.
- The drawing and jointing of PVC insulated FR-LSH copper conductor wires & cables shall be executed with due regard to the following precautions. While drawing wires through conduits care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Insulation shall be shaved off like sharpening of a pencil and it shall not be removed by cutting it square. In case multi stranded wires are used the same shall be provided with lugs for all conductor sizes.
- Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional areas to take all strands. Connecting screws shall have flat ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors having nominal cross sectional area exceeding 6.0 sq. mm shall always be provided with cable sockets. At all bolted terminals, flat washer of large area and approved steel spring shall be used. Nuts & bolts shall be used for all connections. Only certified wiremen & cable jointers shall be employed to do jointing work. All wires shall have the manufactures label and shall be brought to site in original packing. For all internal wiring, PVC insulated wires of 1100 volt grade shall be used. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the use of joints is unavoidable due to any specific reason, prior permission, in writing, shall be obtained from the architect / consultant. No wires shall be drawn into any conduit, until all work of any nature, that may cause injury to wires, is completed.

Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Before the wires are drawn into the conduits, the conduit shall be thoroughly cleaned of moisture, dirt, dust or any other obstruction by forcing compressed air through the conduit. The minimum size of PVC insulated FR- LSH copper conductor wires for all sub-circuit wiring for light points shall be 2.5 sq. mm.

- Mains & submains, cables and wires where called for shall be of the rated capacity and approved make. Every main and submain wire shall be drawn into an independent adequate size conduit. An independent earth wire of proper rating shall be provided for every single phase submain. For every three phase sub-main, 2 nos. earth wires of proper rating shall be provided. The earth wires shall be taken internally through the conduit and fixed to the appropriate earth terminal. Where mains & sub- mains are connected to switchgear, sufficient extra length of cable shall be provided to facilitate easy connections and maintenance.
- Balancing of circuits in 3 phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.
- Color code shall be maintained for the entire wiring installation : red, yellow, blue for three phase, black for neutral, white for 'off' wire and green for PVC insulated earthwire (if PVC insulated FR-LSH Earth Wire is called for) and yellow + green for Dedicated Earth Wire.
- Point Wiring for light points, fan points, exhaust fan points, switch socket outlets shall include the cost of conduits wire, earth wire, ceiling rose / connector, junction box, fan hook box, switch mounting box, receptacle, switch and switch plate complete as required & nothing shall be paid over and above the quoted rates.
- Staircase and corridor lights shall be on separate circuits and shall be independently connected so that it could be operated by on switch installation on the ground floor easily accessible to fire fighting staff at any time.

2.00 Examination of Work

- No work shall be covered or otherwise put out of view without the approval of the Consultant / Engineer-in-charge. The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination & the Consultant / Engineer-in- charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining & measuring such work.

3.00 Field Tests

- The following Field Tests shall be carried out for the Wiring Installation : All low voltage wires furnished under the contract shall be tested by the contractor to ensure and prove satisfactory performance
 - Insulation Resistance
 - Earth Continuity
 - Polarity

IV. Measurement

1. Wires shall be measured by length or form part of the enumerated items in case of point wiring etc.

2. Looping from switch of initial first light point to switch of next first light point shall form part of circuit wiring and nothing extra shall be paid over and above quoted rates.

Section – 12

Technical Specification for Switches, Socket Outlets & Receptacles

I. General

1. Work Included

- Switches
- Socket outlets
- Receptacles
- Installation (includes fixing, testing and commissioning)

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect work of this section.

- Co-ordinate work with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying, fixing, testing & commissioning of Switches, Socket Outlets & Receptacles.
- The requirements specified in these clauses refer to switches, socket outlets and receptacles on 50 Hz, AC supplies and nominal 240 volts. All 240 volts outlets shall be three pin type with earth contact effectively connected to earth in all cases.

4. Codes and Standards

- The switches, socket outlets and receptacles shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules :-
 - IS 3845 (1966) : Light and power switches
 - IS 5987 (1970) : Light and power switches
 - IS 1293 (1967) : Socket outlets
 - IS 4615 (1968) : Socket outlets
 - IS 5133 (1969) : Boxes for enclosure of electrical accessories.
 - IS 3854 (1966) : Switches for domestic & similar purposes.

5. Quality Assurance

- The Contractor shall ensure that all materials furnished & installed by him under the contract shall meet the requirements of relevant Indian Standards.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The switches, socket outlets and receptacles shall be guaranteed against trouble free operation, defective workmanship & materials for a period of 18 months from the date of supply or 12 months from the date of erection & commissioning, whichever is earlier. In case of any defects during this period switches, socket outlets and receptacles shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- All switches, socket outlets and receptacles shall be carefully handled and stored at site in a neat and orderly manner for fixing the same at a later date.

II. Products

1. General Detail

- The switches, socket outlets and receptacles shall be brand new and in good condition.

2. Switches, Socket Outlets and Receptacles

- Light / Power switches shall comply with IS 3845 - 1966 and IS 5987 - 1970. These shall be rated for 6 amps or 16 amps whichever is applicable and shall be one way, two way or intermediate as detailed & match the switched socket outlets in design. All switches shall be the type suitable for the nature of supply to which they are to be connected. Socket outlets shall be 6 amps or 16 amps single or twin whichever is required and manufactured in accordance with IS 1293 - 1967 and IS 4615 - 1968.
- For external locations the switches shall be of weather proof pattern with IP – 67 degree of position.

III. Installation, Testing and Commissioning

1. Erection

- Switches controlling the light points shall be connected to the phase wire of the circuit. Where several switches on one phase are shown they will be installed in composite ganged units. Different phases shall not be ganged in one box unless each phase is segregated in a separate compartment.
- Where possible the arrangement of switches in ganged boxes shall be similar in plan to the lighting plans they control. Switches not so arranged shall be labeled in an approved manner to indicate the circuits controlled.
- All switches, sockets, switch plates and other receptacles for light & power shall be covered with cling film during installation. This cling film shall be neatly removed after the final painting / polishing of walls / furniture is over.
- All fixing boxes shall be MS / GI boxes as called for with proper brass earthing terminal. Sunk switches and socket outlets shall be mounted in above boxes with minimum depth of 50 mm. The face plate of switches shall be fixed square and flushed with the wall. The switch controlling the socket outlet shall be on the phase wire of the circuit.
- The mounting height to the bottom of the outlet box shall be 1050 mm unless otherwise specified and where the structure and furnishing permits. The distance from the edge of the door to the near edge of the switch shall be 225mm. The swing of the door shall be checked on site before marking out any chases for switch positions. Socket outlets shall be supplied & installed by the Contractor in position and of the type indicated on the drawings or the schedules and shall be installed in the position indicated. Switched or unswitched as required on the drawings mounted in multi assemblies where grouped.
- Sockets for special circuits will be particularly specified. Any requirement for sparkles switches / sockets will be particularly indicated. Where socket outlets are mounted on work benches, they shall be mounted 150mm above the bench surface unless otherwise specified and not flushed with the bench surface. Generally outlets shall be installed 50mm above the skirting level to the bottom of the outlet box.
- Surface mounted switches connected to surface mounted conduits shall be fixed to either MS or PVC moulded box as required.
- The earthing to each socket in case of Raw Power shall be effected by terminating the main earth conductor to a proper earth terminal fixed in outlet box. For this earth terminal the Contractor shall install an earthing fly lead of 2.5 sq. mm. cross sectional area with an overall insulation of PVC coloured green to the socket outlet

earthing terminal. The fly lead shall be of sufficient length to facilitate the ease of removal during maintenance. Where a cable outlet / socket outlet of 20 amps / 16 amps is installed for purpose of supplying power to A/C units the same shall be mounted in a position as indicated on the drawings.

- In case of sockets required with Dedicated ground supply, there shall be 2 nos. PVC insulated green and yellow + green earth wires one to be taken from brass earthing terminal mounted in the box and the other from earth pin of the receptacles / socket.

2. Examination of Work

- The Contractor shall give due notice to the Consultant / Engineer-in-charge whenever any such work is ready for examination and the Consultant / Engineer-in-charge shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining such work.

3. Field Tests

- All low voltage cables furnished under the contract shall be tested by the Contractor in the presence of the Consultant / Engineer-in-charge to ensure and prove satisfactory performance and for same the Contractor shall provide all test equipment required.
- Each socket outlet / receptacle shall be tested for the following :-
 - **Open ground**
 - **Open neutral**
 - **Open hot**
 - **Hot / Ground reverse**
 - **Hot / Neutral reverse**
 - **Correct**

IV. Measurement

1. Switches, Socket Outlets and Receptacles shall be enumerated.

Section – 13

Technical Specification for Lighting Fixtures, Ceiling Fans, Bracket Fans & Exhaust Fans

I. General

1. Work Included

- Fluorescent / CFL / Incandescent / Halogen Light Fixtures
- Fluorescent / CFL / Incandescent / Halogen Lamps

- Ceiling Fans
- Bracket Fans
- Exhaust Fans
- Installation, Testing and Commissioning

2. Related Work and Obligations

- The general requirements apply to work specified in this section.
- Examine all the other sections of the specification for requirements, which may affect work of this section.
- Co-ordinate work with all other trades affecting or affected by activities of this section. Co- operate with such other trades to assure the steady progress of all operations under the contract.

3. General Requirements

- This specification covers requirements for supplying, fixing, testing and commissioning of Lighting Fixtures, Lamps, Tubes, Ceiling / Bracket Fans and Exhaust Fans in accordance with make and catalogue numbers as mentioned in BOQ.

4. Codes and Standards

- The Lighting fixtures, Ceiling fans, Bracket fans and Exhaust fans shall comply with all applicable Indian Standards, Indian Electricity Act and Indian Electricity rules.
 - IS 371 / 1966 : Ceiling roses, two and three terminal
 - IS 418 / 1963 : Electric Lamps, Tungsten Filament general service
 - IS 1913 / 1969 : General and safety requirement for electric light fitting
 - IS 3837 / 1966 : Waterproof electric light fitting

5. Quality Assurance

- The Contractor shall ensure that all materials furnished & installed by him under the contract shall meet the requirements of relevant Indian standards.
- Manufacturers regularly engaged in manufacture of Lighting Fixtures, Lamps / Tubes, Ceiling / Bracket Fans and Exhaust Fans as required, whose products have been in satisfactory use in similar service for not less than 5 years.
- Installation shall be carried out by a firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for project.

6. Guarantee

- Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.
- The Lighting Fixtures (excluding compact fluorescent lamps, fluorescent tubes & halogen lamps), Ceiling Fans, Bracket Fans and Exhaust Fans shall be guaranteed against trouble free operation, defective workmanship & materials for a period of

18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. In case of any defects during this period cables shall be replaced free of cost by the Contractor.

7. Delivery, Handling and Storage

- All lighting fixtures, fans and exhaust fans shall be inspected for the following:
 - Damage
 - Compliance with specification
 - Quality
- These shall be protected from weather, fire or mechanical damage during storage

II. Products

1. Lighting Fixtures / Luminaries

- All Lighting Fixtures to be used in the installation shall be in accordance with make and catalogue number as mentioned in BOQ or as approved by the Architect / Consultant. Lighting fixtures shall be complete in all respects including, housing lamps, tubes, lamp holders, reflectors, ballast, starters and wiring.
- All luminaries control gear components and wiring shall be enclosed in sealed boxes which can protect from corrosion.
- Recessed, surface mounted and suspended luminaries shall be designed for use with control gear having maximum case temperatures, installed in ambient temperature and conditions stated in Indian Standards and IEC relevant sections.
- All luminaries shall be labeled with the voltage, wattage, frequency and current rating to include control gear and lamps, manufacturer's name and fixture type.
- All ballast shall be of the dry type epoxy resin encapsulated copper iron unless otherwise mentioned in the particular specification. In case HF Electronic Ballast are required, these shall be specially called for in the BOQ.
- Where reflector & louvers assembly are employed with fluorescent lamps, these shall be constructed from anodized aluminum coloration.
- Wherever called for luminaries shall be fitted with dry type high power factor correction capacitors correcting to 0.95 lagging.
- The metal canopy shall be finished with a white high gloss solve enameled paint.

2. Lamps

- All Fluorescent / CFL / Incandescent / Halogen Lamps shall be in accordance with those specified in BOQ or as approved by Architect / Consultant.
- Colour of lamps shall be verified with Architect / Consultant prior to ordering.
- All Lamps and Tubes shall be suitable for 230 Volt AC, 50 Hz supply system.

3. Ceiling / Bracket / Exhaust Fans

- Ceiling, Bracket & Exhaust fans shall be in accordance with sizes, makes and catalogue numbers as mentioned in BOQ.

III. Installation

1. Erection

- Lighting Fixtures, Fans and Exhaust Fans shall be installed at locations and heights as verified by the Architect / Consultants.
- All wiring from Junction box up to the fixtures shall be through PVC/GI flexible along with couplers as called for or not called for in BOQ.
- Equipment earthing connections with green copper wire for each lighting fixture shall be provided.
- Fixtures shall be fastened securely to structure support and check to ensure that solid pendent fixtures are plumb.
- Interior lighting fixtures, fans and exhaust fans shall be cleaned of dirt and debris upon completion of installation.
- It shall be Contractor's responsibility to protect installed fixtures, fans and exhaust fans from damage during remainder of construction period.
- In addition to above all fixtures shall be installed as per manufacturer's recommendations and contractor shall be responsible for coordinating with the manufacturer. After the fixtures are installed, he shall also be responsible for obtaining in writing from the manufacturer that the fixtures have been installed as per their recommendations.

2. Examination of Work

- Upon completion of installation of interior lighting fixtures & after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance, otherwise, remove and replace with new units and proceed with retesting.

IV. Measurement

1.00 Light fixtures, fluorescent lamps, CFL, Halogen lamps, ceiling fans, bracket fans and exhaust fans shall be enumerated.

TECHNICAL SPECIFICATIONS FIRE FIGHTING WORKS

FIRE FIGHTING SYSTEM

- 1. FIRE FIGHTING WORKS- FIRE PROTECTIONS**

Scope of work shall include design, engineering, supply, installation, testing & commissioning of firefighting system.

All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge.

The firefighting shall be carried out strictly as per NBC -2016.

Testing, commissioning and live demonstration of the system shall be provided to various inspection authorities and obtain their No objection certificate (NOC) for occupation of buildings.

1.1. TENDER DRAWINGS

For guidance of the bidder, drawings (Schematic Fire Fighting Layout/External Fire Layout, Plant Room Layout etc.) are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer and get the same approved by Local Fire Authority/other statutory bodies. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer/ Local Fire Authority.

1.2. SHOP DRAWINGS

The contractor shall prepare and furnish all shop drawings including floor plans, Schematic Fire Fighting Layout/External Fire Layout, Plant Room Layout etc. at no extra cost for approval by the Engineer before commencing fabrication/ manufacture of the equipment. Such shop drawings shall be based on the Architectural drawings/Tender Drawings and requirements laid down in the specifications and as per site conditions. The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings are approved in writing by the Engineer. Such drawings shall be coordinated with other services work. These shop drawings will be approved by NBCC which will be considered as base for execution of firefighting work.

1.3. COMPLETION / AS BUILT DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer. General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories "As installed". These drawings shall in particular give the following:

- a. General layout of pump house
- b. Panels and other equipment location and sizes etc.
- c. Fire fighting floor layout indicating internal hydrants, sprinklers complete with pipe dia., pipe spacing interval etc.
- d. Complete schematic as installed.
- e. Location of External Hydrants, 2-way/4-way fire brigade inlet connection, Earth pipes, route of earthing conductors etc.
- f. Route of all cables and pipes run along with detail sizes and mode of installation.

1.4. DOCUMENTS

The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

- a. Warranty for equipment installed.
- b. Test certificates
- c. History sheets of the equipments
- d. Catalogues/Brochures
- e. Operation and maintenance manuals
- f. List of recommended spares and consumables

- g. Reconciliation statement
- h. All approvals including technical approvals and sanctions
- i. NoC from Fire authority before commencement of execution & after completion of entire work etc.

1.5. SANCTION/ APPROVALS FROM STATUTORY AUTHORITIES/ LOCAL FIRE AUTHORITY

The contractor shall be fully responsible and shall carry out following activities:-

- a. Submission of working drawing
- b. Obtaining the approval of drawings
- c. Arranging inspection of site by officials of the Authority
- d. Obtaining the final no objection/ completion certificate after submitting required documents.
- e. Any other statutory approvals required.

1.6. MANUFACTURING

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.7. MAKE OF MATERIALS

Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The contractor shall get the samples of required items approved from the Employer/ Engineer- in-Charge before commencing the supply.

1.8. MANUFACTURER INSTRUCTION

Any specific instruction furnished by manufacture covering the points not mentioned in technical specifications of the tender shall be brought to the notice of project incharge engineer in writing for further instructions in this regard at the time of tendering.

1.9. MATERIAL TESTING

The project incharge engineer shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

1.10. INSPECTION AND TESTING

- a. All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/ directed by engineer.
- b. Contractor shall perform all such tests as may be necessary to meet requirements of Local Authorities, Municipal or other statutory laws/ bye-laws in force. No extra shall be paid for these.
- c. The project incharge engineer may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.
- d. Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

1.11. TRAINING OF DEPARTMENT PERSONNEL

- a. The contractor shall train the CLIENT/ NBCC's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).
- b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.
- c. The CLIENT/ NBCC's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- d. Nothing extra shall be paid to the contractor for training CLIENT/ NBCC's personnel.

1.12. PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ NBCC against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ NBCC.

- a. Any defective material or equipment supplied by the contractor.
- b. Any material or equipment supplied by the CLIENT/ NBCC which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

2. PIPING FOR WET RISER SYSTEM

2.1. SCOPE

This section covers the details of requirement of piping used in wet riser system, including the associated auxiliary equipment.

2.2. GENERAL

The wet riser system shall remain pressurized at all times during operation, and as such the piping work shall be carried out to withstand the same.

2.3. PIPES AND FITTINGS

Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. and all such connecting devices that are needed to complete the piping work in its totality.

Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints.

Forged steel fittings of approved type with "V" groove joints.

Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below. When used, they shall be fabricated, welded and inspected in workshops whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler System under the supervision of Engineer-In-Charge. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

Pipes for Wet Riser system shall be of black steel MS conforming to IS: 1239/3589 (Heavy Class/ Class C).

2.4. JOINTING

2.4.1. Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

2.4.2. Groove Joint (65 mm dia and above)

Joints between M.S. pipes and fittings shall be made with the pipes and fittings having groove. Welded joints are not acceptable.

2.4.3. Flanged

Flanged joints shall be provided on:

- a. Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.
- b. Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.
- c. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as per good engineering practice.
- d. Flanges shall be as per Table 17 of IS-6392. with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

2.4.4. Unions

Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges. Joint for black steel pipes and fittings shall be metal to screw grid up to 50 mm dia and above 65 mm dia Grove joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. Hold tight will be used for threaded pipes joint.

All the Grove shall be radiographic ally tested. Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

2.5. DIA OF FLANGE AND HOLE CONFORMING IS:

Size of pipe →	80 mm	100 mm	150 mm	200 mm
Dia of flange →	200 mm	220 mm	285 mm	340 mm
Flange thickness	20mm	20mm	22mm	24mm
Dia of bolt →	16 mm	16 mm	16 mm	16 mm
No. of hole →	4 mm	4 mm	8 mm	8 mm

2.6. PIPE PROTECTION

- a. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.
- b. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous pypkote or Hessian cloth and finished with one coat of hot bitumen paint.
- c. Pipe passing through structural members will be provided with M.S. pipes.

2.7. PIPE SUPPORTS

All pipe clamps and supports shall be galvanized mild steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally uncounted. For pipe spacing, the stringent of the IS Code- clause no. 10.3.10, table -11 & below mentioned table should be opted.

2.8. ORIFICE PLATES

Contractor shall provide orifice flanges fabricated from 6 mm thick SS plates on the branch lines feeding different zones/ floors so as to allow required flow of water at 3.5 Kg/ sq.cm. Pressure. The contractor shall furnish design for these orifice flanges.. The orifice shall be plain central hole without burs, diameter not less than half of the internal diameter of pipe to which it is fitted.

2.9. AIR VESSEL AND AIR RELEASE VALVE

Air vessel on top of each wet riser/ sprinkler piping shall be installed before execution for approval fabricated out of at least 8 mm thick steel to withstand the pressure, with dished ends and supporting legs. This shall be of 250 mm dia and 200mm high. This shall be completed with necessary flange connection to the wet riser/ sprinkler piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be of continuous welded construction and painted with red Colour. This shall be tested for twice the working pressure. The drain arrangement will have 25mm dia GM valve with required accessories and pressure gauge.

2.10. VALVES, GAUGES

Butter-fly, Sluice valves and NRV above 65 mm shall be of cast iron body. They shall conform to type PN 1.6 of IS: 13095,780. Valve wheels shall be of right-hand type and have an arrowhead engraved or cast thereon the direction for turning open and closing.

Non-return valves shall be of cast iron body. They shall be swing type conforming to Class 1 of IS: 5312 and should have Nitrile Rubber/EPDM Seal They shall be swing check type in horizontal runs and lift check type in vertical runs of piping.

Pressure gauge of suitable range shall be installed on the discharge side of each pump vacuum gauge shall be provided on suction side for pumps with negative suction. The dial size shall be 250 mm. The gauges shall have brass cocks.

Orifice plates shall be made of 6mm thickness Brass material to reduce pressure on individual hydrants to operating pressure of 3.5-kg/ sq.cm. Design of the same shall be given by the contractor as per location and pressure condition of each hydrant.

2.11. EXTERNAL YARD HYDRANTS

External yard hydrants shall be of 'Stand Post' type conforming to IS: 908 and comprise stand post for single or double outlet, duck foot bend, flange riser and single headed brass/ gunmetal valve conforming type A/ type-B and conforming to IS: 5290.

The stand post column shall be of cast iron, cast in one piece, conforming to grade 20 of IS: 210 or M.S. pipe. The internal diameter at the top shall be at least 80 mm.

The outlet shall be angled towards ground, with instantaneous spring lock type gunmetal female coupling of 63 mm dia. For connecting to hose pipe.

2.12. INTERNAL HYDRANTS

The internal hydrant outlet shall comprise double-headed double outlet gunmetal or SS landing valve' conforming to type A conforming to IS: 5290. Separate valves one on each of the two heads shall form part of the landing valve construction.

A brass cap with chain is provided on one head of the outlet which will have an instantaneous pattern female coupling for connection to the hose pipe. The landing valve shall be fitted to a tee connection on the wet riser at the landing.

2.13. FIRST AID HOSE REEL EQUIPMENT

First aid hose reel equipment shall comprise reel hose guide fixing bracket, hose tubing globe valve, stopcock and nozzle. This shall conform to IS: 884. The hose tubing shall conform to IS: 12585 Type-2 and made of thermoplastic (textile reinforced).

The hose tubing shall be 20 mm dia and 36 m long. The gunmetal / brass nozzle and globe valve shall be of 25 mm size.

The connection from riser will be with 40mm dia stop valve & MS pipe

The fixing brackets shall be of swinging type. Operating instructions shall be engraved on the assembly.

2.14. HOSE PIPES, BRANCH PIPES AND NOZZLES

Hose pipes:- Hose pipes shall be rubber lined woven jacketed 63 mm in diameter and 15 m long. They shall conform to controlled percolation type comply with type A (reinforced rubber lined) of IS: 636. The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose pipe shall be complete with necessary coupling at the ends of match with the landing valve or with another run of hose pipe or with Branch pipe.

The coupling shall be of instantaneous spring lock type.

Branch pipe: - Branch pipe shall be of brass or gunmetal of 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

Nozzle: - The nozzle shall be of brass or gunmetal, 20 mm in internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with the nozzle spanner.

End couplings, branch pipes, and nozzles shall conform to IS: 903. Each hydrant point will be provided with two hoses of 15 m each and one gunmetal branch pipe.

2.15. HOSE CABINET

Each Hydrant shall be housed in a Hose cabinet of suitable size. The hydrant cabinet shall hold single/double headed hydrant as specified, two hoses and one branch pipe as required. The cabinet shall be of minimum 14 SWG MS sheet with glass front door. Complete with hinges, handle, locking arrangement & painted with approved synthetic enamel paint.

2.16. FIRE BRIGADE INLET CONNECTIONS/ DRAW OFF CONNECTION

One set of 2/4 ways collector head Fire Brigade connection shall be provided at underground tank, Ring Main, Sprinkler system and individual wet risers as specified conforming to IS 904.

The inlet to the wet riser sprinkler header shall be with 150 mm dia butterfly or sluice valve and non- return valve. The scope shall include necessary reducers, tees bends and special fittings as required.

It should be provided with M.S. enclosure fabricated from 1.5 mm thick M.S. sheet, front glass locking arrangement supported on M.S. structural members, painting with two coats of postal red enamel.

3. ELECTRIC DRIVE, HORIZONTAL FIRE PUMPS

Without restricting to the generality of the foregoing, the pumps and ancillary and accessories.

1. Electrically operated pumps with motors, base plates and accessories.
2. Alarm system with all accessories wiring and connections.
3. Pressure gauges with isolation valves and piping bleed and block valves.
4. M.S. pipes, valves, suction strainers, delivery headers and accessories.
5. Foundations, vibration eliminator pads and foundation bolts.

3.1. QUALITY CONTROL

These shall comply with the IS codes as specified.

3.2. SUBMISSIONS

- a. Product Manuals
- b. Hydraulic Details

3.3. STORAGE

These shall be stored as delivered in original packing.

4. FIRE, SPRINKLER AND JOCKEY PUMPS Electric drive and Diesel Engine

4.1. PUMPING SETS

- a. All pumps (main sprinkler & hydrant pumps, jockey pumps, diesel driven pump) shall be of suitable capacity & head to meet the requirements of NBC 2016.
- b. Pumping sets shall be multi stage horizontal split casing centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings. The centrifugal pumps shall conforming to IS 1520.
- c. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.
- d. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard. Pump and motor engine shall be mounted on a common base plate fabricated from MS section.
- e. Pumps shall be provided with approved type of mechanical seals.
- f. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- g. The pump shall meet the requirements of N.B.C. 2016 and N.F.P.A. and the unit shall be design proven in fire protection services.

4.2. ELECTRIC DRIVE

- a. Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors of efficiency rating IE-3. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.
- b. Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- c. Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.
- d. Motors for fire pumps shall meet all requirements and specifications of N.B.C.-2016 and N.F.P.A.
- e. Motors shall be suitable for 415 volts, 3 phase 50 cycles A/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.
- f. Motors shall be designed for two-start system.
- g. Motors shall be capable of handling the required starting torque of the pumps.
- h. Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- i. Speed of the motors shall be compatible with the speed of the pump.

4.3. PRESSURE VESSEL

- a. Provide one air vessel fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 2000 mm high In Plant Room & 250 mm dia. & 2000 mm high at Terrace or as per requirement and tested to 20 kg/ sq. cm pressure.
- b. The fire pumps shall operate on drop of pressure in the mains as given below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

4.4. VIBRATION ELIMINATORS

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors (double arch of min. PN 16 rating). Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

4.5. INSTALLATION

- a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations. Angle iron frame of size 35mmx35mmx3mm shall be provided on the edge of foundation.
- b. Pumps and motors shall be truly aligned by suitable instruments.
- c. All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.
- d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

- e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Engineer-in-charge or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the NBCC.
- f. Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.
- g. Provide vibration eliminating pad and connectors for each pump.
- h. A minimum clearance of 1M around the pumps shall be provided.

4.6. DIESEL ENGINE

- a. Diesel engine shall be of multi cylinders (4/6 cylinder AS PER REQUIREMENTS) with individual head assemblies. The engine shall be water-cooled and shall include heat exchanger/radiator cooled and connecting piping, strainer, isolating and pressure reducing valves, bye-pass line complete in all respects.
- b. Engine shall be direct injection type with low noise and exhaust emission levels and shall conform to BS649/IS 1601/IS10002 as amended upto date.
- c. The speed of the engine shall match the pump speed for direct drive.
- d. The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg. C and shall take full load within 15 seconds from the receipt of the signal to start.
- e. The Engine shall efficiently operate at 38 deg. C ambient temperature at 50 m above mean sea level.
- f. Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 m distance.
- g. The engine shall be self starting type up to 4 deg. C and shall be provided with one 24 V heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.
- h. Provided a battery recharger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator.
- i. Annunciation panel shall be suitable for working on 24 volts D.C. Arrangement for starting shall be automatic on receiving the signal but shutting off shall be manual.
- j. The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.
- k. Engine shall be suitable for running on high speed diesel oil.
- l. The system shall be provided with a control panel with push button starting arrangement also and wired to operate the engine on a differential pressure gauge.
- m. The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.
- n. Provide one fully mounted and supported day oil tank fabricated from 5mm thick M.S. sheet electrically welded Provide level indicating gauge glass on the day oil tank and low fuel indication of the control panel. The capacity of tank should be sufficient to allow engine to run on full load for at least 2 hours. The fuel pipe from diesel tank to pump should be of robust construction, preferably of hard rubber.

- o. Provide one exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions. The piping shall be duly insulated with 50mm thick glass wool and 1.0mm thick aluminium sheet cladding.
- p. Provide all accessories fittings and fixtures necessary and required for a complete operating engine set.

4.7. OPERATING CONDITIONS FOR JOCKEY , ELECTRIC & DIESEL PUMPS

- a. Jockey pump shall start automatically when the Water Pressure in the System falls to a pre-set value and shut down when the system pressure reaches the set value. Both Limits shall be adjustable. The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.
- b. Main Electric Fire Pump shall operate on account of sudden pressure loss. So, long as Main Electric Fire Pump is working, other Fire Pumps will not operate. The Pump shall start when the water pressure falls to a pre-set value in the system The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.
- c. The Diesel Fire Pump will start on sudden pressure loss, only in case supply to main electric Fire Pump is not available or within a pre-set time the main Electric Fire Pump fails to start or fails during operation. No other pump will be working when Diesel Engine fire Pump is in operation. Audio- Visual Alarm shall be available to indicate failure of Main Electric Fire Pump.
- d. A three attempts starting facility will be provided for diesel Pump.
- e. If within a pre-set time, the pump also fails to start or fails to develop pressure, the diesel pump shall also be shut down and locked out. An audio visual alarm indication shall be given at the Control Panel.
- f. The Terrace Pump will start on sudden pressure loss of pressure only when both the Fire Pumps have either failed to start or exhausted water.
- g. Only one pump will be working at a time. In manual mode, more than one Pump can be started.
- h. Water Level in UG and Terrace Tanks shall be monitored and in case of low water level, pumps connected with the tank shall not operate (even on manual mode) or stop operation as the case may be. An audio-visual alarm shall be given at the Control Panel. The Terrace Fire Tank shall be provided with Baffles to ensure proper circulation of water before overflow/discharge into domestic tank.

4.8. VIBRATION ELIMINATORS

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

Pump channels shall be provided with min. one coat of black paint.

5. ELECTRICAL INSTALLATIONS

5.1. POWER AND CONTROL PANEL AND OTHER CONTROL COMPONENTS

For Fire Fighting Panel & Control Panel, specifications under Technical Specifications for LT Panel under Electrification shall be followed.

5.2. CABLE LAYING:

Cable shall be laid generally in accordance with CPWD Specifications (Electrical) External & Internal amended upto date. Cables shall be laid on 14 gauge perforated MS sheet cable trays and cable drops/risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal/ replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls/trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable 1.1 KV cable shall be buried 600 mm below ground level. For additional details pertaining to Cable Laying, Refer the Electrical Works Specifications under the relevant Head.

5.3. WIRE SIZES:

For all Single phase/ Three phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminum conductor wires of adequate size. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminum conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

The minimum size of control wiring shall be IS marked 2.5 mm² PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes:

- i. Upto 5 HP motors :- 3 x 4 mm² Cu conductor wires.
- ii. Above 5HP upto 15 HP motors :- 2 Nos. 3 x 6 mm² Cu conductor wires.
- iii. From 20 HP to 25 HP motors :- 2 Nos. 3 x 10 mm² Al conductor armoured cables.
- iv. From 60 HP to 75 HP motors. :- 2 Nos. 3 x 50 mm² Al conductor armoured cables.
- v. 100 HP motors. :- 1 No. 3 x 150 mm² Al conductor armoured cables.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

The motor starter shall conform to IS 1822 as amended upto date.

5.4. Earthing:

For Earthing details, Refer the CPWD Electrical Works Specifications 2013 and electrical specification.

5.5. Drawings:

Shop drawings for control panels and wiring of equipment showing the route of conduit/ cable shall be submitted by the contractor for approval of Engineer-in-Charge before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed"

drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

5.6. Testing:

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorized person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

5.7. Painting:

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

5.8. Label and Tags

Engraved PVC labels shall be provided on all incoming and outgoing feeders switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Manager.

1. All panels to have provision for padlocking and all MCCB's/ MCB's to have provision for locking in off position.

5.9. ELECTRIC FIRE PUMP PANEL :-

The main switch board shall be floor mounted/ wall mounted fabricated from 2mm thick CRCA sheet powder coated with IP 42 protection

3Ph 415V Normal supply for fire pumps near UG tank and Essential supply for terrace pump and jockey pumps

The panel shall incorporate the following facilities.

- i. TP &N Moulded case circuit breaker of appropriate fault level
- ii. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- iii. Starter unit, current transformer and ammeter
- iv. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.
- v. Pump lock out devices due to faults or abnormalities as specified.
- vi. Visual/ audio alarms, indications and communications facility as specified.
- vii. Necessary inter-connection control and power cable work, cable glands, lungs and internal wiring and connections.

5.10. ENGINE SECTION: -

The engine section shall incorporate the following facilities.

- a. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.
- b. Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.

- c. Engine shut down and block out devices due to faults or abnormalities as specified.
- d. Visual/ audio alarm indication and enunciator facility as specified.
- e. Inter-connection control and power cable work, cable glands, lugs, all internal wiring and connection etc.

5.11. AUXILIARY PUMP SECTION: -

Each of the auxiliary pump section for priming pump shall incorporate the following:

- a. TP&N Moulded case circuit breaker
- b. Control system components such as relays, timers, contractors etc. as are necessary for functional requirements.
- c. Starter unit, current transformer and ammeter
- d. Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.
- e. Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.
- f. Low water level alarm for terrace tank, where provided.

5.12. SYSTEM CONTROLLER: -

The system controller shall consist of relay timer, contactor etc for interlocking of fire pump and fault isolation and incorporate the following:

- a. Control components integrating the various sections, so as to satisfy the functional requirements.
- b. Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.
- c. Visual/ audio alarms not covered in individual sections.
- d. Lamps healthy test facility.
- e. Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.
- f. Test facility to stimulate operation of hydrants.

5.13. OTHER CONTROL COMPONENTS

5.13.1. Pressure Switches:

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at present pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

5.13.2. Low water level indication and switch:

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level audiovisual alarm. This should indicate the level of water at different stages is the power and control panel.

5.13.3. Power Supply for Controls:

In order ensure that the control systems remains operational at all times, the control system shall be designed for 24V DC operation, fed from 24 V wet battery. This shall be independent of the starting battery for the engine i.e., battery shall remain trickle charged at the times from the common battery, charges at the control section.

6. Gas based Fire Suppression System:

6.1. For Low Voltage equipment /Laboratories, & other Critical Areas:

The Total Room Flooding system of fire detection and quenching is proposed in all Low Voltage Equipment rooms where Water sprinklers cannot be used. The Gas cylinder assembly should be UL/FM approved with seamless CCOE approved cylinder and will be connected to discharge nozzles through metal Piping. The master cylinder Kit fitted on Gas cylinder will be operated through separate Fire detection Panel and will release zero Ozone depletion potential Gas through the nozzles in case of fire.

6.2. For Electrical panels:

Tube based Fire protection system is used in the Electrical Panels to be installed in substations. The detection Tube shall be installed throughout the compartment of panels. The location and spacing of tube shall be above the hazard to be protected. Cylinder equipped with brass valve, pressure Gauge isolation valve will be fitted on the wall of the panel with suitable brackets and will be connected to the detection tube. in case of fire the tube shall rupture at a point. The rupture Tube shall result in formation of discharge point and release Gas Agent in Uniform pattern.

6.3. Portable Fire Extinguishers:

ABC Powder stored pressure type Fire Extinguishers of 6 KG capacity IS : 15683 & CO2 gas based Fire Extinguisher of 4.5 Kg capacity with IS : 15683 is proposed for all floors near internal hydrant locations. The ISI marked Extinguisher and their installations shall be in accordance with acceptable standard of NBC 2016. These units shall be mounted at a convenient height to enable to its quick Access. There requirement shall be as per NBC 2016 Part - 4 Table -7.

7. Fire Signages :-

Various types of signage are proposed in the complex as per NBC 2016 Part -4. At every floor near Lift landing diagram showing stairways shall be provided mentioning instructions - 'IN CASE OF FIRE USE STAIRS UNLESS INSTRUCTED OTHERWISE'. The signage shall be above call button in Lift Lobby. Floor Signage will be provided in each floor within the staircase. The Numerical shall be Bold Type of minimum 75 MM height. Each corridor of every floor will have directional signage indicating Fire Escape route. These Signage may be LED lit with UPS power backup or of photo Luminescent paint. So that they will be visible in dark in case of power failure.

8. INSTALLATION, TESTING AND COMMISSIONING

8.1. SCOPE

This section covers the requirements of installation of the various components of the wet riser system.

A survey of the site of the work shall be made by the contractor before preparation of the detailed drawings for submission to the department for approval. The installation shall be carrier out strictly in accordance with the approved drawing.

The scope of installation work shall include the following, where or not expressly mentioned in the schedule or work.

- i. Cement concrete (1:2:4 Mix) foundation for all pump sets. Iron Angle framing around the Pump foundation (at the edges/periphery) to protect it from chipping/damage etc.
- ii. Vibration isolation arrangement for all pump sets
- iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes
- iv. Necessary supports and clamps for wet riser pump room
- v. Necessary supports and camps for wet riser plumbing in the building
- vi. Supporting bracket/ frame work for the fuel oil tank of the Diesel engine.
- vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.
- viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are no strong enough to support the pipes, thereby likely to case different settlement.
- ix. Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.
- x. Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.
- xi. Valve chambers of approved design with external (yard) hydrant.
- xii. Ground level hydrants of approved design, where specifies.
- xiii. Cutting and making good the damages for the installation work of the riser system
- xiv. All the required control piping, exhaust piping from engine to outside, oil piping for fuel oil and lubricating oil for the engine, drain piping from the pumps to the drain point in the pump room, overflow piping from priming tank to the sump. The piping work shall include all necessary fittings, valve and accessories for effective functional requirements.
- xv. Inter-connecting cable work with controls, control panel, batteries etc. including battery leads.
- xvi. Orifice plates at individual hydrants as required.

Where provision of MS pipe shall below ground become inescapable, it shall be protected from soil corrosion by two coats of bitumen painting and wrapped with bituminous Hessian cloth and finish with hot bitumen paint.

Each MS pipe shall be subjected to hydraulic pressure test before installation, in presence of the Engineer or his authorized representative.

External (yard) hydrants shall be located at least 2m away from the face of the buildings but not more than 15m and be accessible. Distance between the two hydrants should not be more than 45 metre.

Where external hydrants are below ground level , they shall be enclosed in masonry trenches of size 75sqcm and 8cm above ground level. The hydrant shall be with in 8cm from the top of the enclosure.

Landing Valve of Internal hydrant at each floor shall be located at about 1m above floor level. Valve chambers in ground shall be of 1sqm in size, with cover.

8.2. HOSES AND HOSE CABINET

Hose Pipe shall be 63 mm dia. & 15 mtr length and fabric reinforced rubber lined as per IS 636 Type A. They should be flexible and capable of being rolled. All Hose pipe shall carry ISI Marking on the body of the Hose. The instantaneous coupling shall be as per IS 901. It shall be fixed to the Hose pipe by Galvanized wire & copper rivets.

Each Hydrant shall be housed in a Hose cabinet of suitable size. The hydrant cabinet shall hold single/double headed hydrant as specified, two hoses and one branch pipe as required. The cabinet shall be of minimum 14 SWG MS sheet with glass front door. Complete with hinges, handle, locking arrangement & painted with approved synthetic enamel paint.

8.3. PAINTING

Painting of the entire wet riser piping over the ground shall be done with anticorrosive primer and 2 coats of approved paint. The color shall be red to shade No. 536 of IS: 5, Paint shall conform to IS:2932.

The pumps and engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

8.4. APPROVAL BY LOCAL BODIES

It shall be the responsibility of the contractor to obtain the approval of drawings and to get the installation inspected and approved by the concerned authorities as may be necessary as per local by- laws,

8.5. PIPE WORK ASSOCIATED WITH DIESEL ENGINE

Pipe works for fuel system, lube oil system and exhaust system shall be complete with all required supports, clamps, hangers etc. for a complete work.

Fuel feed is by gravity and the fuel tank shall be located at least 60cm above the fuel injection pump. Fuel pipe of copper shall not be soldered but brazed or welded.

No valves or cocks shall be provided in the fuel feed line to engine from the fuel tank.

Precautions shall be taken to prevent any air locks in any part of the fuel system. No air relief cock shall be permitted and where inescapable, screwed plugs shall be provided for the purpose.

The installation of the fuel supply system shall be such that a completely primed condition is maintained, free from air lock.

Filters shall be provided in fuel oil and lube oil circuits allocations that are easily accessible for maintenance.

9. TECHNICAL SPECIFICATIONS FOR SPRINKLER SYSTEM

All the piping for sprinkler work shall be with MS Class C & shall conform to IS 1239/3589.

9.1. SPRINKLER HEADS

- a. **Sprinkler heads** shall be quick response type of quartzoid bulb type with bulb, valve assembly yoke and the deflector, rosette plate & complete with all accessories & shall be UL listed & FM approved . The sprinklers shall be as per IS:9972 of approved make and according to type of discharge.

b. Types

- i. Conventional Pattern

- ii. The sprinklers shall be designed to produce a spherical type of discharge with a portion of water being thrown . The sprinklers shall be suitable for erection in upright position or pendant position. The designing of installation will be as per IS 15105.
- iii. Spray Pattern
- iv. The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.
- v. Ceiling (flush) Pattern
- vi. These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.

c. Side Wall Sprinklers

- i. These shall be designed for installation along with the walls of room close to the ceiling. The discharge pattern shall be similar to one quarter of sphere with a small proportion discharging on the wall behind the sprinklers.

d. Constructions

- i. **Bulb:-** Bulb shall be made of corrosion free material strong enough to with stand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches a predetermined level.
- ii. **Valve Assembly:-** Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.
- iii. **Yoke:-** The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is housed in corrosive conditions.
- iv. **Deflector:-** The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.

e. Colour Code

The following color code shall be adopted for classification of sprinkler according to nominal temperature ratings:

Sprinkler Temperature Rating: - 68 deg. C

Color of the Bulb: - Red

f. Size of Sprinklers Orifices

The following sizes of sprinklers shall be selected for various classes or hazards.

Moderate hazard :- 15 mm nominal bore

g. Stock of replacement sprinkler

The following spare sprinklers shall be supplied along with the system.

Moderate hazard systems :- 24 sprinklers

h. Temperature Rating

For normal conditions in temperature climates rating of 68 deg. C shall be used. However the temperature rating shall be as close as possible to, but not less than 30 deg. C above the highest anticipated temperature conditions.

- i. Maximum & Minimum Distance between sprinklers, between sprinklers & boundary wall shall be as per hazard classification of building & relevant IS codes.
- j. Zoning of sprinklers with ICV to be placed in Plant Room in required buildings to be done as per relevant IS codes/NBC 2016/CPWD specifications. The required buildings as specified in DBR (Design Basis Report) where sprinkler provision is to be considered shall be with min. one independent ICV.
- k. In order to avoid any kind of leakage from sprinklers, it shall be wound with Teflon tape & any other suitable water resistant sealing material.
- l. All measures to be considered so that sprinkler bulb is cleaned & free from any blemishes.
- m. Sprinkler type (pendant/upright/sidewall) shall be conforming to requirements & relevant IS codes.

9.2. PIPES AND FITTINGS

a. Pipes

- i. Pipes less than 25mm dia shall not be used and shall be Black steel conforming to IS: 1239 (Heavy Class) upto 150mm.
- ii. Black Steel Pipe, Heavy Class conforming to IS: 3589 for size greater than 150mm.
- iii. Fittings for black steel pipes shall be malleable iron suitable for approved type cast iron fittings with tapered screwed threads.

b. Jointing

Joint for black steel pipes and fittings shall be metal to metal tapered thread or Groove joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. For Pipe size upto 50mm, Thread Joints are to be considered and for Pipe size above 50mm, Groove joints are to be considered.

Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with

M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

c. Pipe Protection

- i. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.
- ii. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous Hessian cloth and finished with one coat of hot bitumen paint.

d. Pipe Supports

All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structurals e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red and two coats of black enamel paint. Where inserts are not provided, the contractor shall provide anchor fasteners.

e. Orifice Flanges

Contractor shall provide orifice flanges fabricated from 6mm thick Brass plates on the branch lines feeding different zones/ floors so as allow required flow of water at 3.5 kg/ sq.mm pressure. The contractor shall furnish design for these orifice flanges.

f. Valves

Butterfly or Sluice valves of size 80mm and above shall be double-flanged cast iron conforming to IS: 780.

Check valve shall be of cast iron double flanged conforming to IS: 5312.

Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.

g. Air Valves

25mm dia screwed inlet cast iron single acting air valves on all high points in the system or as shown on drawings.

h. Drain Valves

50 m dia black steel pipe conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

9.3. INSTALLATION CONTROL VALVE: -

Installation control valves shall comprise of the following.

- a. One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut
- b. One automatic alarm valve, fitted with handle and cover.
- c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.
- d. One combined waste and testing valve including 5 mtr of tubing and fittings
- e. Alarm stop valve
- f. Strainer
- g. Drain plug
- h. Padlock & strap
- i. Wall box for installation of valve

9.4. Zonal Control Valve :-

Zonal Control Valve Assembly shall comprise of the following :

- a. Butterfly Valve
- b. Non-Return Valve

- c. Flow Switch
- d. Pressure Gauge
- e. Drain Valve
- f. Sight Glass
- g. Necessary MS piping

Flexible connection for sprinklers shall be braided type of various lengths as per site requirements & shall be UL listed & FM approved.

9.5 ANNUNCIATION SPRINKLER PANEL

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

- a. Panel should be made in a module of suitable nos. of zones e.g. each module will have audible and visual indications and will monitor the circuit conditions. With 24v DC battery.

A.C. Power Supply

Fault and Fire indication lamp

Alarm acknowledgment push buttons

- b. The circuits provided in the control panel for each zone shall indicate the following conditions:
 - i. Open Circuit in zone wiring
 - ii. Short Circuit in zone wiring
 - iii. Normal conditions
 - iv. Power failure
 - v. Low battery
- c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.
- d. Suitable protection may be provided against charging of the battery over and above the specified values.

9.6 BATTERY UNIT

- i. The system shall be powered by lead acid storage stationery complete with automatic dual rate charger boost and trick operating from 220 V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.

- ii. The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1 V 20 per cell, and operate at a trickle charge rate of 100 to 200 AH, when the battery terminal voltage exceeded about 2.25 per cell.
- iii. The power unit should have the following.
 - a. Voltmeter of suitable range
 - b. Ammeter of suitable range
 - c. Indicator lights for mains
 - d. Indicator lights for DC output
- iv. The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (If and isolated supply is provided a line earthing indicator should also be provided).
- v. The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.
- vi. The connection to the 230 V, 50 Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for earthing all non-current carrying metal parts of the sprinkler system, except those that are either doubly insulate or mounted at a height exceeding 2.2 meters.
- vii. The battery unit shall be housed in a steel cabinet at least 2 mm thick suitably painted with two coats of Post Office Red, Enamel necessary vent holes should be provided for proper ventilation.

10. PRESSURE GAUGES

Bourden type pressure gauges of SS material with Isolation Valves and Brass Stop Cock conforming to IS/ BS specifications of dial size 150 mm shall provided at the following locations.

- a. Just above alarm valve
- b. Just below alarm valve, on the installation stop valve
- c. One pressure gauge on delivery side of each pump
- d. One Pressure Gauge, part of Pressure vessel installation.
- e. On the Common Delivery Header of Fire Pumps, one on either side of the Non Return Valve.
- f. On the Wet Riser in every Fire Hose Cabinet Shaft.
- g. Any other location as per requirement.

11. INSTALLATION OF PIPING

A. Below ground piping: -Under ground piping should be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. All pipes shall be protected against corrosion with two coats of bituminous painting and wrapped with pypkote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.

B. Above Ground Piping:-

- a. All above ground piping shall be installed on suitable pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.
 - i. 25 mm - 50 mm dia. 1.5mtr.

- ii. 65mm – 100mm dia. 1.75 mtr.
 - iii. Above 100mm 2 mtr.
 - iv. Vertical Piping 2 mtr.
- b. Piping shall be screwed type up to 50 mm dia. Groove of joints will be allowed for pipes of 65mm mm of larger diameters.

12. TESTING & COMMISSIONING:-

4.1 PRESSURE TESTING OF PIPES

During laying of pipes, the same shall be subjected to 10 Kg/cm² hydraulic pressure for a period of 24 hrs , in sections. After completion of the work, all valves/fittings shall be installed in position and entire system shall be tested for 24 Hrs. at a pressure of 10 Kg/cm². The drop of pressure up to 0.5 Kg/cm² shall be accepted. The pressure Testing may be carried out by means of Electric Driven Pump or Manually operated Test Pump.

All leaks and defects in different joints, noticed during the testing and before commissioning shall satisfaction of engineer.

Testing of fittings/ equipments shall be carried out either at site or at works in the presence of a representative of the engineer. Test certificates shall also be furnished by the contractor.

The automatic operation of the system and alarms for the various functional requirements, as laid down in this specification, shall be satisfactory carried out in the presence of Engineer-in- charge.

4.2 INTERNAL HYDRANT/SPRINKLER & EXTERNAL HYDRANT SYSTEM:-

After laying and jointing, the entire piping shall be tested to hydrostatic test pressure. The pipes/sprinkler heads shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a period of not less than 24 hours and then tested under pressure. The test pressure shall be 12 kg/cm². The test pressure shall be applied by means of manually operated test pump or by a power-driven test pump to be provided by the contractor. The Lines shall be flushed before completion of building work so that any foreign matter which might have entered the system is taken out. The Jockey Pump should be operated and Valves must be open at different locations.

After completion of work, all valves/ fittings shall be installed in position & entire system shall be tested for 24 hours at a pressure of 10 kg/sqcm. The drop of pressure upto 0.5 kg/sqcm shall be accepted.

After completion, all operation checks (operation scheme of pumps & pressure swtich settings) needs to be carried out for automatic operation of the system. landing valves may be opened at different locations repeated couple of times to ensure trouble free operation.

Flow Test -The design flow of pumps shall be checked. The pump shall be operated after opening a number of Landing Valves at different locations. Design pressure is to be maintained in the Pump House. Water discharge is to be measured by drop in level in UG Tank for a certain period. All pumps shall be tested one by one. The flow rate shall not be less than as specified while maintaining the design pressure in pump house.

4.3 FINAL TESTING

After completion, all operation checks shall be carried for automatic operation of system including flow test. The exercise shall be repeated couple of time to ensure trouble free operation.

Commissioning: - before commissioning , entire system be flushed properly. As soon as the work is completed the system shall be commissioned and made available for use. If required, isolate the system of under construction portion of the buildings.

For automatic operation sprinkler system by using inspection testing valve. In this case annunciation panel of that particular zone and mechanical gong valve should work.

Overhead Tanks shall be so designed so that the Pipe Inlet & Outlet Spout of Tank and the opening lid is not at the same level so as to ensure smooth filling of Tanks and subsequent overflow.

All other testing & commissioning methods to be adopted & performed as per relevant IS Codes/CPWD Specifications & NBC 2016 norms.

5 PAINTING

Painting of the entire wet riser piping & sprinkler piping over the ground shall be done with 1 coat of anticorrosive primer and 2 or more coats of approved paint till the satisfaction of engineer-in-charge ensuring that one coat of paint is done after final painting of the pump house & buildings. The color shall be post office stove enameled red with shade No. 536 of IS: 5, Paint shall also conform to IS:2932.

The pumps/ engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

TECHNICAL SPECIFICATIONS

HVAC WORKS

GENERAL SCOPE OF WORK: ALL HVAC WORKS IS TO BE CARRIED OUT AS PER DRAWINGS AND TECHNICAL SPECIFICATION.

ITEM GIVEN IN THE DRAWINGS AND SPECIFICATION ARE TENTATIVE AND IF ANY ITEMS ARE MISSED BUT REQUIRED FOR FUNCTIONALLTY IS TO BE EXECUTED BY AGENCY WITHOUT ANY EXTRA PAYMENT.

1. Definitions

- 1.1 Employer:** This refers to the entity or authority responsible for issuing this tender and subsequently entering into a contractual agreement for the execution of the Heating, Ventilation, and Air Conditioning (HVAC) system works under an Engineering, Procurement, and Construction (EPC) framework.
- 1.2 Contractor:** This denotes the successful bidder who will be formally appointed to undertake the comprehensive engineering, procurement, construction, testing, and commissioning of the HVAC system as stipulated within the tender documents.
- 1.3 Engineer-in-Charge:** This refers to the duly authorized representative of the Employer who will be responsible for the oversight, review, and approval of all aspects of the Works.
- 1.4 Works:** This encompasses the entire scope of activities required for the project, including the engineering, procurement, construction, testing, commissioning, and ultimate handover of the HVAC system, along with all related controls and system integration, as specifically defined in the tender documents.
- 1.5 Contract:** This signifies the legally binding agreement established between the Employer and the Contractor, which includes, but is not limited to, the General Conditions of Contract (GCC), technical specifications, relevant drawings, performance requirements, and all other documents forming part of this tender.

2. Scope of Work

- 2.1** The Contractor shall undertake the comprehensive design, procurement, installation, testing, and commissioning of the Heating, Ventilation, and Air Conditioning (HVAC) system for the hospital project, operating under an Engineering, Procurement, and Construction (EPC) framework. The Contractor is accountable for delivering a fully functional system that satisfies all specified performance criteria outlined in the tender documents.
- 2.2** The scope of work encompasses, but is not limited to, the following key deliverables:

- Detailed engineering and design of the complete HVAC system, including but not limited to chillers, air handling units (AHUs), ductwork, piping, insulation, and associated control systems.
 - Complete procurement and supply of all required HVAC equipment, materials, and components in accordance with the project specifications.
 - Thorough installation, comprehensive testing, and successful commissioning of the entire HVAC system.
 - Effective integration of the HVAC system with the Building Management System (BMS) and other interfacing systems, such as the fire alarm system, as mandated by project requirements.
 - Provision of detailed design calculations, shop drawings, comprehensive test reports, operation and maintenance manuals, and accurate as-built drawings.
- 2.3 All aspects of the executed works shall be in strict compliance with the National Building Code (NBC) 2016, the Energy Conservation Building Code (ECBC), applicable ASHRAE standards, and all other relevant Indian Standards (IS) pertaining to HVAC systems.

3. Contractor's Responsibilities

3.1 The Contractor is obligated to undertake the following responsibilities:

- To develop and implement the HVAC system design in strict adherence to the Employer's stipulated requirements, approved drawings, and the directives issued by the Engineer-in- Charge.
- To procure and furnish all necessary labor, materials, equipment, and tools required for the complete and satisfactory execution of the Works.
- To ensure meticulous compliance with all relevant safety regulations, quality assurance protocols, energy efficiency mandates, and environmental protection standards.
- To submit detailed HVAC design calculations, including but not limited to cooling load, airflow, and duct sizing analyses, along with comprehensive equipment submittals and shop drawings, for the Engineer-in-Charge's review and formal approval prior to any procurement or installation activities.

3.2 The Contractor shall be held responsible for ensuring that the completed HVAC system achieves the following performance benchmarks:

- Provision of sufficient cooling and heating capacity tailored to the specific zoning requirements of the hospital.
- Operation with optimal energy efficiency, strictly adhering to the guidelines set forth in the ECBC.
- Maintenance of indoor air quality (IAQ) standards suitable for a healthcare environment, including the implementation of HEPA filtration in specified zones as detailed in the tender documents.

4. Employer's Responsibilities

4.1 The Employer is responsible for the following:

- Providing the Contractor with unrestricted access to the designated project site and securing all necessary governmental and regulatory approvals required for the Contractor to commence the execution of the Works.

- Effecting payments to the Contractor in accordance with the mutually agreed-upon payment schedule, contingent upon the Engineer-in-Charge's certification of completed work stages.
- Furnishing the Contractor with comprehensive performance requirements, pertinent site- specific data, and any necessary clarifications that may reasonably be required to ensure the effective and efficient progression of the EPC process.

5. Contract Price and Payment

5.1 The Contract Price shall be a fixed lump-sum amount as detailed within the accepted EPC proposal. This price, unless explicitly stated to the contrary, shall be deemed to be inclusive of all applicable taxes, duties, and levies, and shall constitute the complete compensation for the design, procurement, and construction of the HVAC system.

5.2 Payments shall be disbursed in the following sequential stages:

- An advance payment equivalent to ten percent (10%) of the total Contract Price shall be released upon the Contractor's submission of a valid and conforming bank guarantee, if such a guarantee is stipulated.
- Progressive payments, totaling sixty percent (60%) of the Contract Price, shall be made against the satisfactory completion of pre-defined milestones pertaining to design approval, material procurement, and installation, subject to formal certification by the Engineer-in-Charge.
- The final tranche, representing thirty percent (30%) of the Contract Price, shall be released upon the successful completion of all testing procedures, the satisfactory commissioning of the HVAC system, and its formal handover to the Employer.

5.3 All invoices submitted by the Contractor for payment shall be accompanied by the requisite supporting documentation, including but not limited to design approvals, material delivery receipts, and comprehensive test reports, and shall be subject to the formal approval of the Engineer-in-Charge prior to payment processing.

6. Time for Completion

6.1 The Contractor is obligated to achieve completion of all Works within a period of -----

- commencing from the official date of issuance of the Notice to Proceed.

6.2 In the event of any delay in the completion of the Works that is directly attributable to the Contractor's actions or omissions, liquidated damages shall be levied at a rate of one-half of one percent (0.5%) of the total Contract Price for each week of delay, subject to a maximum aggregate penalty not exceeding ten percent (10%) of the Contract Price.

6.3 Extensions to the agreed-upon Time for Completion may be considered and granted by the Engineer- in- Charge solely for delays demonstrably caused by events of Force Majeure or by specific issues directly originating from the Employer. To be eligible for such an extension, the Contractor must formally submit a detailed claim to the Engineer-in-Charge within fourteen (14) calendar days of the initial occurrence of the event necessitating the extension.

7. Quality Assurance and Testing

7.1 All HVAC equipment and materials utilized in the execution of the Works shall strictly adhere to the approved technical specifications and the stipulated performance standards. The

Contractor shall provide verifiable test certificates, such as AHRI certification for chillers and AMCA certification for fans, for all critical system components as evidence of compliance.

- 7.2** The Contractor shall undertake a comprehensive suite of performance tests on the installed HVAC system to verify its operational capabilities. These tests shall encompass, but not be limited to, the measurement of airflow rates, the validation of temperature control accuracy, and the assessment of energy consumption efficiency, all conducted in strict accordance with the relevant ASHRAE standards and applicable Indian Standards (IS).
- 7.3** Comprehensive records of all test results, including detailed system balancing reports and complete commissioning data, shall be meticulously documented and formally submitted to the Engineer-in-Charge for thorough review and subsequent approval prior to the final handover of the completed HVAC system to the Employer.

8. Safety and Compliance

- 8.1** The Contractor is obligated to ensure strict adherence to all pertinent safety regulations and to implement a robust safety management system. This includes, but is not limited to, the mandatory provision and consistent use of appropriate Personal Protective Equipment (PPE) by all site personnel and the rigorous application of safe installation methodologies for all HVAC equipment.
- 8.2** The HVAC system, upon completion, must meet and maintain all relevant safety and hygiene standards specific to healthcare facilities. This necessitates the incorporation of effective infection control measures, such as the establishment and maintenance of specified pressure differentials and the implementation of required filtration systems, as detailed in the tender documents.

9. Defects Liability Period

- 9.1** The Contractor warrants that the HVAC system shall be free from defects in materials and workmanship for a period of twelve (12) months from the date of successful commissioning and formal handover. During this Defects Liability Period, the Contractor shall promptly rectify any such defects that may arise, at no additional cost whatsoever to the Employer.
- 9.2** In the event that the Contractor fails to remedy any notified defects within a commercially reasonable period, the Employer shall be entitled to engage an independent third-party contractor to perform the necessary remedial works, and all costs incurred thereof shall be directly recoverable from the Contractor.

10. Termination

- 10.1** The Employer reserves the unequivocal right to terminate this Contract upon the occurrence of, but not limited to, the following events:
- The Contractor's failure to achieve completion of the Works within the agreed-upon Time for Completion, as stipulated herein.
 - Material non-compliance with the approved design specifications or a persistent failure to adhere to the legitimate instructions issued by the Engineer-in-Charge.
 - The initiation of bankruptcy proceedings or a declaration of insolvency by the Contractor.
- 10.2** Upon the issuance of a formal notice of termination, the Contractor shall immediately cease all work and vacate the project site. Following such termination, the Employer shall have

the full authority to take possession of the site and undertake the completion of the remaining Works, entirely at the risk and expense of the defaulting Contractor.

ADDITIONAL CONDITIONS

EPC Tender for HVAC System

1. Applicable Specifications

The HVAC works shall be executed in accordance with the National Building Code (NBC) 2016, Energy Conservation Building Code (ECBC), ASHRAE standards, and relevant Indian Standards (IS), as amended up to date, and as per the directions of the Engineer-in- Charge. These additional conditions shall be read in conjunction with the tender specifications, and in case of any discrepancies, the specifications provided in the tender documents shall take precedence.

2. Storage Responsibilities

The Contractor shall be solely responsible for the safe and secure storage of all HVAC equipment, materials, and components required for the execution of the works at the site.

3. Power and Water Supply

The Contractor shall arrange and bear the cost of power and water supply necessary for the installation, testing, and commissioning of the HVAC system during the execution of the works.

4. Material Approval

All HVAC equipment and materials intended for use in the works shall be submitted for approval by the Engineer-in-Charge prior to installation. The Engineer-in-Charge reserves the right to direct the Contractor to remove and replace any material or equipment deemed non-compliant with the tender specifications at no additional cost to the Employer.

5. Proof of Material Authenticity

The Contractor shall maintain and provide copies of invoices, test certificates, delivery challans, and other relevant documents to verify the authenticity and quality of procured HVAC materials and equipment. The responsibility for sourcing genuine and specified materials rests entirely with the Contractor.

6. Inspection and Testing

No overseas inspection of HVAC equipment shall be permitted. Any requirement for such inspection shall be deemed waived, and the Contractor shall submit comprehensive test reports and certifications from recognized testing authorities prior to the dispatch of equipment to the site.

7. Guarantee and Warranty

All HVAC equipment and components shall be guaranteed for a period of 36 months from the date of successful commissioning and handover. Any defects identified during this period shall be rectified or replaced by the Contractor at no additional cost, as directed by the Engineer-in-Charge.

8. System Commissioning

The Contractor shall supply and install all necessary items, components, and accessories required to fully commission the HVAC system, even if not explicitly listed in the tender documents, at no extra cost to the Employer.

9. Applicable Standards and Updates

The HVAC works shall comply with the following standards, including all revisions, amendments, or corrections up to 31 March 2025:

- National Building Code (NBC) 2016.
- Energy Conservation Building Code (ECBC).
- ASHRAE standards relevant to HVAC systems.
- CPWD's General Specification and guide book for Mechanical services.
- Other codes and standards specified elsewhere in the tender documents.

General

These General Conditions of Contract (GCC) shall be read in conjunction with all other documents forming part of the contract, including technical specifications, drawings, and schedules. In the event of any conflict or variance, the provisions of these GCC shall take precedence over other contract documents unless explicitly stated otherwise.

The materials, design, and workmanship for the HVAC system shall comply with the specifications outlined in this document and the referenced codes/standards. Where the technical specifications impose requirements beyond those in the standard codes, the additional requirements shall also be met. In the absence of specific standards or specifications for any aspect of the HVAC works, the instructions of the Engineer-in-Charge shall be binding on the Contractor.

All HVAC installations shall be of high quality, fully functional, and complete, including all necessary components and accessories, whether explicitly specified or not, to the satisfaction of the Engineer-in-Charge.

Scope of Work

The scope of work encompasses the planning, designing, supply, installation, testing, and commissioning of the HVAC system required for the hospital & medical college project, in accordance with the National Building Code (NBC) 2016, Energy Conservation Building Code (ECBC), ASHRAE standards, and relevant Indian Standards (IS).

The Contractor shall provide a fully operational HVAC system, including but not limited to:

- Design and engineering of HVAC components (e.g., chillers, air handling units, ducting, piping, insulation, and controls).
- Supply and installation of all HVAC equipment and materials.
- Integration with building management systems (BMS) and other interfacing systems (e.g., fire alarm) as specified.
- Testing and commissioning to ensure performance as per design intent.

If any additional HVAC-related services or components are required to make the building functional and habitable but are not explicitly listed in the scope, the Contractor shall either raise such requirements during the pre-bid meeting or assume responsibility for providing them within the quoted cost. No additional payment shall be made for such items.

The Contractor shall prepare detailed HVAC layout plans, design calculations, and shop drawings, and obtain approvals from relevant local authorities or bodies prior to commencement of work. Any modifications required by local authorities during execution or post-completion shall be carried out by the Contractor at no extra cost. Obtaining final approvals, NOCs, or clearances from local bodies after execution is the Contractor's responsibility, and no additional payment shall be made for any associated modifications or extra work.

Statutory and Utility Responsibilities

All statutory fees or charges required for obtaining approvals or clearances from local bodies or regulatory authorities related to the HVAC system shall be borne by the Contractor.

The Contractor shall arrange and bear the cost of power supply required for construction, installation, testing, and commissioning of the HVAC system. Water required for testing HVAC equipment shall also be provided by the Contractor at no additional cost to the Employer.

Key Updates and Rephrasing:

1. HVAC Focus: Removed references to unrelated MEP services (e.g., electrical installations, fire alarm, CCTV, lifts) and limited the scope to HVAC systems and their integration.
2. EPC Alignment: Emphasized the Contractor's responsibility for end-to-end delivery (planning, design, supply, installation, and commissioning) under the EPC framework.
3. Clarity and Precision: Rephrased ambiguous sections (e.g., "fully operational including all necessary items" instead of "complete and dully operational") and streamlined language for contractual clarity.
4. Standards: Replaced broad electrical standards (e.g., CPWD, IE Rules) with HVAC-specific standards (e.g., ASHRAE, ECBC) relevant to the scope.
5. Cost Inclusion: Reinforced that additional works or modifications required for functionality or approvals are included in the quoted cost, aligning with EPC principles.

MECHANICAL (HVAC SERVICES) : STANDARDS OF CODES

This chapter covers the specifications for supply, installation, testing and commissioning with procurement of HVAC service equipment and accessories.

Weather-Conditions: The site details are as under for estimating Heat load and HVAC system design.

Site location. : BALLIA , UTTAR PRADESH

Latitude. : 25.44 °N

Longitude : 84.11 ° E

Altitude. : 123 meters above sea level

The Air conditioning System shall be designed with following design parameters.

1.1. Outside Conditions

The ambient temperature is taken from ISHRAE and the location is BALLIA.

1.2. Inside Conditions.

Central air conditioning system shall be provided to maintain the specified inside design conditions during summer, monsoon and winter for the proposed buildings.

Classification of various spaces in terms of temperature, humidity control, Occupancy, air filtration, air changes & pressurization requirements of various departments shall be as per ASHRAE Standard 170.

1.3. Water Chilling Machine

Temperature of chilled water entering chiller	:	12.2° C (54° F)
Temperature of chilled water leaving chiller	:	6.7° C (44° F)
Fouling factor for chiller in FPS unit	:	0.0005
Temperature of condenser water entering condenser	:	30° C (86° F)
Temperature of condenser water leaving condenser	:	35.6° C (96° F)
Fouling factor for condenser in FPS unit	:	0.001
Refrigerant	:	R134A

1.4. Air Handling Unit

Maximum face velocity across prefilters	:	2.5 m / Sec (500 fpm)
Maximum face velocity across cooling coils	:	2.5 m / Sec (500 fpm)
Maximum fan outlet velocity	:	9 m / Sec (1800 fpm)
Maximum fan speed		
Fan above 300 mm dia	:	900 RPM
Fans upto and including 300 mm dia	:	1440 RPM
Maximum fan motor speed	:	1440 RPM

1.5. Chilled & Condenser Pipe Sizing

Maximum velocity	:	1.2 m/sec for piping 50 mm & under
	:	2.5 m / sec for piping over 50 MM dia
Maximum friction	:	15 k Pa per 30 m run
		(5 ft of WG per 100 ft run)

1.6. Filtration:

Re-circulated air (mixed fresh & return air) at air handling units, fan coil units and ventilation units. : Washable synthetic type air filters having 90% efficiency down to 10 microns.as pre-filter with MERV 8 Minimum requirement. Or specified through technical specification.

Fine Filter shall be recommended for O.T.'s and ICU's Area units. :

The MERV 14 filter effectively captures particles, with a high efficiency of 75% or greater for particles between 0.3 and 1.0 microns in size, and 90% or greater for particles between 1.0 and 3.0 microns.

1.7. Duct Design

Maximum flow velocity in ducts for Air

Conditioning	:	7.5 m / sec (1500 fpm)
--------------	---	------------------------

Maximum flow velocity in ducts for Ventilation : 7.5 m / sec – 12,7 m / sec (1800 – 2500 fpm)

Maximum friction : 0.65 Pa / meter run (0.08 inch WG/100 ft run)

1.8. Ventilation Fan

Maximum fan outlet velocity for fans upto 450 mm dia : 9 m / sec

Maximum fan outlet velocity for fans above 450 mm dia : 12 m / sec

Maximum fan speed for fans upto 450 mm dia : 1440 RPM

Maximum fan speed for fans above 450 mm dia : 1000 RPM

2.0 Central Air Conditioning System

A central air conditioning system has been designed to provide year-round thermal environmental control for proposed Hospital & medical college. Air conditioning shall be provided by a central variable flow chilled water recirculation system for maximum energy conservation, limited to certain Critical areas, General ward is not air conditioned.

The central air conditioning system shall consist of WATER COOLED Screw/ Rotary CHILLERS WITH VFD (WITH HARMONIC FILTER): Primary chilled water pump with variable frequency inverters, condensing water pumps, FRP induced draft cooling towers, air handling units and fan coil units, chilled and condensing water piping, air distribution system, insulation, electrical panels, wiring, control wiring and earthing.

Chilling units shall be housed in the air conditioning plant room proposed to be just adjacent building. Chilled water from chilling units shall be pumped through various insulated chilled water pipes, dedicated for each particular zone.

Chilled system shall be designed for reverse return flow for self-balancing of water flows. In addition, balancing valves shall be installed in major branch pipes and at each AHU for fine tuning at the time of final balancing of the chilled/hot water system. All pipes within plant room shall be supported off the floor to avoid transmission of vibration and occupied floors below. Also, to take care of expansion/ contraction in hydronic circuit, pressurized expansion tank along with air separator shall be provided in the plant room.

Cooling towers for air conditioning system shall be selected for minimum drift losses and minimum noise and shall be installed on the building terrace. These shall be FRP construction induced draft type. Cooling tower motors shall be provided with high efficiency feature. to conserve energy during periods of low ambient wet bulb temperature as cooling towers shall operate round the clock. Operating motor should have the high efficiency feature, to save energy by operating the cooling tower.

All mechanical equipment such as chilling units, pumps, AHU's and larger ventilation fans shall be provided with energy efficient motors in order to attain energy savings, since all this equipment shall operate for extended periods of time.

3.0 Zoning for Chilled Water Distribution System

Central air conditioning shall be provided by a central variable flow chilled water system for maximum energy conservation. In the present design following zones have been considered:

Critical Area : O.T.'s and ICU's

Non Critical Area : Special Care unit, BOH and office area

Each zone shall have its own set of chilled water piping arrangement including a standby accessories, to achieve variable water flow to meet varying load conditions. Water flow in load circuit shall be varied but the same through entire chilled water circuit. Each chiller shall have its own dedicated primary chilled water and condensing water pump.

By monitoring the pressure differential between chilled water supply and return header, the speed of Variable speed chilled water pump shall be automatically varied, thus conserving pump brake horsepower. The main advantage of this system is that the circulation of chilled water through the entire Hospital is avoided, and chilled water is supplied according to demand in each zone, thus achieving energy conservation and flexibility in operation.

Public Areas

Double skin air handling unit, consisting of centrifugal fan, cooling coil and filter section shall be provided for each Public Area. All Public area AHUs shall be provided with 2 pipe system comprising of multiple rows deep cooling coils for maximum dehumidification, along with mixing boxes wherever applicable, to connect return air & fresh air ducts. Ducted return air shall be provided to eliminate intermixing with air from other conditioned areas, and from non- air-conditioned areas. AHU's shall be located in the designated AHU rooms duly agreed with Architect.

All AHUs shall be provided with proportionate modulating two-way (PIBCV) valves in CHW/ HW coils. Depending upon the temperature setting, a sensor through BAS shall activate the valve proportionately to allow required flow of water through coil, depending upon the indoor demand for cooling / heating.

Smoke / Fire dampers shall be provided within supply air ducts and return air ducts at AHU room wall crossings, Smoke detectors shall be provided in return air duct to the AHU's and shall shut down the AHU's in case of fire in the particular area. Volume control dampers shall be provided at all branch connections for air flow adjustments.

Public toilets shall be provided with independent fan coil unit for air conditioning of toilet. The exhaust ducting for these toilets shall be designed to pick up points above W/C area and urinals; makeup air shall be brought from adjoining areas through louvered doors and exhausted from the toilets.

Winter Heating

Since winter temperature goes as low as 6 deg C, we propose to provide winter heating for air conditioned portion of public areas Like ICU's and offices with changeover. This system shall only provide cooling or heating provision at a time.

Mechanical Ventilation for Pump Room and STP Room

Pump Room and STP room shall be provided with mechanical ventilation system. The system shall consist of Axial fan, fresh air grille with filters, air distribution system with grilles, electrical panel, power cabling, control wiring and earthing. Fresh air shall be drawn from outside and supplied to

mechanically ventilated areas by means of grilles. Similar equipment shall be provided for exhausting equivalent amount of air.

Lift & Staircase Pressurization

All internal fire escape staircases connecting from basement to ground level shall be provided with Pressurization system, consisting of supply air fans installed at ground level. This fan shall be connected to supply air ducts installed in vertical risers for supplying air at each staircase landing, for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Supply air fans serving stairwell shall be provided with non-return damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be interlocked with fan motor and shall open upon getting signal from the smoke sensor. Lift wells and Lift lobbies shall also be provided with pressurization by supplying the air through supply air fans installed on roof top.

Server Room, EPABX Room & UPS Room

Server Room, EPABX Room and UPS Room shall be provided with dedicated fan coil units, requiring 24 hours air conditioning throughout the year. Split units shall also be provided, in addition to fan coil units, to provide redundancy.

TECHNICAL SPECIFICATIONS

SECTION: I WATER COOLED SCREW CHILLING MACHINE

1. SCOPE

The scope shall include but not limited to the following:

- a. Screw liquid chillers with associated motors, automatic star-delta, soft starter, VFD and accessories.
- b. All associated items herein to be supplied, delivered and installed.
- c. Manufacture, supply & assembly of chiller components including connection of coolers, condensers, motors, compressors, purge system for low pressure machine and all associated items.
- d. Manufacturer's factory representative's services, including coordination, start-up, testing and commissioning supervision.
- e. Testing at factory and project site, training and providing necessary documentation and tools for operation.
- f. Performance test run at site.

2. QUALITY ASSURANCE PROGRAM

- a. Water chilling machine shall be rated in accordance with Parameters indicated in Schedule of Quantities. Vessels shall be designed, constructed, tested, stamped and complete with devices in accordance with ASME Code, ANSI/ASHRAE 15-1989 Safety Code.

- b. The water chilling machine shall be the product manufactured / assembled of single service/ works.
- c. The water chilling machine shall be designed/manufactured and tested in accordance with the applicable portions of the latest revisions of the following Standards and Codes.

ARI 550 / 590 -2003 - Air Conditioning and Refrigeration Institute Performance rating of water chilling packages using the vapor compression cycle.

ARI 575 - Air Conditioning and Refrigeration Institute Standard Method of Measuring Machinery Sound Within Equipment Rooms (Base of all data presented or field testing of equipment with relation to sound requirements).

ASME CODE - American Society of Mechanical Engineers Code for Unfired Pressure Vessels - Section VIII (Design, construction, testing and certification of pressure vessels).

ANSI-B9.1- American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.)

ANSI-B31.5 - American National Standards Institute. Code for Refrigerant Piping.

ISO R281 - Rolling Bearings – Dynamic Load Ratings and Rating for Life.

3. CAPACITY

The refrigeration capacity of water chilling machine shall be as shown on Drawings and indicated in Schedule of Quantities.

4. COMPRESSOR

Compressor shall be open / semi-hermetic direct / gear drive with integrated lubrication system through compressor pressure differential / oil pump. Compressor casing shall be constructed from a high strength iron casting, having reinforced double wall construction to provide a rigid structure and minimize the transmission of noise. Multiple pressure lubricated rolling element bearing shall be used to absorb axial thrust as well as radial load. Minimum 80 mesh reinforced SS strainer shall be provided at the suction of compressor for protection. Rotors shall be precision made from ductile iron.

Oil separator shall be provided at discharge side of compressor. Oil separator can be an integral part of compressor or alternatively, it could be separate pressure vessel. Oil separator shall contain impingement plate, removable SS oil strainer and electrical oil heater. Drained oil from oil separator shall be piped back to the compressor.

Stepless capacity control to exactly match system load shall be provided. A microprocessor-based controller shall modulate slide valve in response to chilled water outlet temp. Controller shall be programmed for PID&T logic. Compressor shall be able to unload up to 10% of load with stable running.

5. MICRO COMPUTER CONTROL CENTRE

Each unit shall be furnished with factory mounted, wired and tested microcomputer control centre in a locked enclosure. The control center shall include a 40-character alphanumeric display showing all system parameters in English language with numeric data in English (FPS) units.

Digital programming of essential set points through a colour coded, tactile-feel keypad shall include: entering and leaving chilled water temperature and condensing water temperature; percent loading; pull down demand limiting; seven-day time clock for starting and stopping chiller (complete with local holiday schedule); and remote reset temperature range.

All safety and cycling shutdowns shall be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include: high oil pressure; high compressor discharge temperature: low evaporator pressure: motor controller fault: and sensor malfunction. Cycling shutdowns shall include: low water temperature; low oil temperature: chiller/condenser water flow interruption; power fault; internal time clock; and entire cycle.

System operating information shall include: return/leaving chilled water temperatures; return/leaving condenser water temperatures; evaporator /condenser refrigerant pressure; differential oil pressure; percent motor current; evaporator/condenser saturation temperatures; operating hours (Hours Run) and number of compressor starts.

Security access shall be provided to prevent unauthorized change of set points to allow local or remote control of the chiller, and to allow manual operation of the pre-rotation vanes and oil pump. The chiller shall be provided with an RS-232 port to output all system operating data, shutdown/cycling messages and a record of the last four cycling or safety shutdowns to a remote printer or Building Automation System (BAS). The control center shall be programmable to provide data logs to the BAS/printer at a set time interval.

Control center shall be able to interface with the Building Automation System (BAS) to provide remote chiller start/stop reset of chilled water temperature reset of current limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety.

6 INTERFACE WITH BAS

All necessary hardware / software to integrate the chiller panel to BAS system shall be provided free of cost by chiller manufacturer / supplier. Control panel should be with open protocol like Modbus RTU/ Bacnet/ Lon work to integrate with BAS.

For the integration of Microprocessor Panel of the chilling machine with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor. It shall be responsibility of HVAC Contractor / Manufacturer to provide following to BAS Contractor to prepare the interface.

- a. Software Protocol of Chiller Microprocessor panel.
- b. Hardware Protocol of Chiller Microprocessor panel.
- c. Communication structure relating to collection of message / event information.
- d. Description of the formatted packets / blocks of data which construct controller commands / responses.
- e. Written permission to BAS contractor to develop the interface without any financial implication.

7 MOTOR

Motor shall be energy efficient and suitable for $415 \pm 10\%$ volts, 3 phase, 50 cycles AC supply with VFD. Hermetic/semi hermetic motors shall be suction gas cooled, two pole, squirrel cage

induction type. In case of open type compressor, motors shall be screen protected drip proof (SPDP) squirrel cage induction type. Motor shall be designed and guaranteed for continuous operation. Insulation of motors shall be 'B' class. Temperature rise of motor under rated service conditions shall not exceed 80 Deg C (by resistance method of measurement) over an ambient of 40 Deg C. the motor shall be provided with a combination of ball or roller bearing. Starting current shall not exceed 2 times of full load current at rated voltage and frequency. Terminal box shall be of sturdy construction and shall provide enough space for connecting PVC - insulated aluminium conductor cable. All terminal boxes shall have terminal suitable for cable glands of the specified cables.

The efficiency and power factor shall be not less than the following values, at rated voltage and frequency and at the specified loads.

Load	Efficiency	Power Factor
Full Load	96%	0.95
3/4	96%	0.92
1/2	96%	0.88

The total efficiency shall include losses of the auxiliaries such as independent excitation, motor-driven fans, lube-oil pumps etc. Over voltage surge protection shall be provided to protect motor.

8 STARTERS

Shall be automatic star delta starter or soft starter to ensure starting current at rated voltage & frequency does not exceed 2 times full load current. All components of starter shall be housed in dust proof enclosure and suitable for 415 ± 10% volts 50 cycles 3 phase AC power supply.

9 EVAPORATOR AND CONDENSER

- a. **Shells and Water Boxes:** Shells of evaporator and condenser shall be made from rolled carbon steel plate with fusion welded seams. Water boxes shall be of cast iron or welded steel with stub-out water connections provided to permit access for tube cleaning and replacement. Manufacturer's design for water boxes shall be suitable for 150 psig working pressure. These shall be factory hydraulically tested at 225 psig. The tubes finned from outside having spiral ridges from inside, roller expanded into the tube sheets providing a leak proof seal. They shall copper type shall have intermediate steel supports at intervals as recommended by the manufacturer.
- b. **Chiller (Evaporator):** Chiller shall be provided with eliminator to prevent liquid carry over to the compressor. It shall also be provided with liquid level sightglass and a relief device (of the bursting type) to prevent excess pressure in the vessel. The chiller shall be horizontal, shell and tube type, provided with the connections and accessories, but not limited to the following:
 - i. Microprocessor panel having built in software / cards / program ready for connectivity to BAS.
 - ii. Refrigerant inlet and outlet pressure gages.

- iii. Water inlet and outlet connections with victaulic coupling
- iv. Factory fitted / provided flow switch at outlet.
- v. Drain and vent connections with stop valves.
- vi. Pressure gauges on water inlet and outlet connections.
- vii. De scaling valves.

Chiller shall be factory insulated minimum with 25 mm thick rubber based closed cell polyurethane foam or as recommended by manufacturer for tropical areas. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it.

- c. **Water cooled Condenser:** The condenser shall be of same construction as for chiller above but shall be without insulation. It shall be complete with the accessories as mentioned above and as defined in the schedule of quantities. Shell side volume of the condenser shall be suitable to contain complete refrigerant charge in case of pump-down. In case of chiller with de- superheater, main condenser shall be sized for 100% heat rejection duty.

10 ECONOMISER SUBCOOLER

Each chiller shall be provided with shell and tube / PHE / flash chamber type economizer. Condensed liquid in condenser shall be taped off and shall be expanded at intermediate pressure with expansion valve. Value of intermediate pressure (P_i) shall be as follows.

$$P_i = (P_c P_e)^{0.5}$$

Where P_c = saturated condensing pressure (abs) P_e = Saturated Evaporation Pressure (abs)

The liquid expanded to intermediate pressure shall be used to absorb enthalpy from remaining liquid refrigerant in order to provide sub-cooling. Vapor refrigerants due to above heat transfer shall again be admitted to compressor at intermediate pressure port.

11 INSTALLATION

Water chilling machine shall be installed on a cement concrete platform as recommended by the manufacturer and shall be adequately isolated as per manufacturer's recommendations against transmission of vibrations to the building structure.

12 PAINTING

Water chilling machine shall be factory finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

13 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level Capacity ratings, and power consumption with operating points clearly indicated along with the after. These parameters shall be verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurements of chilled water flowrate and temperature at in and out of the chilling unit.

Power consumption shall be computed from measurements of incoming voltage & input current to the chilling machine. Sound Pressure level for Water cooled chillers shall not exceed 75dBA at 1m distance from chiller.

14 WITNESS TESTS

Water Chilling Machines at works, before shipment, shall be inspected to witness performance test by Consultant and Owner's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. Performance test shall be carried out as per procedure laid down by ARI / EUROVENT and as per specified parameters, at 100%, 75%, 50% & 25% loading. Temperature of leaving chilled water shall be kept constant during part load testing.

Fouling factor simulation for condenser and evaporator shall be done as per ARI-550/590-2003. Incremental temperature difference (to be calculated based on Normative appendix-C of ARI-550/590-2003) on account of designed fouling factors shall be added in condenser water entering temperature and shall be subtracted for leaving chilled water temperature. Chiller shall produce design refrigeration capacity and guaranteed power consumption at these corrected set of entering condenser water and leaving chilled water temperature. Outside tube surface area (for condenser and flooded evaporators) and inside tube surface area (for DX- Evaporator), being inputs for ARI mathematical model for fouling, shall be submitted along with the offer.

All expenses inclusive of business class airfare, boarding lodging etc. relating to the witness test will be borne by the vendor / contractor.

VARIABLE SPEED PUMPING SYSTEM

1 SCOPE OF WORK

This section includes the supply, erection, testing and commissioning of variable speed pumping package consisting of following:

- a. Pump Control Panel
- b. Adjustable Frequency Drive
- c. Differential pressure transmitters / switches.
- d. Logic Programming for sequence of Operation
- e. Power wiring and control wiring shall be carried out by installation contractor as included in schedule of quantities and as shown on the field connection drawings and wiring diagrams supplied with the pumping package by the manufacturer / his representative.

2 REFERENCE S

- a. NEC - National Electrical Code
- b. UL - Underwriters Laboratories Inc.
- c. NEMA - National Electrical Manufacturers Association
- d. ANSI - American National Standards Institute
- e. ETL - Electrical Testing Laboratories
- f. CSA - Canadian Standards Association
- g. ISO- International Standards Organization

- h. IEC- International Electrochemical Commission

3 TECHNICAL SUBMITTALS

It shall include the following and shall be project specific & not general.

- a. Sequence of operation
- b. Shop drawing indicating dimensions, required clearances and location and size of each field connection.
- c. Power and control wiring diagrams.
- d. System profile analysis including variable speed pump curves and system curve. The submittal shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.
- e. System summary sheet.
- f. Pump data sheets.

4 QUALITY ASSURANCE

- a. The pumping package shall be assembled in the presence of pump manufacturer / his representative. The "Unit Responsibility" for the complete pumping package shall be of the manufacturer / supplier. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer/supplier.
- b. The manufacturer shall have a minimum of 10 years' experience in the design and construction of variable speed pumping systems.
- c. The local supplier of Chilled Water Variable Speed Pumping System (VSPS) shall have relevant expertise in all aspects of design, application engineering, installation, programming, interfacing, commissioning and after sales service. Supplier must have commissioned minimum 30 sets of chilled water VSPS in India.
- d. All functions of the variable speed pump control system shall be factory tested (prior to shipment) with motor connected to AFD output.
- e. The manufacturer shall be International Standards Organization (ISO) certified. Proof of this certification may be furnished at time of technical submittal.
- f. Manufacturer shall be listed by Underwriters Laboratories or EN as manufacturer of packaged pumping systems.
- g. Vendor / Contractor to comply with all sections of these specifications related to packaged pumping system. Any deviation, if any, from specifications shall be clearly defined in writing at time of bid. If no exceptions are taken at time of bid and duly approved by the Consultant, the supplier shall be bound by these specifications.

5 ASSEMBLED UNITS

- a. Supplier / Contractor to install a Variable Speed Pumping System as per approved shop drawings & manufacturer's instructions.
- b. The control system shall include minimum one programmable logic pump controller for each set of pumps along with adjustable frequency drive(for each pump) and

remote sensor / transmitters as required to make these system complete. Additional items shall be included as specified or as required to properly execute the sequence of operation and to make the installation complete in all respect.

- c. The variable speed pump logic controller, adjustable frequency drives, AFD bypass (if indicated in schedule of quantities) and remote sensor / transmitters shall be shipped as individual components to the job site and installed by the HVAC contractor as shown on the plans.
- d. Power wiring shall be installed by the HVAC contractor as per approved field connection drawings and wiring diagrams supplied with the pumping package by the manufacturer / supplier.
- e. Low voltage control wiring shall be supplied & installed by the HVAC contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package by the manufacturer / supplier.

6 PUMP LOGIC CONTROLLER

- a. The pump logic controller assembly shall be Underwriter's Laboratory INC. (UL) listed. The controller shall be specifically designed for variable speed pumping applications.
- b. The controller shall function to safeguard against hydraulic conditions including:
 - i. Hunting
 - ii. Pump flow surges
 - iii. System over pressure.
 - iv. Motor overload
- c. The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter as indicated on the plans. It will then select the analogue signal that has deviated the greatest amount from its set point. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to three pumps in parallel.
- d. The pump logic controller shall have an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
- e. The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.
- f. The pump logic controller shall be self prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
 - i. Multi-fault memory and recall last 10 faults and related operational data
 - ii. Red fault light, Yellow warning light and Green power on light.
 - iii. Soft-touch membrane keypad switches.
- g. The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.
- h. Controller shall be capable performing the following pressure booster function:
 - i. Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.

- ii. High system pressure cut-out to protect the piping system against high pressure conditions.
- iii. No flow shut down to turn the pumps off automatically when system demand is low enough to be supplied by hydro pneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor pressure switches to determine when a No Flow condition exists.
- i. This system shall be compatible for following through BAS:
 - Remote system start / stop.
 - Failure of any system component with alarm indicator.
 - Selectable output of 4-20 mA for
 - Output Power
 - Output Current
 - Frequency
 - Process Variable
- j. This system shall be equipped with RS-485 port utilizing open protocol & shall have following features communicable through BAS for each equipment:
 - i. Analog Input
 - ii. Zone Set Points.
 - iii. Pump / AFD on/off status.
 - iv. 1 KW signals.
 - v. Percent age speed.
 - vi. System Operation mode.
 - vii. System Start / Stop command
 - viii. System flow, for through flow sensor.
- k. The pump logic controller shall be of approved make & directly provided by the manufacturer. It shall be housed in a NEMA 1 Enclosure & not in plastic enclosure.

7 ADJUSTABLE FREQUENCY DRIVE

- a. The Adjustable Frequency Drive (AFD), shall be factory tested as per UL standard 508. The AFD shall also be CE marked and built to meet ISO 9001 standards.
- b. The adjustable frequency drives shall be microprocessor controlled design with Pulse Width Modulation (PWM).
- c. The AFD shall have voltage vector control to minimize harmonics to the motor to increase motor efficiency and lift. It shall be capable to maintaining power factor near to unity regardless of speed or load.
- d. Input and output power circuit switching can be done without interlocks or damage to the AFD.
- e. The AFD shall have balanced DC link reactors to minimize power line harmonics AFDs without a DC link reactor shall provide a 3% impedance line reactor.
- f. The following adjustments shall also be part of the system.
 - Accel time.
 - Decel time.
 - Minimum Frequency.
 - Maximum Frequency.

g. This system shall have in-built automatic energy optimization selection feature. This feature shall reduce voltage when lightly loaded and provide a 3% to 10% additional energy savings.

h. The AFD shall be suitable for operating ambient temperature of not less than 104 degrees F and also able to operate at 1000 Mt. elevation above sea level without de-rating. AFD shall be suitable for operation in environments up to 955 non-condensing humidity.

k. The AFD shall have the following display information in English:

- i. Voltage
- ii. Current
- iii. Frequency.
- iv. RPM
- v. Kilowatts per hour
- vi. Fault Identification.
- vii. Percent Torque.
- viii. Percent Power

8 AUTOMATIC AFD BYPASS

- a. AFD at variable speed pumping system shall be equipped with an automatic bypass with requirement of Schedule of Quantities.
- b. Bypass shall consist of a main power disconnect with earth fault protection, suitable starter with motor overload relay. All are to be mounted in a NEMA 1 enclosure.
- c. Automatic bypass shall operate as described in the sequence of operation.

9 SENSOR / TRANSMITTERS

Field mounted differential pressure sensor transmitters shall be provided as indicated in BOQ or as identified in the plans. Unit shall transmit an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection. It shall have a NEMA 1 electrical enclosure capable of withstanding 450 PSI static pressure. Accuracy shall be within 0.5% of full span. The installation contractor shall provide pilfer proof housing such MS plate housing with lockable access panel for differential pressure sensors.

10. PUMP ASSEMBLY

a. For, Flowrate upto 1800 GPM (Per Pump in the system)

- "True Back Pull Out Design" End suction vertical split flexible coupled with tangential flow design volute for better efficiency, coupled with EFF1 (IE2) motor, spacer coupling, OSHA complaint coupling guard, in CI Casing Construction & SS Cast grade (CF8)/Bronze fitted Impeller construction, specifically designed for quiet operation for chilled water cooling systems as indicated on the drawings.
- The pumps shall be Suitable for standard operations at 225 F and 125 PSIG working pressure or optional operations at up to 250 F and 250 PSIG working pressures. Working pressures shall not be de-rated at temperatures up to 250F. The pump

internals shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.

- The bearing assembly shall be of High Strength Steel shaft. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
- Pump volute shall be of a cast iron design for heating systems (or cast bronze for domestic water systems) with integrally cast pedestal volute support, rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. (Optional 250 PSIG working pressures are available and are 250# flange drilled) Volute shall include gauge ports at nozzles, and vent and drain ports.
- Pumps with overhung volute shall not be acceptable
- Shut off Head should be more than 10% of duty point head.
- Pump Curve should be continuously rising from High flow to zero Flow, drooping curves are not acceptable.
- **Specially Designed Motors:** shall meet IE2 (High Efficiency) & scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation by the manufacturer's representative.
- End suction pump has to be "Back Pull-Out" Truly defined; the statement should indicate ease of service and disassembly of the pump for service. Specifically, the bearing frame and impeller should be able to be removed for service without disturbing the pump volute or motor assembly. This capability substantially reduces pump downtime and decreases maintenance costs.
- **CONDITION MONITORING SYSTEM:** Continuously measures vibration and temperature at the outboard bearing and automatically indicates when pre-set levels of vibration and temperature have been exceeded, so that changes can be made before failure occurs. A visual indication of pump health makes walk around inspections more efficient and accurate. This onboard pump intelligence helps minimize life-cycle costs while maximizing performance.
- **Specially Designed Coupling guard:** complies with ANSI B15.1 and OSHA 1910.219. The guard offers increased Protection against potential injuries. The guard includes slotted viewing windows for easy inspections. "U" Shape Coupling Guard shall not be acceptable.

11. OPERATION SEQUENCE

Sequence of Operation, for Primary Variable Speed Pumping System:

1. The system shall consist of a Technologic pump logic controller, multiple pump/VFD sets with manual and automatic alternation and pump staging.
2. The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.
3. When the pump logic controller selector switch is in the LOCAL position, the pumping system shall operate automatically.
4. Sensor/transmitters shall be provided as indicated on the plans.
5. Each sensor/transmitter shall send a 4-20mA signal to the pump logic controller, indicative of process variable condition.

6. The pump logic controller shall compare each signal to the independent, engineer/user determined set points.
7. When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
8. The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone:
 - The First priority: The Technologic controller shall monitor the zone differential pressure sensors and compare actual process values with the required set points. The pump speed is modulated to maintain set point. Pump staging will occur if required to meet set point.
 - The Second priority of the Technologic control system will be to ensure that minimum flow requirements are being met for all running chillers.
 - Technologic will monitor individual chiller flows or DP signals, along with digital input signals from each chiller.
 - If the speed signal or the actual flow or DP is not high enough the bypass valve will be opened to the user defined initial opening value and modulate as needed to ensure minimum flow. Display shall indicate valve position.
 - Upon sufficient increase in system flow, valve will modulate to the closed position.
 - The Technologic controller will provide each pump an off delay when a chiller is de-staged or turned off to prevent freezing. When the chiller start and chiller running digital input signals (from the chiller to the Technologic) are turned off the chiller isolation valve will close and the pump will continue to operate.
 - The display will indicate that the isolation valve is now closed. The pump will continue running until the process variable or end of curve de-staging logic determines it is time to turn off the pump.
 - The Third priority of the Technologic control system is to monitor system flow rate to prevent operation above the maximum flow for the chillers and the pumps.
 - When the system flow exceeds the maximum flow rate that the operating chillers can handle the Technologic controller will send out a DO signal to request that the next chiller in sequence be turned on.
 - The display will indicate that the maximum flow has been exceeded.
 - End of curve staging shall be active.
 - To eliminate rate of change issues, the PID output buffer may be enabled through user- setup for use during manual to automatic transitions.
9. If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.
10. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.
11. Further change in process variable shall cause the pumps to change speed together.
12. When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed destage sequence and continue variable speed operation.
13. As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the VFD to speed up or slow down the pump/motor.
14. In the event of a system differential pressure failure due to a pump or VFD fault, the Technologic pump logic controller shall automatically start the next variable speed pump/VFD set in sequence and continue variable speed operation.

15. In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
16. The zone number corresponding to the failed sensor/transmitter shall be displayed on the operator interface of the pump logic controller.
17. In the event of failure to receive all zone process variable signals, all VFDs shall maintain 100% speed; reset shall be automatic upon correction of the zone failure.
18. PUMP or VFD fault shall be continuously scrolled through the display on the operator interface of pump logic controller until the fault has been corrected and the controller has been manually reset.

12. PROJECT EXECUTION

a. INSTALLATION

- a. Install equipment in accordance with manufacturer's instructions.
- b. The contractor shall align the pump and a motor shaft to within the manufacturer's recommended tolerances prior to system start-up in the presence of manufacturer's authorized representative.
- c. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.
- d. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.

b. DEMONSTRATION

- i. The system manufacturer or trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- ii. The system manufacturer or trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

AIR HANDLING UNITS

1. SCOPE

It includes the supply, erection, testing and commissioning of double skin type air handling units, conforming to these Specifications and as detailed in the Schedule of Quantities and approved shop drawings.

2. TYPE

The air handling units shall be double skin construction, horizontal or vertical type through blow through type comprising of various sections i.e. filter section/s coil section/s and fan section. Mixing box (with dampers), (wherever the return air, or and fresh air are ducted) as included in schedule of quantities and shown in shop drawings.

3. CAPACITY

The air handling capacities in terms of air delivery, maximum motor horse power and static pressure shall be as identified in Schedule of Quantities and in shop drawings.

4. CASING

Double skin panels shall be made of 0.63 mm thick plain galvanized preplasticised /Powder coated sheet on outside and 0.80 mm pre plasticized Aluminium inside floor mounted air handling units with thermal break profile with CFC – FREE 50 mm thick PUF insulation panel with thermal break profile consisting of Plug fans with BLDC motor(for supply and return both fans) & three phase motors section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades (Supply & Exhaust both) and vibration isolators, fire retardant double flexible connections as required etc complete as per specifications and drawings. All AHUs shall have stainless steel drain pan with sandwiched insulation. Filter shall be washable type.

The entire framework shall be mounted on an aluminium alloy or galvanized steel channel base as per manufacturer's design. Sealing of panels to the frame work shall be through heavy duty 'O' ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Handles for panels shall be made of hard nylon and shall be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on site assembly gaskets shall be continuous & concealed. AHU shall have hinged, access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be part of double skinned panels. AHU shall have 18 gauge stainless steel sheet condensate drain pan. It shall be isolated from bottom floor panel through insulation as per manufacturer's standards.

5. MIXING BOX

Mixing box shall be provided to AHUs specified in Schedule of Quantities and shall be along with fresh air and return air dampers.

6. THERMAL BREAK PROFILE

TFA AHUs & AHUs with mixing box having ducted return air, shall be provided with thermal break profile whatever or not indicated in schedule of quantities.

7. DAMPERS

Dampers provided at supply air inlet, return air & fresh air intake shall be opposed blade type made of double skinned aero foil aluminium sections, assembled within a rigid extruded aluminium alloy frame work with gasket. All linkages shall be made of aluminium or nylon, having teflon bushes. Dampers shall be provided with a bakelite knob for locking the damper blades in position.

Linkages shall be extended wherever specified for motorized operation. Damper frames shall be manufacturer in such a way that blades never wrap. Air leakage in the closed position of dampers shall not exceed 1.5% of the total flow rate at the maximum design air total pressure.

8. MOTOR AND DRIVE

AHU fan motors shall be energy (TEFC) efficient IE 2 suitable for $415 \pm 10\%$ volts, 50 cycles, three phase, supply motor shall be totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be designed for quiet operation and motor speed shall not exceed 1440 rpm. Drive forwarded to fan shall be provided through pulley belt-drive arrangement. Belts shall be oil-resistant type.

9. FAN

AHU fans as per schedule of quantities either be forward inclined blades (suitable for static pressure up to 70 mm Wg) or backward inclined blades (for static pressure above 70 mm Wg). AHU fan motor driven by variable frequency drive shall have backward inclined irrespective of static pressure casing of fan shall be made of galvanized steel sheet. Fans shall be selected for minimum efficiency of 75%. Fan wheels shall be made of galvanized steel. Fan shaft shall be of carbon steel, supported in self-aligning plummer block, grease lubricated bearings. Fan wheels be tested and balanced dynamically. Fan motor assembly shall be statically and dynamically balanced as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer/ technical submittal.

Motors shall be totally enclosed, fan cooled, to be class 'F' insulation. It shall be mounted inside the AHU casing on slide rails for easy belt tensioning. Motors drive shall be heavy duty V-belt, having constant pitch, suitably selected for rated motor horsepower.

Both fan and motors assemblies shall be mounted on aluminium alloy or galvanized steel base frame, as per the manufacturer's standard.

Anti vibration manuals consisting of spring & rubber combinations shall be provided for isolating the unit casing against vibration transmission. Flame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

10. CHILLED WATER COIL

Cooling coil shall be minimum 0.4mm thick & shall have 12.5 to 15 mmdia (O.D) tubes with sine wave aluminium fins firmly bonded to copper tubes. These shall be assembled in zinc coated steel frame.

Surface areas shall to ensure rated capacity of each unit and such that the air velocity across the coil shall not exceed 150 meters per minute. The coil shall have copper headers with supply & return water connections. These shall protrude out of AHU casing by minimum 150 mm and fitted with dielectric coupling for connection with MS pipes. Each coil shall be factory-tested at 21 kg per sq. m air pressure under water.

Tube shall be mechanically / hydraulically expanded for minimum thermal contact resistance with fins. Fins shall have spacing of 4 - 5 fins per cm. Water pressure drop in coil shall not exceed 10 PSIG. All recirculation type of AHU's shall be provided with minimum 6 Row Cooling Coil. All treated fresh air (TFA) AHU's shall be provided with minimum 8 row cooling coil. Hot water reheat coil shall be minimum 2 rows deep. Coil rating shall be as per ARI-410/2006. Computerized cooling coil selection output shall be part of technical submittal.

11. FILTERS

Each AHU shall be supplied with a factory assembled filter section. This shall be provided with washable synthetic type air filters having anodized aluminium frame. The filters shall have minimum 90% efficiency down to 10 microns. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be and constructed from aluminium alloy and should be fully sealed.

Certified for Green Building each AHU shall also be provided with filter section containing MERV-13 type air filters having anodized aluminium frame. The filter shall have minimum 99% efficiency down to 3 microns.

12.ACCESSORIES

Coil of each air handling unit shall be provided with manual air vent at high point and drain plug in the bottom. In addition, the following accessories shall be required at air handling unit, their detailed specifications are given in individual sections, & quantities separately identified in schedule of Quantities.

- a. Insulated butterfly valves, balancing valves, 'Y' strainer, union & condensate drain piping with 'U' trap up to sump or floor drain in air handling unit room, (or upto sump) as described in section "Piping" (part of piping).
- b. Thermometers in the thermometer wells & pressure gauge (with cocks) within gauge ports in chilled water supply and return lines as per the section "Instruments".

13 ISOLATORS

Vibration isolators shall be provided with all air handling units as per manufacturer's recommendation. Vibration isolators shall be cushy foot mounting type. Else these shall be of neoprene pads 2 Nos. each having minimum thickness of 25mm sandwiched in GI sheet. Minimum vibration isolation efficiency shall be 90%.

14 FRESH AIR INTAKES

Anodized extruded aluminium construction fresh air louvers with bird screen pre filters and dampers shall be provided in the external masonry walls of the air handling unit rooms.

Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.

15 PERFORMANCE DATA

AHU selection shall be for the lowest operating noise level. Fan performance curve and power consumption data, with operating point indicated shall be submitted in technical submittals which shall be verified at the time of testing and commissioning of the installation.

16 PAINTING

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

17 TESTING

Cooling / heating capacity of each air handling unit shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by voltmeter anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometer. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be measured from w.r.t. incoming voltage and input current.

SECTION - V : FAN COIL UNITS

1. SCOPE

The scope shall include the supply (may be directly by the manufacturer) installation, testing and commissioning of fan coil units. The FCU shall conforming to these Specifications and shall meet the requirements of the Drawings and Schedule of Quantities.

2. TYPE

The fan coil units shall be horizontal type for ceiling-suspension and vertical type for floor mounting. Horizontal units mounted within ceiling space shall have horizontal discharge and shall be ductable. Floor-mounted vertical units shall have vertical top discharge. All units shall be complete with chilled / hot water coil, centrifugal fan and motor both on common shaft, cleanable fabric filters, double-skinned insulated condensate drain pan.

3. CAPACITY

The air delivery and cooling/heating capacities shall be as identified on Drawings and indicated in Schedule of Quantities.

4. CABINETS

FCU designed shall be constructed of 20 gauge die-formed cold-rolled galvanized sheet steel, and powder coated with approved shade / color. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing containing the coil and fan section with provision to mount filters within the fan section either of the back or at the bottom. For vertical FCU the cabinets shall be of sufficient size to house all piping and control valves and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal.

5. INTERIOR CHASSIS

The interior chassis of FCU shall be constructed of minimum 18 gauge cold rolled galvanized sheet steel painted with approved shade of powder coating finish. All vertical fan coil units shall be securely mounted on the building structure. Filter, fan, motor & coil shall be easily accessible / removable in. In case of ceiling suspended horizontal units fan deck and cooling coil shall be easily removable from FCU without lowering down of the entire FCU without disturbing the other installation.

6. DRAIN PAN

Primary drain pan shall be fabricated from 20 gauge cold rolled galvanized sheet steel with all corners welded, and an additional inner bottom panel of 20 gauge cold rolled galvanized sheet steel shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 15 mm thick expanded polystyrene or 8 mm thick expanded polyethylene insulation sandwiched between top and bottom panels to effectively prevent condensation.

The pan shall be of sufficient size to catch all drippage of condensation from any part of the unit. The primary pan shall have extended tray large enough to cover supply and return water valve assembly and control valves.

A secondary (auxiliary) condensate pan similar to primary drain pan may be provided by the manufacturer to these units which are so identified in Schedule of Quantities. All drain pans shall be with powder coating finish as per interior chassis defined above.

7. COOLING COIL

Cooling coils shall be standard three-row of copper tube with aluminium sine wave fins having spacing of 10 to 12 fins per inch. The inlet / outlet connections of coil shall be fitted with dielectric coupling for connection with MS pipes. Tubes shall be minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. Tubes shall be mechanically / hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided at top of the headers of coils. The coil shall be easily removable from back side of FCU without removing the FCU cabinet. Coils shall be factory tested at 21 KG per sq. cm (300 psig) air pressure while submerged in water.

8. FANS

Fans shall be centrifugal forward curve double inlet ductable direct driven.

9. MOTOR

Motor shall be energy efficient, BLDC type, six pole, shaded pole type, suitable for 220+ 6% volts, 50 cycles single phase power supply. Speed shall not exceed 1000 rpm at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

10. INSTALLATION

Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through rubber-in-shear vibration isolator.

11. ACCESSORIES

All fan coil units shall be equipped with copper piping connections, dielectric union and manual air vent at the cooling coil outlet header. In addition, the following accessories may be required at fan coil units; their detailed Specifications are given in individual sections and quantities separately identified in Schedule of Quantities.

- a. Imported fan coil units as specified in Schedule of Quantities shall be factory fitted with Ball valves with Y-strainer at inlet and ball valve at outlet along with two way valve as shown in Drawings and included in Schedule of Quantities.
- b. Fire retardant double sleeve flexible canvas connection.
- c. Rubber in-shear type vibration isolators with hangers.

12. PAINTING

Shop coats of paints that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

13. PERFORMANCE DATA

Fan coil, units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at medium/high speed at a distance of 3 meters. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

14. TESTING

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

COOLING TOWERS

1. SCOPE

The scope of this section includes the supply, installation, testing and commissioning of cooling towers in as included in the Schedule of Quantities & as detailed in the approved from construction shop drawings.

2. TYPE

Cooling Towers shall be induced draft /forced draft as per the requirement of Schedule of Quantities.

3. INDUCED DRAFT COOLING TOWER

Cooling Tower shall be suitable for outdoor use. It shall be vertical, induced draft, counter/cross flow type. Tower shall be FRP / GI construction, in rectangular / round / square/octagonal profile, complete with fan, motor, diffusion deck, spray section, eliminators, steel supports and GI ladder etc. Sound attenuation equipment where called for shall be provided as per manufacturers standards or as included in Schedule of Quantities.

a. Capacity

The cooling tower capacities shall be as per Schedule of Quantities & approved for construction shop drawings.

b. Casing

This shall be made out of FRP construction of minimum 3 mm thick and UV stabilized with smooth surface on both sides for minimum resistance to air flow. Casing can be of GI also, as recommended by the manufacturer. Tower shall be sufficiently supported with structural members to withstand high wind velocities and vibration without any damage to the Cooling tower / Building structure. . The casing may be installed in the reinforced cement concrete basin if so identified in drawings, or in Schedule of Quantities. The tower supporting structure shall be made of hot dipped galvanized frame. Air intake shall be all along the sides (or as required by the manufacturer for tailor made cooling tower as per site conditions) so that tower can be installed quite independent of prevailing wind direction. Anodized aluminium or PVC louvers with UV stabilized PVC fill and backed up by galvanized bird screen / FRP louvers shall be provided at air intake. Sufficient clearance between casing / intake louvers and adjoining structures shall be provided to enable easy service and periodic cleaning.

c. Basin

Cold water basin shall be a deep sump and made minimum of 5 mm thick FRP construction, UV stabilized, on which cooling tower super structure shall be supported. RCC suction tank if made, shall be provided with easily removable double brass strainers with this basin. It will be separately identified in the shop drawings or in Schedule of Quantities and shall be cast by civil agency under the direct supervision of HVAC contractor as per approved shop drawings. Basin fittings shall include the following :

- i. Make up & quick fill connection to the side of basin.

- ii. Bottom / side outlet.
- iii. Connection from suction assembly with strainer.
- iv. Drain connection to the side / underside of basin.
- v. Overflow connection to the side / bottom of basin.
- vi. Built-in bleed off attached to inlet header discharging through polyethylene tube into overflow pipe.
- vii. Make up water connection with inlet valve & heavy duty float valve.
- viii. Equalizing connection for the battery of cooling towers.

d. Distribution System

Condenser / heat exchanger water distribution system shall comprise of header and branch arms system with gravity flow system.

e. Fill

Fillings shall be made of rigid PVC film in honey comb structure arranged in shape of cooling tower casing. Fill sheets shall be suspended from H.D.G steel structure supported from the main frame work facilitating cleaning and easy replacement of fills. These shall be arranged in to ensure negligible resistance to air flow and to eliminate back water spots. PVC drift eliminator shall be installed to reduce carry-over losses through entrainment of moisture drops in air stream.

f. Mechanical Equipment

Cooling tower shall be provided with low speed fan running through gears reducer at less than 360 RPM. Direct driven fan speed shall not exceed 700 RPM. Fan shall be of the propeller type with light-weight rotor fitted with multiple aerofoil blades. Fan assembly shall be statically and dynamically balanced. Fan motor shall be energy efficient, totally- enclosed, fan-cooled, weather-proof construction, designed and selected to operate in humid air stream suitable for 415+ 10V, 3 phase, 50 Hz, AC supply. Fan shall be protected by a fan guard and bird screen of galvanized steel construction. A service ladder of GI / Aluminium construction shall also be provided for each cooling tower. The mechanical equipment assembly shall be adequately supported on a rugged steel base frame work assuring vibration-free assembly. G.I canopy shall be provided over the fan motor for weather protection. Motor terminal box shall also be made water tight.

The noise level from cooling tower shall not exceed 65 dB at a distance of 5 meters all around the cooling tower.

4. FORCED DRAFT COOLING TOWER

Forced draft cooling tower shall be FRP construction of minimum 3 mm thick and UV stabilized and structural framed, cross-flow type, suitable for outdoor use. Tower may also be of galvanized street construction as per manufacturer's standards. . Tower shall be complete with fan, motor, diffusion deck, spray section and eliminator plate. Tower shall be selected for low height application and lowest possible noise level.

a. Capacity

The cooling tower capacity shall be as per Schedule of Quantities and shop buildings.

b. Casing

Casing and basin shall be of FRP of minimum 3 mm thick respectively and sealed for water tightness. All joints and corners shall be sealed and an aluminium / GI ladder shall be provided as a part of cooling tower.

c. Cold Water Basin

Cold water basin shall be a with deep sump with cooling tower superstructure/supports. Easily maintainable brass-strainer shall be provided with the basin.

Basin fittings shall include the following :

- i. Make up & quick fill connection to the side of basin.
- ii. Bottom / side outlet.
- iii. Connection from suction assembly with strainer.
- iv. Drain connection to the side / underside of basin.
- v. Overflow connection to the side / bottom of basin.
- vi. Built-in bleed off attached to inlet header discharging through polyethylene tube into overflow pipe.
- vii. Make up water connection with inlet valve & heavy duty float valve.
- viii. Equalizing connection for the battery of cooling towers.

d. Distribution System

Condenser / heat exchanger water distribution system shall comprise of header and branch arms system with gravity flow system.

e. Fill

Fillings shall be made of rigid PVC film in honey comb structure arranged in shape of cooling tower casing. Fill sheets shall be suspended from H.D.G steel structure supported from the main frame work facilitating cleaning and easy replacement of fills. These shall be arranged in to ensure negligible resistance to air flow and to eliminate back water spots. PVC drift eliminator shall be installed to reduce carry-over losses through entrainment of moisture drops in air stream.

f. Mechanical Equipment

Fan shall be centrifugal/axial fan, aluminium alloy aerofoil construction. The entire fan assembly shall be statically and dynamically balanced. Fan motor shall be low RPM, suitable for $415 \pm 10\%$ volts, 3 phase, 50 cycles AC supply, energy efficient electric motor, totally enclosed, fan-cooled, weather-proof construction. The noise level from cooling tower shall not exceed 65 dB from 5 meter distance all around the cooling tower. The mechanical equipment assembly shall be adequately supported through galvanized steel angle frame work. The hot and humid air shall be discharged at the top level. Galvanized steel construction bird screen at outlet shall be provided.

5. PERFORMANCE DATA

Technical submittal shall include complete performance ratings and power consumption at varying loads and at outdoor wet bulb temperatures. These shall be verified at the time of testing and commissioning of the installation.

6. TESTING

Cooling tower capacity shall be calculated from the measurements taken water flow, incoming/outgoing water temperatures and ambient air wet bulb temperature. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption for cooling towers shall be computed from measurements of incoming voltage and input current.

SECTION VIII: BLOWERS / FANS

1. SCOPE

The scope of this section includes the supply, installation, testing and commissioning of centrifugal blowers, in-line fans, propeller type fans and roof fans (roof extractors) conforming to these Specifications and in accordance with the Drawings and Schedule of Quantities.

2. TYPE

Blowers / Fans unit shall be of the type as identified in Drawings and included in Schedule of Quantities.

3. CAPACITY

The air delivery of blowers / fans shall be as per Drawings and Schedule of Quantities.

4. CENTRIFUGAL BLOWER

Centrifugal blower / fan shall be DWDI / SWSI Class I construction arrangement 3 (i.e. bearings on both the sides), squirrel-cage induction motor, including accessories i.e. MS base, V-belt drive, belt guard and vibration isolators. Direction of discharge and motor position shall be as per the Approved-for-Construction shop drawings.

- a. Blower housing shall be constructed of 14 gauge sheet steel having welded construction. It shall be reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. Packing shall be provided throughout split joints as per manufacturer standards to make it air-tight.
Galvanized wire mesh inlet guards of 18 gauge shall be provided on both inlets. Direction of rotation shall be clearly marked on the housing. Housing shall be provided with standard cleanout door with handles and neoprene gasket.
- b. Fan wheel and housing shall be statically and dynamically balanced. Fan Wheel shall be backward- curved non-over loading type. Fan outlet velocity for fans upto 450mm dia meter, shall not exceed 550 meter/minute and fan speed not exceeding 1450 rpm. Fans above 450 mm dia, shall have the outlet velocity within 700 meter/minute and fan speed not exceeding 1000 RPM. High static pressure fan speed shall be as per manufacturer.
- c. Shaft shall be constructed of steel, turned, ground and polished.
- d. Bearings: shall be of the ball-bearing type mounted directly on the fan housing. These shall be especially designed for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.
- e. Motor: Blower motor shall be energy efficient and suitable for $415 \pm 10\%$ volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled, having class F insulation. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1440 rpm. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. The blower and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), to minimize the sound level.
- f. Drive to fan shall be through belt/s with adjustable motor sheave. Belts shall be of the oil- resistant type. Drive assembly shall be provided with proper guard.

- g. **Vibration Isolation:** MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through casing foot type vibration isolators. The concrete foundation shall generally be 150mm above the finished floor level, or as shown in approved-for- construction shop drawings.

5. AXIAL FLOW FAN

Fan shall be complete with motor (direct or belt driven type) motor mount, and vibration isolators. Installation arrangement shall be as per approved for construction shop drawings.

- a. **Casing:** Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.
- b. Casing shall have flanged connection on both ends for duct connections. Casing shall have welded support brackets for suspending fan unit from ceiling. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.
- c. **Rotor:** hub and blades shall be cast steel or cast aluminium construction. Blades shall be aero foil shaped shall vary in twist and width from hub to tip for maximum efficiency & to effect equal air distribution along the blade length. Fan blades on the hub shall be statically and dynamically balanced. Extended grease parts for external lubrication shall be provided. The fan pitch control shall be manually readjust able. Upon installation it may require manual readjustment at site, for obtaining actual air flow values, as specified and quoted.
- d. **Motor:** shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, continuous duty, suitable for $415 \pm 10\%$ volts, 50 cycles, 3 phase AC power supply. It shall be provided with class 'F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans for fans with impeller diameter above 450mm shall not exceed 1000 RPM and 1440 RPM for fans with impeller diameter 450 mm and less. Fan shall be selected for maximum efficiency or minimum horsepower for lowest sound level. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.
- e. **Drive:** From motor to fan shall be provided either directly though motor shaft or through belt drive with adjustable motor sheave and standard sheet steel belt guard. Belts shall be of oil- resistant type.
- f. **Vibration Isolation:** The assembly of fan and motor shall be suspended from the slab by vibration isolators of rubber-in-shear type.
- g. **Accessories:** The following accessories shall be provided with all fans:
- h. Outlet cone for static pressure regain.
- i. Inlet cone.
- j. Fans shall be factory assembled and shipped with all accessories factory fitted. Silencers at fans may be provided as per project demand and is included in schedule of quantities.

6. PROPELLER FAN

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

- a. Mounting Plate shall be of steel construction, square with streamlined venturi inlet, reversible for supply applications coated with baked enamel paint. Mounting plate shall be constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.
- b. Fan Blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.
- c. Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.
- d. Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for $415 \pm 6\%$ volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for $220 \pm 6\%$ volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.
- e. Accessories: The following accessories shall be provided with propeller fans :
 - i. Wire guard on inlet side and bird screen at the outlet.
 - ii. Fixed or gravity louvers built into a steel frame at the outlet.
 - iii. Regulator for controlling fan speed for single phase fan motor.
 - iv. Single phase preventer for 3 phase fan.

7. ROOF MOUNTED FAN

Roof mounted fan shall be propeller type or centrifugal fans, direct driven or belt driven as shown on drawing and in Schedule of Quantities, complete with motor drive, and casing / housing with weather-proof cowl.

- a. **Casing:** shall be constructed of 16 gage steel sheet. The housing shall have an adjustable flange to facilitate installation and shall be especially adapted to receive fan, motor, and drive. The housing shall have a low silhouette. For belt driven units, motor shall be installed in ventilated water proof housing outside the air stream. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and raised from the roof terrace sufficiently to prevent down flow of rain water accumulated on the terrace. 18 gage galvanized steel mesh bird screen shall be provided on all discharge cowls around the outlet area.
- b. **Fans:** shall be backwardly inclined centrifugal wheel or propeller type as required, designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.
- c. **Motor:** shall be shaded pole, of split capacitor type with lubricated sleeve or ball bearings, designed for quiet operation. Bearings shall be designed for vertical mounting. Motor name- plate horse-power shall be such that the motor shall not be

overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable. Motor power supply characteristic and maximum speed shall be as specified for propeller fans and as indicated in the Schedule of Quantities.

- d. **Fan Bearings:** shall be heavy duty, self-aligning sleeve/ball bearings designed for thrust load and sealed for grease retention.
- e. **Back draft Damper:** Where called for in the Schedule of Quantities, roof-mounted fan shall be equipped with a rattle-free backward raft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatter proof under all conditions.
- f. **Vibration Isolation:** The motor and fan assembly shall be isolated from the base with vibration isolators.

8. PERFORMANCE DATA

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

9. TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

EXPANSION TANK

1. CLOSED EXPANSION TANK

The closed expansion tank will be of M.S. construction with interchangeable EPDM- BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve and pressure gauge.

The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations. The tank shall be fabricated as per IS 2825- 1969 for “non-fired pressure vessels” and the flanges shall be as per IS 6392-1971.

For chilled water application, it will be insulated with 50mm thick insulation to the specifications and cladded with 26G-aluminium cladding.

The expansion tank shall be supplied along with pressurization unit. The pressurization unit shall consist of two nos. (1 working + 1 stand-by) high pressure pumps of suitable pressure rating mounted on M.S. frame, complete with interconnecting piping, isolation valves, NRV, Y- strainer, pressure gauge, pressure transmitter, auto-logic panel (IP 55) with dry-run protection, electrical MCB and interconnecting wiring.

The unit shall be housed in powder-painted canopy suitable for external installation, if required.

2. AIR SEPARATORS

The centrifugal air - separator will be of M.S. construction with flanged connections. The air separator will be adequately sized to achieve maximum air-separation. It will be provided with a

high capacity super-vent at the top. The shell shall be fabricated as per IS 2825-1969 for “non-fired pressure vessels” and the flanges shall be as per IS 6392-1971.

For chilled water application, it will be insulated with 50 mm thick insulation to the specifications and clad with 26G-aluminium cladding.

PIPING

1. SCOPE

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards. All welders used for piping erection shall be well qualified (certificate should be submitted to Project Manager for approval) and shall have minimum 8 to 10 years experience.

2. PIPE SIZES

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor’s guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

3. CHILLED WATER PIPING

- a. All chilled water pipes and all fittings shall be Mild Steel (MS) Class ‘C’ (Heavy Class) conforming to relevant BIS-1239 Code. Factory rolled pipes between 250 mm to 600 mm diameter shall have 8 mm wall thickness. All jointing in the pipe system shall generally be Groove, unless otherwise mentioned, or directed at site. All Groove shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel.

Welder shall be having minimum 5 years of experience. First butt weld of each welder shall be fully radiographed for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

- b. All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall- thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following :

All joints shall have 45 degree bevel type, pipe mill-beveled or machine-beveled by the contractor.

All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

- c. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of epoxy paint over epoxy primer before being installed. For vibration isolators

premoulded polyurethane pipe sections of 160 Kg/m³ density with adhesive shall be fixed between pipe and MS support. 10 mm thick MS 'U' clamp with resistoflex shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site.

- d. Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Schedule of Quantities.
- e. Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- f. Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings:

Size	Construction	Ends	Type
15 to 32 mm	Brass		
ASTM B62	Screwed		Ball
40 mm and over	Body Cast iron,		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 PN 16 rating.

- g. Butterfly valves shall perform the function of isolating valves. Butterfly valves shall have cast iron body with black nitrile rubber seat and shall be suitable for PN16 rating. All butterfly valves shall be provided with locking devices. Valves 250 mm and above dia shall be gear driven.
- h. Automatic balancing valves shall automatically control flow rates with + 5% accuracy. Valve control mechanism shall consist of a stainless steel cartridge with a ported cup and coil / helical spring to avoid corrosion. Four operating ranges shall be available with the minimum range requiring less than 14 kPa to actuate the mechanism. Manufacturer shall provide independent laboratory tests verifying assurance of performance.
- i. Manual double regulating balancing valves shall be provided at chiller, condenser, various tapp-offs 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 enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flowrate, differential pressure and temperature, computerized balancing instrument shall have a computer programme to provide the following functions:
 - i. To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.
 - ii. To store the results of balancing.
 - iii. To log measured values from a valve (differential pressure, flow rate or temperature).
 - iv. To printout saved data in computerized measurement protocol (CMP) consisting of:
 - o Name and size of Balancing Valve (BV)
 - o Presetting position of BV

- P at BV
 - Flow at BV
 - Design Flow
- a. Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick).
 - b. All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless-steel constructions. These are separately identified in Schedule of Quantities.
 - c. Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications:

Size	Construction	Ends
50 to 150 mm	Body cast iron, gun metal plate.	Flanged
200 mm to 450 mm	Body cast iron, plate carbon steel with 13% chrome overlay.	Flanged

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be PN 16 rating.

- l. Strainers shall be 'Y' type or Pot Strainer suitable for PN 16 rating as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non magnetic 20 gage SS sheet with 3 mm perforation. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet /outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet / outlet connections as shown in drawing and included in BOQ. The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water.

A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non magnetic 18 gage SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently large drain pipe with butterfly valve shall be provided at the bottom chamber to flush-out foreign particles.

This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint water tight. Bearing loaded tope cover lifting and swinging arrangement shall be provided.

The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as under:

Pipe size(mm)	Pot Dia(mm)	Pot ht.(mm)	Element Dia (mm)	Element Ht(mm)	MS Plate Thickness (mm)
50	300	400	200	240	6
80	350	450	250	250	6
100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8
300	1000	1105	750	580	8
350	1190	1300	895	678	12
400	1350	1500	1020	785	12
450	1518	1700	1060	890	12
500	1690	1800	1100	900	12
600	2000	2200	1500	1160	12

Each Port strainer shall be provided with a Test Certificate.

- m. All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".
- n. Grooved coupling: Grooved coupling shall have 3 main parts viz. Housing, Gasket and bolting arrangement. Housing shall be made out of ASTM-A 536 Grade 65-45-12. The housing key shall engage into the grooves around the full pipe circumference, securing the pipe ends together with positive grip. Housing shall be designed to provide optimum combination of pressure, stress relief and end load conditions while maintaining reasonable weight. Gasket shall be of high sealing efficiency and shall be able to withstand upto (-) 0.35 Bar pressure. Bolt shall confirm to ASTM A183, while nut shall confirm to ASTM A194. Nut-bolt shall be electro- galvanized.

All pipe / equipment connections with in the plant room shall be with Victaulic couplings.

4. GROOVED PIPE JOINTING SYSTEM

A. References:**1. American Society for Testing Materials (ASTM)**

- a. ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- b. ASTM A-183 – Carbon Steel Track Bolts and Nuts
- c. ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
- d. ASTM A-449 – Quenched and Tempered Steel Bolts and Studs
- e. ASTM A-536 – Ductile Iron Castings
- f. ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

2. American Society of Mechanical Engineers

- a. ASME B16.9 – Factory Made Wrought Butt Welded Fittings
- b. ASME B31.1 – Chemical Plant and Petroleum Refining Piping
- c. ASME B31.9 – Building Services Piping

3. American Water Works Association**a. AWWA C-606 – Grooved and Shouldered Joints****Quality Assurance**

All grooved components (including couplings, fittings, valves and accessories) to be supplied by one manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

B. Grooved Mechanical Couplings for Joining Carbon Steel Pipe

- 1. Grooved Mechanical Couplings:** Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.
 - a. **Rigid Type:** Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
 - b. **Flexible Type:** Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source.
 - c. **Flange Adapters:** For use with grooved end pipe and fittings, for mating to ANSI Class 150 flanges.
- 2. Grooved couplings shall meet the requirements of ASTM F-1476.**

3. Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D- 2000.

C. Grooved End Fittings: Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

1. Grooved Hole-Cut Branch Outlets:

- a. **Bolted Branch Outlet:** Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.
- b. **Strapless Outlet:** 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).
- c. **Strapless Thermometer Outlet:** To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

5. COLD WATER AND DRAIN PIPING

- a. All pipes to be used for cold water (makeup), drain, condensate drain and fittings shall be galvanized steel class 'B' (medium class) conforming to relevant BIS Codes.
- b. All jointing in the pipe system shall be by screwed joints and/or by screwed flanges using 3 mm 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, 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. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.
- e. Gate valves, globe valves, check valves and strainers shall be similar to those specified for chilled, condensing and hot water piping.
- f. For proper drainage of AHU Condensate, 'U' trap shall be provided in the drain piping.
- g. All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

6. REFRIGERANT PIPING

- a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.
- b. All joints in copper piping shall be sweat 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 carbon dioxide / nitrogen.
- c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.
- d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.
- e. Heat exchanger shall be MS heavy duty pipe in pipe type & without any joint in inner pipe.
- f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.
- g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.
- h. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

7. PIPING INSTALLATION

- a. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in the building through which pipes are designed to pass.
- b. Piping shall be properly supported on, or suspended from, stands, clamps, hangers 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. All pipes in HVAC plant room shall be supported with pipes and channels from floor only with necessary PUF pipe supports and resistoflex sheet.
- c. Pipe supports shall be of steel, adjustable for height and epoxy painted over epoxy 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	Rod Size
Upto 12 mm	1.5 Meter	10 mm
15 to 25 mm	2.0 meter	10 mm

30 to 150 mm	2.0 meter	10 mm
Over 150 mm	2.5 meter	12.5 mm

- d. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick resistoflex pads between the cleat and channel. U clamps with resistoflex sheet shall be provided to keep the pipe in position.
- e. Bull heading in water/refrigerant piping shall be avoided.
- f. Pipe sleeves atleast 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fibreglass and finished with retainer rings welded on the ends of the sleeve.
- g. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant such as fire barrier caulks.
- h. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gage metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm on both sides of the clamp, saddles or roller.
- i. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.
- j. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cut- outs shown in the Drawings do not meet with the requirements.
- k. The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- l. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges bevelled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- m. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.
- n. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fibre glass tissue, each layer laid in bitumen.
- o. Insulated buried pipes shall be cleaned, derusted, then coated with rust-resistant primer and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. Insulation shall be applied as per the section "Insulation", wrapped with GI wire and covered with polyethylene sheet. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in Schedule of Quantities, buried insulated pipes shall be water-proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibre glass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage G.I wire tied at 15 cm intervals.

- p. Auto purge valves shall be provided at all highest points in the piping system for venting air. Air valves shall be 15 mm pipe size with screwed joints.
- q. Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.

8. PRE-INSULATED PIPES

Pre insulated pipes, as called for in schedule of quantities shall be sourced from the factory in length of minimum 6m. Metered dose of Polyurethane foam shall be injected in annular space between pipe OD and outer jacket to achieve average density of 36 Kg/m³. After expanding, homogenous foam shall be formed between the cavity with no air gaps. Suitability of temperature range shall be from (-) 200C to 1200 C.

Outer jacket shall be of GI / AL / SS304 as indicated in schedule of quantities.

9. PRESSURE GAGES AND THERMOMETERS

- a. Pressure gages as specified under section "Automatic Controls and Instruments" shall be provided at suction and at discharge of each pump, at chilled water supply and return at each air handling unit, at each chillers and condenser, and as shown on the Drawings and included in Schedule of Quantities. Care shall be taken to protect pressure gages during testing. Pressure gage sockets on insulated pipes and accessories shall be extended upto insulation to avoid damage of insulation for replacement of gages.
- b. Thermometers as specified under section "Automatic Controls and Instruments" shall be provided at chilled water supply and return at each air handling unit, at each chiller and condenser, and as shown on Drawings and included in Schedule of Quantities.
- c. Thermometers on CHW lines shall be with long stem. Thermometer socket shall be extended upto insulation thickness so that the thermometer shall be removable without damaging the insulation.

10. TESTING

- a. During construction , the contractor shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.
- b. All piping shall be tested to hydrostatic test pressure of atleast two times the maximum operating pressure, but not less than 10 kg per sq. cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified, retested and gotten approved
- c. Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- d. Piping may be tested in sections and such sections shall be securely capped, then re-tested for the entire system.
- e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

- f. The contractors shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser/chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.
- g. 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 connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re- finishing of floors and walls if required.
- h. After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room 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. For painting of insulated and clad pipes refer to Insulation section.
- i. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral. Before handover Owner's site representative shall be provided with certificate of cleaning of pipe systems, signed by the contractor.
- j. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

11. BALANCING

- a. After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.
- b. All balancing valves, Automatic control valves and two-way diverting valves shall be set for full flow condition during balancing procedure. Each water circuit shall be adjusted thru balancing valves provided for this purpose; these shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.
- c. Complete certified balancing report shall be submitted for evaluation and approval by Owner's site representative. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

12. VALVE IDENTIFICATION

Provide 30 mm dia brass valve tag, with embossed letters and number for each valve and attach the tag to valve handle by "S" hook or by suitable means. Contractor shall provide valve tag schedule and valve chart for each piping system, consisting of schematic drawing of piping layout, along with a valve list, showing and identifying each valve by number, service and location and describing its function.

The contractor shall frame under glass in the air conditioning plant room or as directed by Owner's site representative two copies of valve chart. Two additional unmounted copies shall be supplied to the Owner's site representative.

Tags shall correspond with the valve schedule and record drawings. In back of house areas, where ceilings are installed and the valve or valve tag is not visible, a self adhering tag with the valve

number shall be installed on the wall or directly under the ceiling. For public area ceiling valves, these tags are to be installed in the service corridor, leading to the public areas.

13. MEASUREMENT FOR PIPING

Unless specified otherwise, measurement for piping for the project shall be on the basis of centre line measurements described herewith.

Piping shall be measured in units of length along the centre line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the centre line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted.

The quoted rates for centre line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, PUF supports, nuts, check nuts, vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured nor paid for.

However, all valves (gate / globe / check / balancing / purge / butterfly / drain etc), strainers, thermometers, pressure gages shall be separately counted and paid as per their individual unit rates, which shall also include their insulation as per Specifications. Piping measurements shall be taken before application of the insulation.

Contractor shall get pressure testing of pipes/measurements etc. verified by the Owners representative at site.

AIR DISTRIBUTION

1. SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal/ aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

2. DUCT MATERIALS

a RAW MATERIALS

Galvanizing shall be Class VII – light coating of zinc, nominal 180 / 120 gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

b GAUGES, BRACING BY SIZE OF DUCTS

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

For Ducts with external SP upto 250 Pa (25mmWg)

Rectangular Ducts G. S. Pressure 250 Pa Duct Section Length 1.2 m (4 ft)

Maximum Duct Size Gauge Joint Type Bracing Spacing

1-750 mm 26 C & SS Nil

751 – 1000 mm 26 4 Bolt Transverse Duct Connector-E (TDC) with built

in sealant	Nil	
1001 – 1200 mm	24	4 Bolt TDC - E Nil
1201 – 1500 mm	24	4 Bolt TDC - H Nil
1501 – 1800 mm	22	4 Bolt TDC - H Nil
1801 – 2100 mm	20	4 Bolt TDC - J Zeebar stiffener 1-S
2101 – 2700 mm	18	4 Bolt TDC - J Zeebar stiffener 1-S

Note:- All ducts shall be fabricated with minimum 24 gauge sheet

3. FABRICATION STANDARDS & EQUIPMENT

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

- a) Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
- b) All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
- c) All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
- d) Kitchen exhaust ducting shall be with 16 G MS. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood.

4. DUCT CONSTRUCTION

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

- a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
- b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- c) All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care

should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

- d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- e) Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
- f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
- g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- h) Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

5. INSTALLATION PRACTICE

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

- a) The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.
- b) All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the
- c) drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.
- d) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.
- e) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor

fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

- f) Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.
- g) Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.
- h) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.
- i) Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

6. DAMPERS

- a) Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
- b) Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
- c) Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

7. FIRE & SMOKE DAMPERS

- a) All supply and return air ducts at AHU room crossings and at all floor crossings shall be provided with Motor operated Fire & smoke damper of atleast 90 minutes rating as per UL555/1995 tested by CBRI. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span.
- b) Fire damper blades and outer frames shall be of 16G galvanised steel construction fitted with 18 gauge extended sleeves on both sides. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals

- shall be provided on top and bottom of the damper housing made of 16G galvanised sheet steel. For preventing smoke leakage metallic compression seals will be provided.
- c) The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct or temperature sensor. The fire damper shall also close upon sensing temperature rise in supply air ducts thru the electronic temperature sensor.
 - d) Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have atleast the following features:
 - Potential free contacts for AHU fan ON/ Off and remote alarm indication.
 - Accept signal from external smoke / fire detection system for tripping the electrical actuator.
 - Test and reset facility.
 - Indicating lights / contacts to indicate the following status:
 - Power Supply On
 - Alarm
 - Damper open and close position.
 - e) Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with it's control panel. Control panel shall be wall mounted type.
 - f) It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.
 - g) HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energizing all the smoke detectors with the help of smoke.
 - h) HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.
 - i) HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing at site.
 - j) Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.
 - k) The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

FIRE DAMPERS

- a) Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.
- b) Fire damper blades shall be one piece folded high strength 16 gage galvanised steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from

creating noise or chatter. The blades shall be held in position through fusible link of temp 70o C.

- c) In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.
- d) Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.
- e) The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), as recommended by the manufacturer, at the time of commissioning of the installation.

SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom).

The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodised in black colour shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

- a) All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
- b) All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.
- c) Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and upto 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d) Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.
- e) All volume control dampers shall be anodized aluminium in mat black shade.

10. SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

- a) Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities. These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.
- b) Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.
- c) Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.
- d) Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

11. DOCUMENTATION & MEASUREMENTS FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by proper documentation viz:

a) Bill of material/Packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise. Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification. Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith

Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centerline distance

between the flanges of the duct section. For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline. The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber/access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall NOT be separately measured nor paid for.

b) Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith :

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

12. TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

13. STEEL WIRE ROPE HANGERS& SUPPORTS:

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

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available.

The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self- locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002

The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

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

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

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

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

Table. 1

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

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

HVAC Supports –Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct, Desertification fans, Air Conditioning Units, Plenum Boxes, Radiant Panels, Heaters, Fan Coil Units, Diffusers and Chilled Beams.

Ducting Supports:

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be.

The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun.

Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

In case of PEB structure Loop and Catenary system can be used based on the site conditions as per approved suspension system drawings.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 3000mm centre, for 3001mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection or as per approved drawings. Support ducting in accordance with Schedule I at the end of this Section. Any other solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener. Catenary Supports: Refer to manufacturer's recommendations on Catenary supports with C-clip, special care should be taken with tensioning of the wire and angles at which the installation of services are made.

Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Refer to manufacturers catalogue and installation guide for further technical information. Comply with manufacturer's load ratings and recommended installation procedures.

Schedule I: Duct Hanger Schedule

For ducts with external SP upto 250 Pa				For ducts with external SP upto 500 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger No.		Maximum Duct Size (mm)	Gauge	Gripple Hanger No.
1 - 750	26	1 or 2		1-600 mm	26	1 or 2
751-1000	26	2		601-750 mm	26	2
1001-1200	24	2 or 3		751-1000 mm	24	2 or 3
1201 - 1500	24	3		1001-1200 mm	22	3 or 4
1501 - 1800	22	3 or 4		1201-1300 mm	20	3 or 4
1801-2100	20	3 or 4		1301-1500 mm	18	4
2101-2700	18	4		1501-1800 mm	18	4
				1801-2100 mm	18	4
				2101-2250 mm	18	4 or 5
				2251-2400 mm	18	4 or 5
				2401-2700 mm	18	4 or 5

Notes: All supports are considered at 2400 mm interval in above table and may vary as per the design but should not be greater than 2400mm.

Desertification fans, Air Conditioning Units, Plenum Boxes, Radiant Panels, Heaters, Fan Coil Units, Diffusers, Cassette units and Chilled Beams.

All units shall be adequately secured and supported in an approved manner using wire hanger suspension Y fit solution as per manufacturers' recommendation with prior approval.

Rigid Supports:

Rigid supports if required in conjunction with wire hangers shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black. Where supports and clamps are of dissimilar materials, a gasket shall be provided in between. If the MS angle at the bottom if required as per design should be as per following table:

Longer size of Duct	Type of Joints
Up to 750	25x25x3 mm L angle with M8 nuts & bolts
751-1000	25x25x3 mm L angle with M8 nuts & bolts
1001-1500	40x40x5 mm L angle with M8 nuts & bolts

1501-2250**50x50x5 mm L angle with M10 nuts & bolts 2251 &****Above 50x50x6 mm L angle with M10 nuts & bolts**

All the supporting system should be supplied from same manufacturer.

INSULATION**1. SCOPE**

The scope of this section comprises the supply and application of insulation conforming to these specifications.

2. MATERIAL**Elastomeric Nitrile Rubber**

Insulation material for Duct & Pipe insulation shall be anti-microbial closed cell Elastomeric Nitrile Rubber. Thermal conductivity of the insulation material shall not exceed 0.037 W/moK at an average temperature of 24oC. Density of the nitrile rubber shall be 40-60 Kg/m³. The product shall have temperature range of -40oC to 105oC. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa i.e. $\mu=7000$: Water vapour diffusion resistance). The material shall have approval from the Chief Fire Officer.

OR**Chemically Cross-linked Polyethylene Foam**

Thermal insulation material for Duct & Pipe insulation shall be anti-microbial closed cell chemically cross-linked polyethylene foam. Thermal conductivity of the insulation material shall not exceed 0.032 W/moK at an average temperature of 25oC. Density of the material shall be 25-30 Kg/m³. The product shall have temperature range of -40oC to 105oC. The insulation material shall be fire rated for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test and Class 0 (or alternatively, Class 1) as per BS 476 Part 6 for fire propagation test. Water vapour permeability as per DIN 52615 shall not exceed 0.15ng/Pa.sec.m.

Thermal conductivity of the material shall not be affected by ageing, as per DIN 52616. The material must be tested for ageing effect in an accredited laboratory for a minimum period of five years to satisfy the ageing criteria. The smoke density of the material as per AS-1530.3 shall not exceed 1. There shall be no toxicity in the emitted smoke, both under flaming and non- flaming conditions, as per AITM 3.000 (1993).

The insulation shall comprise of a single layer up to 18 mm thickness.

The material shall be antimicrobial as per ISO 22196, C1338 and ASTM G21-96. There shall be no growth of fungus and mould.

OR**For Duct & Pipe Insulation****Resin Bonded Non-combustible Grade Rockwool**

Thermal insulation material for Duct insulation shall be Rockloyd Resin Bonded non- combustible Grade Rockwool (tested to BS: 476 Parts 4,5,6,7) of density 48 kg/m³ conforming to IS : 8183-1993. Material shall be in the form of slabs or rolls of uniform thickness and laminated with aluminium foil. The 'K' value at 10°C shall not exceed 0.029 Kcal/m.hr0C (0.030 W/mK).The

Product shall have temperature range of -10°C to $+750^{\circ}\text{C}$ Thermal insulation material for Pipe insulation shall be Rockloyd Resin Bonded Rockwool Pipe section (tested to BS : 476 Parts 4,5,6,7) with or without aluminum foil lamination of density 144kg/m^3 conforming to IS : 8183-1993. The 'K' value at 10°C shall not exceed $0.0370\text{ Kcal/m.hr}^{\circ}\text{C}$ (0.0430 W/mK). The Product shall have temperature range of -10°C to $+750^{\circ}\text{C}$ Isoloyd-d-Nil-flame Polyisocyanurate Foam (PIR) Rigid Slab & Pipe section (CFC Free)

Thermal insulation material for duct insulation shall be Iso loyd Nil flame Polyisocyanurate Foam (PIR) Rigid Slab with aluminum foil lamination of density $32\pm 2\text{ kg/m}^3$ and 'K' value shall not exceed $0.020\text{ Kcal/m.hr}^{\circ}\text{C}$ (0.023 W/mK) at mean temperature of 10°C conforming to IS:12436 : 1988. It conforms to BS:476 Part-71987) & 5(1968) and water vapour transmission conforms to BS: 4370 Part-2(1972). Conforms to "Class O".

Thermal insulation material for Pipe insulation shall be IsoloydNilflamePolyisocyanurate Foam (PIR) Pipe section (Also available Shiplap Pipe section) with or without aluminum foil lamination, which acts as ready-made vapour barrier, of density $32\pm 2\text{ kg/m}^3$ and 'K' value shall not exceed $0.020\text{ Kcal/m.hr}^{\circ}\text{C}$ (0.023 W/mK) at mean temperature of 10°C conforming to IS:12436 : 1988. It conforms to BS:476 Part-71987) & 5(1968) and water vapour transmission conforms to BS: 4370 Part-2(1972). Conforms to "Class O".

OR

For Pipe Insulation only

Polyurethane Foam Insulation Rigid Pipe section (CFC Free)

Super foam Polyurethane Foam Pipe section (Also available Shiplap Pipe section), machine cut from buns and ready to use with or without aluminum foil lamination, which acts as ready-made vapour barrier, of density $36\pm 2\text{ kg/m}^3$ and 'K' value shall not exceed $0.020\text{ Kcal/m.hr}^{\circ}\text{C}$ (0.023 W/mK) at mean temperature of 10°C conforming to IS : 12436- 1988 and BS: 476 Part-5(1968) and water vapour transmission conforms to BS:4370 Part- 2(1972) Insulation material for Duct Acoustic Lining shall be elastomeric Nitrile rubber.

OR

The acoustic lining shall consist of 25mm rigid slabs of Rockloyd Resin Bonded non-combustible Grade Rockwool of density of 64 kg/m^3 . Then it shall be covered by 26G perforated aluminium sheets having min. 15% perforation.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be non-flammable, vapour proof adhesive strictly as per manufacturer's recommendations.

Ducting insulation thickness shall be as per table below.

Elastomeric Nitrile Rubber with factory laminated black glass cloth

Ducting position	Thickness for non-coastal places	Thickness for coastal places
SA duct in RA path	13mm	16mm
Ducted return air system SA duct: 19mm RA duct: 9mm SA duct: 32mm RA duct: 13mm		

Both SA& RA exposed	Both 25mm	Both 32mm
--------------------------------	------------------	------------------

Cross linked Polyethylene foam with factory laminated black glass cloth/ Aluminium foil facing

Ducting position	Thickness for non- coastal places	Thickness for coastal places
SA duct in RA path	13mm	19mm

Ducted return air sys SA duct: 19mm RA duct: 13mm SA duct: 25mm RA duct: 19mm

Both SA& RA exposed	Both 25mm	Both 25mm
--------------------------------	------------------	------------------

Rigid Polyisocyanurate Foam Insulation (CFC Free)

Ducting position	Thk. For non-coastal places	Thk. For coastal places
SA duct in RA path	25mm	30mm

Ducted return air sys SA duct:30mm RA duct:25mm SA duct:40mm RA duct:30mm

Both SA & RA exposed	Both 40mm	Both 40mm
---------------------------------	------------------	------------------

Resin Bonded Rockwool Insulation

Ducting position	Thk. For non-coastal places	Thk. For coastal places
SA duct in RA path	25mm	40mm

Ducted return air sys SA duct:40mm RA duct:25mm SA duct:50mm RA duct:40mm

Both SA & RA exposed	Both 65mm	Both 65mm
---------------------------------	------------------	------------------

3. DUCT ACOUSTIC LINING

Insulation material for Duct Acoustic Lining shall be elastomeric Nitrile rubber.

Material shall be engineered Nitrile Rubber open cell foam. The material should be fibre free. The density of the same shall be within 140-180 Kg/m³. It should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C . The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -200°C. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7). Thickness of the material shall be as specified for the individual application. The insulation should be installed as per manufacturer's recommendation. The adhesive shall be specially formulated for the Duct insulation application and supplied by insulation manufacturer. The adhesive shall be Solvent based rubber insulation adhesive, free from benzene. Ducts so identified and marked on Drawings and included in Schedule of Quantities shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters (or 30% of the duct length whichever is more).

Installation Procedure

The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface

OR

Insulation material for Duct Acoustic Lining shall be resin bonded rockwool

Material shall be Rock loyd Resin Bonded non-combustible Grade Rockwool (tested to BS: 476 Parts 4,5,6,7) of density 48 kg/m³ conforming to IS : 8183-1993. Material shall be in the form of slabs of uniform thickness and laminated with aluminium foil. The 'K' value at 10°C shall not exceed 0.029 Kcal/m.hr0C (0.030 W/mK).The Product shall have temperature range of -10°C to +750°C.Thickness of material shall be as specified for the individual application.

Ducts so identified and marked on drawings and included in schedule of quantities shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:

The inside surface for the ducts shall be covered with adhesive, and provided with 22 gauge GI Channels 25X25mm screwed back to back and fixed on the inside of the duct, spaced not more than 60 cm centre to form a frame work of 60X 60 cms². Cut panels 60X60 cms or 60X75cms of resin bonded rockwool 25mm thick shall be fitted in the squares or 60X75cms rectangles.

These insulation panels shall be fixed to the sheet metal with cold setting adhesives compound. The inner most surface shall be covered with fiberglass tissue and 28gauge perforated aluminium sheet having at least 15 percent perforations. The aluminum sheet shall be screwed to GI channels using cup washer and neatly finished to give true inside surface.

4. DUCT INSULATION

External thermal insulation shall be provided as follows:

The thickness of nitrile rubber/cross linked polyethylene foam (XLPE)and shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber/XLPE and sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber/XLPE and sheets shall be done with adjustable blade to make 900 cut in thickness of nitrile rubber/XLPE sheet. Hackshaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide nitrile rubber tape/3mm thick 50mm wide XLPE tape. The adhesive shall be strictly as recommended by the manufacturer.

OR

External thermal Insulation shall be provided as follows;

The thickness of Resin Bonded Rockwool / Polyisocynurate foam (PIR) insulation slab with Al. foil lamination shall be as shown in drawing or identified in the schedule of quantity, following procedure shall be adhered to:

Duct Surface shall be cleaned to remove all the grease, oil, dirt prior to carrying out insulation work. Material shall be fitted under compression and no stretching of material shall be permitted.

Fix self-adhesive GI Pins / fasteners of appropriate length at regular interval of 300mm on top, 180mm on sides and at 150mm interval at the bottom. A layer of suitable adhesive shall be applied on the metal surface. When adhesive is tack dry, insulating material shall be placed in position and pressed firmly to achieve a good bond and secured to ducts by means of metal staples or insulation stick pins. These pins shall be applied on 600mm centers on all duct surfaces.

All longitudinal and transverse joints shall be sealed by providing 75mm wide reinforced Aluminum tape (duct tape). PUF battens shall be provided at duct locations to ensure insulation does not compress at duct support locations. The entire duct shall clad with suitable thick aluminum sheets.

	RW	PIR
AC duct in conditioned space	25 mm	25 mm
AC duct in unconditioned space AC	50 mm	30 mm
duct with treated fresh air	50 mm	30 mm

5. PIPING INSULATION

All chilled water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipes shall be brushed and cleaned. All MS pipes shall be provided with a coat of zinc chromate primer. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Elastomeric Nitrile Rubber with factory laminated black glass cloth

Pipe nominal bore	Thickness for non-coastal places	Thickness for coastal places
15mm – 40mm	25mm	32mm
50mm – 150mm	25mm	38mm
200mm – 300mm	32mm	44mm
350mm – 600mm	32mm	44mm

Cross linked Polyethylene foam with factory laminated black glass cloth/ Aluminium foil facing

Pipe nominal bore	Thickness for non-coastal places	Thickness for coastal places
15mm – 40mm	20mm	25mm
50mm – 80mm	25mm	32mm
100mm – 300mm	30mm	38mm
350mm – 600mm	40mm	45mm

Insulating material in tube form shall be sleeved on the pipes. On piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension using correct tools. Scissors or Hacksaw-blade shall not be allowed. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. All longitudinal and transverse joints shall be sealed by providing 6 mm thick, 50 mm wide nitrile rubber tape or 3mm thick, 50mm wide XLPE tape. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above.

Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced. Manufacturer's installation manual shall be submitted and followed for full compliance. All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. Un-insulated MS pipes shall be painted throughout and direction of fluid marked. All painting shall be as per relevant BIS codes.

Pipe section/In-situ PIR/PUF

Pipe Nominal Bore	Thickness for Non Coastal places	Thickness for Coastal places
15mm to 25mm	40mm	50 mm
32mm to 80mm	50 mm	60 mm
100mm to 400mm	60 mm	65 mm
Above 400mm	70 mm	70 mm

The above thicknesses are designed for heat ingress of 5.5W/m² at 10°C operating temperature of chilled water and to prevent surface condensation at 35°C ambient temperature, 85% relative humidity

Premoulded pipe sections shall be placed over the pipes, the longitudinal and transversal joints of these pipe sections shall be sealed with the adhesive compound. The insulation shall be continuous over the entire run of piping, fittings and valves.

If owner allows option for Cast in-Situ foaming the same can be suggested with correct application procedure. Superfoam Polyurethane Foam insulation (PUF) applied by Cast in- situ foaming method at a density of 40±2 kg/m³. The system shall be in accordance with IS: 13205.

Method of application

Surface to be insulated shall be cleaned properly & if the surface is painted ensure that there is no damage to protective layer due to cleaning. Pre Formed Pipe Sections of required thickness should be fixed with adhesive as specified by manufacturer. The joints of pre Formed Sections shall be sealed with the specified sealant as per directions of manufacturer. The insulation shall be secured with bands / Tape at 300mm centre to centre distance. Vapour Barrier mastic, in two coats, with a fabric shall be applied for reinforcement in between. Provide and fix external protection, if any (such as metal cladding / Weather Barrier) over the above taking care to see that the Vapour Barrier layer is neither disturbed nor damaged. All longitudinal and transverse joints in the outer

cladding shall have a minimum overlap of 50mm duly beaded and grooved and shall be sealed suitable.

Manufacturer's installation manual shall be submitted and followed for full compliance. All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 300mm wide band of paint along circumference at every 1200mm for colour coding. Direction of fluid shall be marked. Un-insulated MS pipe shall be painted through and direction of fluid marked. All painting shall be as per BIS codes.

PRE-INSULATED PIPES: Polyurethane foam Insulation

All buried chilled water pipes and condensate drain pipes shall be preinsulated type. Buried chilled water pipes and condensate drain pipes are shown on layout drawings.

The system shall be non-corrosive, non-metallic, structurally strong completely water proof and entirely resistance to attack by salts, water and all ground chemicals normally encountered. The system manufacturer shall have fabricated systems of the composition defined here for at least five years.

All straight sections fittings, anchors end seals and other accessories shall be factory prefabricated to the project dimensions. The same may be allowed at site if OWNER permits. Pipe movement due to thermal expansion shall be accommodated with expansion loops or elbows. PVC warning tape shall be provided 300 mm above the buried throughout the length of the pipe (By others).

Pre-insulated, jacketed pipe work shall conform to the following specifications.

The core pipe shall be MS, ERW heavy duty class to comply with thickness as mentioned in BOQ. All pipes shall be with bevelled ends for welded joint.

The insulation shall be Lloydfoam rigid cellular polyurethane foam, injected between the core pipe and the outer casing/jacket, having a density of 40kg/m³ (2.5 lbs/ft³) nominal and thermal conductivity coefficient of 0.021W/m²°K maximum at a mean temperature of 24°C (75°F). The insulation shall meet IS 12436 specifications with typical operating temperature between -30°C to +100°C.

The outer casing/jacket shall be made of extruded high-density Polyethylene (HDPE) pipe having a density of 900 to 960 kg/m³. HDPE wall thickness shall be 4mm thick for 60.3 mm dia and above. For small bore pipes (below 60.3mm) available HDPE pipes shall be used, where thickness can be lower than 4mm as per standard for HDPE pipes. Material shall be UV resistant.

Pre-insulation process shall be by high pressure foaming machine. Due care shall be taken to avoid air gaps. All ends of straight pipes and fittings shall be sealed with polyolefin end seal, applied to the exposed ends of the insulation for protection against moisture ingress.

The field joint insulation shall consist of polyurethane foam chemical poured into a 4mm thick HDPE sheet roll-up around the joint. Contractor shall provide methodology for approval of consultant before proceeding with work at site.

6. MECHANICAL AND UV PROTECTION OVER INSULATION

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber as indicated in BOQ shall be covered with fibre glass fabric of 7 mil minimum thickness. Insulated pipes & ducts exposed to UV rays shall be covered with fibre glass fabric. Over the fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure

to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

Closed cell cross linked polyethylene foam shall be provided with factory laminated aluminum film foil for indoor applications or with factory laminated fiber glass cloth facing for external (exposed) applications. Over the fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure to non-stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

OR

Rockwool/PUF/PIR insulation shall be provided with factory laminated Aluminum foil for both pipe and duct insulation.

To provide extra mechanical strength & protection from damage all pipe insulated with Rockwool/PUF/PIR as indicated in BOQ shall be covered with Aluminium roll jacketing manufactured from alloys 3105 and 3003 conforming to ASTM B-209 designation, half hard temper (H-14) up to 36" outer diameter 0.5mm thick aluminium shall be used and 0.8mm (above 36" dia) shall be used. AL cladding shall be with PolySurlyn coated moisture barrier.

Alternatively, colour coated Galvanised steel cladding of 0.5mm thick 270gsm as per IS: 277 (with colour selected by the clients) may be provided.

7. PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

8. SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

9. COLD WATER AND EXPANSION TANK INSULATION

Cold water tank and chilled water expansion tank shall be insulated as per manufacturer's standard.

10. ACOUSTIC LINING OF MECHANICAL ROOMS

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining approved material as per Schedule of Quantities and as shown on the Drawings. Installation procedure shall be as per manufacturer standard. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

OR

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of lightly resin bonded rockwool slab as per Schedule of Quantities and as shown on the Drawings. The surface shall be cleaned and frame work of 22 gauge GI fabricated channels 25 mm x 50mm screwed back to back at 60 cm centers shall be provided vertically and horizontally so that 60X 60 cm square are formed. The gaps between frames shall be filled with 50mm thick about 60cm X 60cm cut panels of lightly resin bonded Rock wool slabs. The entire surface shall then be covered with fibre glass tissue and 26 gage perforated aluminium sheet, 60cm or 120 cm wide having atleast 15 percent perforations, fixed with sheet metal screws. Overlapping of sheets shall be covered with Aluminium beading. Acoustic lining of walls shall be terminated approximately 15cm above the finished floor to prevent damage to insulation due to

accidental water-logging in plant / AHU rooms. The material shall be in accordance with IS 8183:1993

11. OVERDECK INSULATION

Overdeck insulation shall be done with 75 mm thick extruded polystyrene of density 45-48 kg/cm³ & thermal conductivity of 0.21 Btu in / ft²hr°F (at 24°C as per ASTM C – 518). Minimum compressive strength as per ASTM D-2842 shall be 570 kPa water absorption as per ASTM D-2842 shall not be more than 1%.

OR

Overdeck insulation shall be done closed cell Rigid Cellular Polyurethane foam of suitable thickness of with density 36±2 kg/cm³ & thermal conductivity of 0.21 W/mK (0.1456 Btu in/ ft² hr°F) at 10°C mean temperature Minimum compressive strength shall be 172KN/m² (min).

Method of Application

- a) Clean RCC slab and make it free from dust and other laitance matter.
- b) Lay cement based water proofing on roof with a minimum slope of 1:100 and average thickness of 110 mm using brickbats of appropriate size and shape suitable to achieve the required slope laid over 15 mm thick waterproof cement mortar 1:4 and finished with 20 mm thick waterproof plaster with cement mortar 1:4 and making false squares of 300 mm size including rounding off the junction of roof and parapet walls for a height of 300 mm with brickbats and 20 mm thick waterproof plaster and conducting necessary leakage / dampers tests, etc.
- c) Lay 65 mm thick extruded polystyrene boards/50mm thick Polyurethane foam slab over prepared surface fixing with adhesive. Adhesive shall be strictly as per recommendations from manufacturer.
- d) Lay 80 gsm geotextile fabric or 400G Polythene sheet over insulation board
- e) Lay 40 x 40 x 4 cm precast paver blocks.

(Note : If contractor is awarded work of waterproofing + overdeck insulation, follow all steps from (a) to (e). if contractor is awarded work of only overdeck insulation follow step

(c) and

(d). Rest will be done by Civil Contractor).

OR

OVERDECK INSULATION

Lloyd foam CFC free Closed Cell Spray Polyurethane Foam insulation of density 40- 45kg/m³ and thickness 40 mm. Lloyd foam conforms to IS: 12432 Part-3 and having thermal conductivity value 0.023 W/mK at 10 deg.C mean temperature. Lloyd foam has min. 92% closed cell content and negligible water absorption 0.2 kg/m³ (7 days). Lloyd foam is sprayed with the help of two components Gusmer machines, which are capable of maintaining the mix ratio at ±2% accuracy minimizing wastage

APPLICATION SPECIFICATIONS

1. Roof slab should be totally dried and free from all protrusions and depressions and should have proper sloped for free flow of water.
2. Cleaning the surface properly with wire brushes manually.

3. Providing and applying a coat of Polyurethane primer at entire roof surface @ 6-8 Sqm/Ltr.
4. Providing and applying 40mm thick closed cell CFC Free Lloydfoam sprayed Polyurethane Foam with Graco / Gusmer machine.- Lloyd foam Overdeck insulation conforming to IS : 12432 part III:2002, Density of Foam shall be 40-45kg/m³. The sprayed foam adheres instantly to the roof surface.
5. Providing and laying 400g polythene sheet over the fixed PUF Spray, for the protection and as separation layer.
6. Providing and laying in slope gradient min.40mm thick PCC(1:2:4)in chequered 2.5mtr x2.5mtr panels, reinforced with welded mesh of 75mm x 75mm x1.5mm embedded in between over the Polythene sheet
7. Sealing all joints between panels with polymerized mastic.
8. Providing suitable waterproofing treatment and final top finish as per specs or engineer in- charge.

12. UNDERDECK INSULATION

Underdeck insulation shall be 50mm thick TF Quality expanded polystyrene (32 Kg/m³) or 30mm thick phenotherm. Underdeck surface of ceiling shall be cleaned and made dirt free. Insulation panels shall be pasted on this surface with black CPRX compound. 28g wire net shall be tightened around insulation so as to avoid any kind of sagging. Ends of net shall be overlapping by at least 25mm. Overlaps shall be Magnetic Bearinged with galvanized Magnetic Bearings to avoid rusting.

OR

Iso Lloyd Nil flame Rigid CFC free PIR (Polyisocyanurate) foam insulation of 30mm thick and density of 32+2 kg/m³ having thermal conductivity value of 0.021 W/mK at 10 °C mean temp.

The slabs will have one side aluminium foil lamination it is available in slab form 1 mtr.X ½ mtr. Fire Properties Conforms to Class-O. Underdeck surface of ceiling shall be cleaned and made dirt free. Insulation panels shall be pasted on this surface with black CPRX compound and further holding it with screw.

OR

Resin Bonded Non-combustible Grade Rockwool

Under deck insulation with Resin Bonded Rockloyd Rockwool conforming to IS: 8183 and density 48 kg/ m³,50 mm thick, wrapped in 200 G Virgin Polythene bags fixed to ceiling with metallic cleats (50x50x3 mm) @ 60 cm and wire mesh of 12.5mm x 24gauge wire mesh, for top most ceiling of building.The 'K' value at 10°C shall not exceed 0.029 Kcal/m.hr0C (0.030 W/mK).The Product shall have temperature range of -10°C to +750°C

13. SOUND ATTENUATORS

Attenuators shall be installed in ducts in accordance with requirements of drawings and as included in Schedule of Quantities.

Noise levels within conditioned spaces shall be not greater than those set out in schedule below:

a. Noise Level Design Criteria

S. No.	Area	Acceptable Noise Levels (NC)
<hr/>		

- i **Guest room or Suite 25-30**
- ii **Service Apartment 25-30**
- iii **Ball Room/Meeting Rooms 25-30**
- iv **Guest floor corridors 30-35**
- v **Restaurant / Staff Dining 40-45**
- vi **Health Club-Gym. Squash, Snooker 40-45**
- vii **Public Circulation. 40-45**
- viii **Back-of-the-house areas 40-45**
- ix **Offices 30-35**
- x **Office Corridor 35-40**

- b. Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, non-hygroscopic, vermin proof, fibre glass of required density adequately protected against corrosion and covered with 26 gage perforated aluminium sheet. Attenuators shall be supplied complete with flanges.
- c. The pressure drop values of the silencers shall be indicated for each duty.
- d. Manufacturers shall submit a test certificate for acoustic and aerodynamic performance of the attenuators. Attenuators shall be tested in accordance with ACMA test methods/BS 4718 and insertion loss and self generated noise for each octave band and pressure drop shall be stated in the schedule.

14. MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

- a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

AUTOMATIC CONTROLS AND INSTRUMENTS

1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of automatic controls and instruments conforming to these Specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

2 TYPE

All automatic controls shall be electric controls as described in the various sections of these Specifications. All instruments shall be as described in the various sections of these Specifications.

3 AUTOMATIC CONTROLS

Automatic controls required for various types of machines have been described in the various sections of these specifications and shown on the Drawings. The individual safety controls and selected automatic controls, may be installed within the machines by the manufacturers before shipment. However, the following automatic controls, if not already installed on the machines, may be installed at site by the contractor, as indicated in Schedule of Quantities.

- a) Two way modulating control valve for each air handling units shall be provided in chilled water line at each air handling unit as shown on the Drawings and included in Schedule of Quantities. The valve shall be balanced, high rangeability, globe type of cast iron construction, of PN 16 rating with flanged connections. The valve shall have a minimum stroke of 15 mm and rangeability of 300. The valve actuator shall be electronic, motorized, modulating type with linear stroke, operating on 24Vac and 0-10 Vdc or 4-20 mA control signal. The actuator shall have provision for 0-10v dc position feedback signal and manual operation mode also. It shall be possible to operate the valve manually and the actuator shall switch back to auto mode when the power is restored. The valve actuator housing shall have IP 54 protection. The actuator should be suitable for a valve close-up pressure of 1.5 times the pump head or a minimum of 4 bars. Each valve shall be controlled by a space temperature controller with a provision to limit the flow through the control valve based on temperature difference across the coil
- b) Two way or Three -way diverting Valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall be provided with spring return function so that it reverts to fully bypass position when fan is shut off.
- c) Valve shall be similar to Honeywell two position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.
- d) Flow Switch shall be provided in condensing water outlet and chilled water outlet at each water chilling machine, and at each water-cooled condensing unit for refrigeration system in cold stores, as shown on Drawings and included in Schedule of Quantities. Flow switch shall prevent the compressor from starting unless the cooling water flow is established in condensing water lines, and chilled water flow is established in chilled water lines.
- e) Thermostat shall be electric, fixed differential cooling / heating type as specified herein, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes, as recommend by the manufacturer. The

profiles, mounting arrangement and exact location of thermostats shall be approved at site. Requirement of thermostats shall be as shown on Drawings and included in Schedule of Quantities.

- i. Proportional control thermostats for air conditioning application for actuating the two way or three way modulating valve at each air handling unit, as shown on Drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell model T921B/T92A or equivalent, line voltage cooling thermostat. Range shall be 56-84 degree F, differential shall be 3 degree F.
Proportionate type thermostat for air conditioning applications for modulation of two way or three- way diverting valve at each fan coil unit as shown on Drawings and included in Schedule of Quantities.
 - ii. Thermostat shall be similar to Honeywell model T694A or T4039 and RCC20 or RDF 300 Siemens, V30 CIAT, RTR72XX Eberle or equivalent cooling thermostat, for range 56-84 degree F, differential 3 degree F, with OFF-HI-MED-LO fan switch, temperature adjustment NORMAL- COOL setting. Switching off must break fan circuit.
 - iii. Snap acting fixed differential heating thermostat for electric reheat applications for putting on/off power supply to electric reheat coil in air handling unit as shown on Drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell; model T451A, two stage thermostat.
 - iv. Safety thermostat for electric reheat application for cutting off power supply to tubular heaters in case air flow across tubular heater is not established. Thermostat shall be similar to Varma Trafag model MS 95R.
- f) Humidistat may be provided with air handling unit for areas which require constant indoor humidity or humidity control with reheat, as shown on Drawings and included in Schedule of Quantities. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit, another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached.
Humidistat shall be snap acting or modulating type as per the requirement, 20-80 percent relative humidity range with differential of 5 percent. Humidistat shall have removable knob to prevent tempering of set point.
- g) Airstat and Safety thermostat may be provided as shown on Drawings and included in Schedule of Quantities, within air handling units containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

4 INSTRUMENTS

Instruments required for different types of machines have been described in the various sections of these Specifications and shown on the Drawings. Following instruments may be provided as per the requirements indicated in the Schedule of Quantities.

- a) **Thermometers:** shall be dial type 100 mm dia or V form industrial type. Body shall be aluminium alloy, anodized gold-coloured surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0°C to 60°C & +32°F to 150°F. Graduation of scale shall be 1° in both readings. Range of scales shall be 30-120 degree F (0-50 degree C) for air conditioning applications of cooling only. Quality has been included in Schedule of Quantities.

Thermometer shall be suitable for 15 mm connections. Thermometer for chilled water shall be with long stem, so that thermometer is removable without damaging the insulation. M S socket to be welded on pipes shall be provided with thermometer. Thermometers shall be installed on chilled water supply and return at each air handling unit, supply and return at each chiller and condenser as shown on the Drawings and included in Schedule of Quantities.

- b) Pressure Gages:** shall be 100 mm dia & casing made out of SS 304 installed on suction header and at discharge side of each pump, in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller and condenser, as shown on the Drawings and included in Schedule of Quantities.

Suction side gage at pump suction header shall be compound gage with 100 mm dia, range 75 cm vacuum to 10 kg (30 inch vacuum to 150 psi) pressure. Discharge sides gage at pumps and at all other locations shall be 100 mm range 0-10 kg per sq. cm (0-150 psi) pressure. Gages shall be connected to the pipes by 6 mm diameter Stainless Steel Syphon tube through a ball valve, required for gage protection.

- c) Room Thermometer:** shall be dial type, wall-hung temperature indicator, of appropriate range for cold stores and deep freezers, in accordance with the requirements of Drawings and Schedule of Quantities.
- d) Room RH Indicator:** shall be dial type, wall hung, relative humidity indicator of appropriate range, for special areas, in accordance with the requirements of Drawings and Schedule of Quantities.
- e) Electronic Thermometer:** shall be electronically operated Digital Temperature Indicator in accordance with requirement of Drawings and as included in Schedule of Quantities. The display shall be 3-5 digit Liquid Crystal Display. The thermometer shall consist of fully solid state integrated circuit. The thermometer shall have front LED 'on' indication and automatic low battery indication. The resolution shall be 1° centigrade. Thermometer shall be complete with suitable electronic sensor to accurately sense the temperature with sensor housed in suitable air-well / thermowell for air temperature / water temperature measurement. The thermometer shall be suitable for operation on 9V DC / 230V AC. The display unit shall be housed in attractive sheet metal cabinet with prominent display of conversion charts of °F & °C on front plate. Thermometer shall be complete with separable socket type interconnecting cables of 2 m length suitable for installation within a radius of 2 m of the thermowell or air sensing point.

Electronic thermometer may be installed at chilled water supply and return at selected air handling units as shown on Drawings and included in Schedule of Quantities. Range of scale shall be 30 degree F - 120 degree F (0-50 degree C) for air conditioning application.

TWO WAY MODULATING / PRESSURE INDEPENDENT/ BALANCING and FLOW CONTROL VALVE

The Self balancing flow control valves that are pressure independent, 2-way, modulating to accept Input signals from the control system.

Each Air Handling Unit / Fan Coil Unit shall be provided with a 2Way Pressure Independent Balancing and Control Valve integrated in a single Body. The valve should be a Globe Type.

Diaphragm based delta p controller should ensure 100% valve authority & linear characteristics at all loads and all settings.

Regarding Control - Valve should be equipped with electronic modulating gear type spring return actuator which can accept either "4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

All Valve actuators should be microprocessor based with self-calibrating feature.

Valve Actuator combination should be able to give logarithmic control characteristics to achieve linear control.

Actuator shall be able to work against pump head or maximum closing pressure. Manual Override Flow Balancing should only be done in Valve, not in actuator and should not involve opening of actuator Body.

Regarding Balancing - Each Valve should have a stepless adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible.

VALVE SPECIFICATIONS

Description	For 15 to 32 mm	For 40 to 250 mm
Diff Pressure (P1-P3)	16 To 400 kPa	30 To 400 kPa
Media Temperature	-10 ° to 120 °C, to 248 °F	-10 ° to 120 °C, to 248 °F
Body Material	Brass (CuZn40Pb2 - CW 617N)	Grey iron EN-GJL-250(GG25)
Test Ports	Needle measuring nipple	Needle measuring nipple
Leakage acc. to standard IEC 534	No visible leakage (at 100N)	max.0,01 - 0.05% of kv at 650N
Stem Seals	EPDM - CuZn40Pb2 - CW 617N	EPDM -NBR
Maximum Close Off Pr	1600 kPa,	1600 kPa,
Pressure rating	PN16	PN16
Control Range	Standard IEC 534 Since CV Characteristic is Linear Control Range is Infinity	
Control Valve Character	Valve Actuator combination should be able to give logarithmic control characteristics to achieve linear control	

ACTUATOR SPECIFICATIONS FOR ALL SIZES

For Valve Sizes	15- 32mm	40- 100mm	125-150mm
Actuator Type	Modulating Spring return	Modulating Spring return	Modulating Spring return
Supply Voltage	24Volt AC	24Volt AC/DC	24Volt AC
Frequency	50Hz/60 Hz	50Hz/60 Hz	50Hz/60 Hz
Power Consumption	9VA	14 VA	19.2VA
Close of Force	300N	450N	2000N
Maximum Stroke	5mm	15mm	50mm
Speed	14 Seconds/mm	15Seconds/mm	2 or 6 Seconds/mm
Protection	IP54	IP54	IP54
Body	Non Corrosive Actuator Body		
Weight	1.8Kg	2.3Kg	8.6 Kg
Safety function	Yes	Yes	Yes

6 CALIBRATION AND TESTING

All automatic controls and instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and their accuracy shall be guaranteed by the manufacturer. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installation.

Technical Specifications for Modular Pre-Fabricated Operation Theatres

GENERAL

Modular OT should be as per Class 500 (CLEAN ROOM STANDARD), BSEN-5682, BSEN 12150 WITH R300mm standard & Design. For Quality assurance, ZED Certificate (Minimum Bronze) should be produced and Products should be manufactured by ISO 9001:2016, ISO 13485:2016 & ISO 7396-1-2016 certified company having enlistment with NSIC, MSME.

In an operation theatre for which the most integrated function is required, cleanliness and sterile area. Air inside the Class 100 MOT must be kept 99.97% pure all time with temperature ranging between 18°C - 21°C, humidity level 25% - 40% must be kept and the safety of facilities, equipments and devices must be maintained any times. Furthermore, the working environment for medical staff such as Doctors and nurses must be considered from the view point of human engineering.

Only Seamless Modular Operation Theatre CLASS 500 SS 304 satisfying those conditions like consists of wall, ceiling, corner & 3D Corner panels, and it is capable of incorporating not only electrical equipment, medical equipment's, medical gas pipe system and lighting equipments but all the necessary functions and equipments at need. The Modular Operation Theatre as per NABH guidelines/ Standards must be remaining all the time under positive pressure up to 15 PSI & 20-25 air changes per hour. The highest quality seamless glass operating room must be as per Class 100 standard.

TECHNICAL SPECIFICATION

The MOT shall comprise of free-standing wall substructure, SS wall panelling system, SS ceiling system, conductive flooring with necessary levelling, laminar air flow system, SS Exhaust air Cabinet with bottom fluff strainers, Auto/manual doors having double glass window in door leaf with necessary operators, illumination peripheral lights, Operating Theatre lights, HD Cameras, Monitor & recorder, Control Panel, X-Ray viewing screen, Writing board, scrub station. The Modular OT wall system shall have certification for hygiene, noise protection, radiation resistance/ protection & fire resistance /protection. The bidders shall provide Test Reports/certification. a. The fire resistance for single panelled wall system including substructure work should confirm to Class A2, according to DIN 4102/ BIS (or equivalent) required. b. Metal structure work should be in accordance to DIN 18360/ BIS (or equivalent) to be certified by

manufacturer/ installer. c. The Manufacturer must be member of Green Building Council (IGBC). GRIHA Certificate for Modular Wall Panel to be produced in accordance to relevant criterion specific to project. (These IGBC/ GRIHA standards are related to complete building as the MOT is a part of building.)

WALL & CEILING SYSTEM

It should be made of galvanized steel having thickness not less than 1.5mm. This steel substructure will provide backing for prefabricated wall panels mounting and flush mounted equipment, display and control units, storage etc. The cavity between the inner and outer walls should be left with minimum obstructions for the possible addition of equipment at a later date and to enable services, pipes, conduits etc., to be run within the cavity.

Wall & Ceiling shall comprise of:

1. Pre- Fabricated SS Sandwich Wall Panelling System.
2. Pre- Fabricated Theatre SS-304 Round Corner.
3. Pre- Fabricated Modular OT SS 304 Sandwich Ceiling Panelling System.

ANTI STATIC CONDUCTIVE PVC FLOORING:

Providing, fixing, supply and Installation of seamless antistatic & conductive flooring, 2 mm thick, 2'x2' size with perfectly curved flash covings, all joints welded as per the colour and pattern approved by hospital. The tiles are to be laid on the smooth & levelled floor with anti-fungal & anti-bacterial adhesive.

The conductive copper grid laid underneath the PVC sheet should be supported by liquid epoxy compounds allowed to set as a uniform and level surface. The copper strips to be made visible by grinding and no copper strip should project more than 0.5 mm above level surface to avoid damage to the PVC sheet. One earthing lead should be brought out from 150 sq Ft area and attaching it to the main earthing strip/ground. The floor should efficiently discharge electric charge up to 2 Kv.

DIGITAL TOUCH SCREEN OT CONTROL PANEL:

Providing, fixing, supply, Installation, testing and commissioning of digital touch screen control panel, wall mounted in the theatre wall comprising of the following:

- The control panel shall be touching screen panel. This control panel shall work as the central control panel for the HVAC controls, instruction board, touches screen and ON/OFF of MOT light.
- The touch screen shall be wall mounted, stationed in the visibility line of the surgeon and MOT staff. The access height shall be convenient for the nurse to operate.
- The panel shall accommodate digital clock and the elapsed time indicator.
- The medical gas alarm shall indicate high and low gas pressures for each gas service (except for vacuum, for vacuum it shall be normal or low) present in the MOT.
- This shall be supported by audio visual alarm also. The panel shall have an alarm mute (fault annunciation) facility. The sensors (pressure switches) shall be at the nearest isolation valve.
- It shall have control for general lighting: ON/OFF and dimming controls organized in groups to provide uniform illumination.
- On/Off operation of the operating light (major and satellite) shall be provided.
- Hands free telephone set with memory shall be located at one side.

- Temperature and humidity control for the room connected to the AHU (adjustable from the panel) shall be provided. There shall be a provision of MOT temperature adjustment from the controller (temp adjustment of +/-5 oC to be achieved within 5 minutes against the current temperature).
- The separate AHU is provided for each MOT.
- Digital room pressure indicator in cm of H₂O or equivalent shall be provided (signal from pressure
- Sensor shall be provided to indicate pressure differential between MOT and outside). HEPA filter bank differential pressure indicator shall be provided.
- The Control Panel should have the option to be able to be integrated with HIS (Hospital Information System)/BMS
- The Control Panel shall be able to display the Isolation Panel Alarm Conditions along with MGPS Alarms.

CEILING AIR MANAGEMENT SYSTEM:

Laminar Air Flow H14 HEPA System: The ceiling filtration system should be designed to ensure unidirectional distribution of sterile air with differential flow velocities decreasing from centre to perimeter of the surgical theatre to ensure the cleanliness of all the area covered by the air flow. The ceiling system should be equipped with HEPA filters with different performances according to their position in the ceiling to achieve different flow velocities. The complete filtration ceiling system should be factory assembled its holding structure; Filter frames and top plenum should be made of ANSI (OR EQUILANT) 304 SS stainless steel. boards OR (DOUBLE SKIN PANELS, BOTH SIDE 0.6 mm thick SS 304 SHEET & INFILL OF FIRE-RESISTANT PUFF OF 40 DENSITY also having TOUNG & GROVE

TECNOLOGY) Filtration ceiling system should have HEPA filters, according to EN1822 or ISO 29463. the filtration ceiling system should have flow equalizer to achieve uniform & constant air distribution over the whole surface it should also have connection for surgical lamp to be fitted in place of any filter. The HEPA filters should have dust spot efficiency of 99.997% for 0.3-micron particles. Number of air changes should be such that clean room classification can be maintained at Class 100, as per ISO 14644 System shall have CE mark as per MDD 93/42/EEC. Air extraction modules of the laminar flow system having two openings each, should be placed at four corners of the OT. The material of construction of the front cladding panel should be same as that of wall panels, and for riser duct may be same as that of air ducting inside OT. The extraction module openings should have suitable grills with fine washable filter, for easy cleaning and prevent residue build-up in the extraction chamber.

HEPA Filters Specification:

Frame – Aluminium

Type- Flange type.

Media- Micro Fiber Glass (Imported)

Sealing of media- By means of epoxy.

Efficiency- 99.99 % down to 0.3-micron particle size.

I.P.D-< 15 mm WG

F.P.D.- 50 mm WG

All should be **CE certified**.

PANEL LED X RAY VIEWER

Providing, fixing, supply, Installation, testing and commissioning of 3 panel dimmable X-Ray viewing screen designed to provide a high level of control luminance without flicker. Proper spring-loaded film clips with rollers should be provided to hold the films firmly and to remove the film without scratches. Each panel should be able to illuminate films up to 14”X17” size. (Total 3 panels in each OT).

PRESSURE RELIEF DAMPERS (STAINLESS STEEL)

Pressure relief dampers should be provided in each room to prevent contamination of air from clean and dirty areas. Suitably sized air pressure relief damper should be strategically placed, enabling differential room pressure to be maintained and ensured when doors are opened. Counter-weight balancing system should be provided in the PRD to maintain positive pressure inside the operation room. Air pressure stabilizers should have unique capability of controlling differential pressure to close tolerance. The PRD should remain closed at pressure below the set pressure and should open fully at pressure only fractionally above the threshold pressure of 25 KPa. The body should be stainless steel grade 304 with stainless steel grill. Stainless Steel 304 Grade Plate should be used for body and with high grade SS 304 stainless steel for blades. Overall size of the P.R.D: 305 x 335mm or as per room size.

PRESSURE STABILIZER (WITH SS BLADES)

Providing, Fixing, Supply Installation and Commission of proper pressure Relief Dampers Having multi 304 graded stainless-steel blade for maintaining the positive pressure inside the operation theatre.

- Pressure relief dampers of over flow ports should be provide in each operating room.
- Suitably sized air pressure relief damper should be strategically placed, enabling differential room pressure to be maintained and ensure that when doors are opened between clean and dirty areas.
- Counter – weight balancing system should be provided in the PRD to maintain positive pressure inside the operation room.
- Air pressure stabilizes should have unique capability of controlling differential pressure to close at a pressure only fractionally above the threshold pressure
- The body should be epoxy powder coated as per standard BS colours. High grade electrolyzed steel plate should be used for body and high grade SS304 stainless steel for blades. Total 3 or more blades should be provided.

STORAGE UNIT, SS CABINET GLASS DOORS & SHELFs

The storage unit made from 1.5 mm of Stainless steel of SS304 grade. The doors shutter of the storage cabinet should house glass, and should be installed on the storage units with the help of fittings allowing an opening allowance of at least 160. The storage unit should be divided in 2 equal parts and each part should have individual doors with stopper system. Each part should be provided with glass racks as per user department, and should be adjustable type. The storage unit should be divided 2 or more parts and each part should have individual glass doors with high quality locking system. The shelves should be welded SS mesh of size 3 mm and grid size 30mm X 30 mm removable for cleaning. It should be continuously ventilated by positive air in the room through ventilation holes provided at the bottom and top of opposite sides.

WRITING BOARD/WHITE BOARD

Supply & Installation of writing board/white board of size 900/600 mm flush mounted 1.60 mm thick white laminate board, bonded to a 40 mm high density fiber board sheet.

HERMETICALLY SEALED DOOR & FRAMES

The doors of the theatres should maintain sterility and the correct air pressure in the room. All doors into and out should be of the sliding, 100% hermetically sealing type. These doors should be durable and with ease of control, and versatility for clean environments. Each door should have vision panels of a minimum size of 300mm X 300 mm. In case of 2 doors, each leaf should have vision panels of a minimum size of 300mm X 300 mm. The doors should meet the following specifications:

The doorframe and the door panels should be made of high-quality ANSI 304 Stainless Steel that can withstand high abrasion. Permissible Noise level is 60 DB.

MEDICAL GAS PIPELINE SYSTEM INSIDE THE EACH OT

- To provide oxygen, air, vacuum, AGSS and nitrous oxide supply to operation theatre from the existing lines terminated outside the OT.
- The contractor should be responsible for supply, Installation, testing and commissioning of complete medical GAS Pipe line system inside the operation theatre including Distribution piping, Pendants outlets and other essential accessories.
- Terminal units should be gas specific and only accept medical gas probe. Gas specific components shall be pin indexed to ensure that a correct gas specific assembly is accepted.
- Each terminal unit and pipe-line should be identified by the appropriate recognized name or symbol, colour, coding and shape as per HTM 02-01 Outlets should be CE certified/UL listed.
- In MGPS, copper pipes should be of solid drawn, seamless, deoxidized, non-arsenical, and half hard, tempered and degreased copper pipe. All copper pipes should be degreased and delivered capped at both ends. The pipes should be accompanied with manufacturer's test certificate for the physical properties and chemical composition. The copper pipe should comply with EN 12448.
- Fittings should be of copper and suitable for a working pressure of up to 17 bar and especially made for brazed socket type connections.
- The copper fitting should comply with EN 1254-1
- The brazing filler material should comply with EN1044.
- Copper pipe must have reputed third party inspection certificate (Eg. Lloyd's, TUV, SGS)

HERMETICALLY SEALED LED PERIPHERY LIGHT TRAYS FOR CLEAN ROOM LUMINANCE

- To provide peripheral lighting and clean room laminate min 500 Luxs of size 1200x300x75 It should be 8 in numbers for each OT. Should be with highly specular anodized aluminium reflectors and optical antiglare system
- Luminaires cover should be made of highly resistant, disinfectant proof laminated safety glass with stylish fine-grained surface, glass panel with white coated steel frame.
- The reflectors should be of high Quality, cleanable and non deteriorating.
- The white luminaire's body should be made of sheet/perfectly powder coated, supplied ready for connection optionally for individual or series circuit with digital electronic

control gear in milliamp technology.

- Recess frames should be gas tight. The fitting should be flush with the ceiling and should be removable from top or bottom. The light fitting should be uniformly and aesthetically distributed on the ceiling to provide uniform illumination in the OT light should not interfere when green mode endoscopy is performed.
- Peripheral lighting should be done according to IP65 (international protection rating 65).
- Control equipment for the general lighting and the light dimming should be providing in the theatre control panel.

REMOTE CONTROLLED LED, DOUBLE DOME, OT LIGHT WITH CAMERA & MEDICAL GRADE MONITOR

MOT light with camera monitor and recorder MOT surgical lighting system shall provide an ideal combination of brightness, manoeuvrability and shadow resolution without sacrificing colour and accuracy through a consistent LED technology. Such lighting system shall have the following specs.

- | | |
|--|---|
| 1. Colour Temperature range | 3800 K to 5000 K ($\pm 10\%$) variable colour temp. |
| 2. Field size diameter | 20 to 28 cm ($\pm 10\%$) |
| 3. Working range | 750 to 1100 mm ($\pm 10\%$) |
| 4. Illumination level minimum & minordome) | 160000 lux (both for major dome & minordome) |
| 5. Controls Control panel | 2 one on the wall and other on dome) |

CAMERA FOR OT

the centre of the one of the domes of this lighting system/third arm in order to capture images and video sequences of the open cases. Such a autofocus- lockable camera shall have the following specification.

- | | |
|---------------------------------|--|
| 1. Signal to noise ratio | >50 DB CCD/CMOS: 1/3" or 1/2.8"(S/N Ratio) |
| 2. Optical Zoom | 10 x digital zoom 12-15 x |
| 3. Video output | HD, DVI, S-video and composite |
| 4. Video white balance and gain | Automatic/Manual |

High-Definition Camera: The OT lights and camera system should have CE certification. The Camera should have full HD video Output and following specification:

- | | |
|---------------------|--------------------------------------|
| 5. CCD Sensor | – 1/3 type CMOS (Progressive Scan) |
| 6. Zoom | – 20x - 20x (200x with optical zoom) |
| 7. Signal | – HD 1080 |
| 8. Effective Pixels | - Approx. 2 million |

9. Aperture – F1.8 – F2.1
10. White Balance – Auto/ Manual
11. Focus System – Yes (lockable)
12. Antiflicker – Integrated
13. Freeze – Integrated
14. Contrast Enhancement – Auto
15. Location of camera – Integrated within OT light
16. Monitor for HD Camera
17. Picture Size > 24.0”
18. LCD Panel – Active Matrix
19. Resolution – 1920 x 1200

NOTE: MOT light and integrated camera shall have a control through touch panel of the control equipment placed inside the operating room.

(For all other items please follow the NHM/IPHS/CPWD guideline)

TECHNICAL SPECIFICATIONS FOR MEDICAL GAS PIPING SYSTEM

General

Supply, Installation, Testing and Commissioning of complete Medical Gases Pipeline System, all the components must comply as per the referred below standards and the manufacturing company/bidder must be having minimum 7 years in existence (manufacturing experience) from the date of inception of registration/ foundation (Certificate of Incorporation Form 1 should be submitted as a proof of incorporation) with same trade name / Brand name (Trade name/brand name must be registered with Trademark Registry, Govt. of India, New Delhi – Certificate should be submitted). Tenderer should submit certificate of registration of original equipment manufacturer. Manufacturing company (Tenderer should submit Udyog Udyam and NSIC certificate as a proof of manufacturer) all the products from source to delivery must be from single origin (or compatible origin/manufacture) for better compatibility. Bidder must provide country of origin certificate at the time of supply (quality management of the company and ISO 9001:2015, ISO 13485:2016 & ISO 7396-1:2016). All materials, installation and workmanship shall comply with the applicable requirements and standards addressed. All specifications should be as per following standard. HTM 2022/02 01, or NFPA 99, or ISO 7396-1, 2 or DIN standard where ever mentioned.

Manifolds, Emergency manifolds / system, fully automatic control panels, Medical Air Plant, Medical Vacuum Plant, Surgical Air Plant, AGSS/ WAGD plant, Gas Outlets, Alarms, Isolation Valves, and Valves Box with isolation valves, medical grade copper pipes and fittings.

Contractor shall be responsible for free maintenance of Gas pipeline system, other plants and manifolds during warranty (DLP+CSMC) period. Bidder shall be responsible for supply, installation, testing and commissioning of Oxygen manifold system, Vacuum plant, Air plant, AGSS system, Medical Gas lines, Area valve service units, Alarm systems Gas outlets and OT pendants & all related equipment's & systems i.e. MGPS complete as per HTM 02-01 / NFPA 99 / BSEN ISO 7396-1,2:2007 / DIN standards Bidder should provide factory test certificates for the materials used. Bidder should supply complete set of Spare parts manuals, service manuals and user manuals for all the systems and subsystems to be supplied.

Scope includes:

- Oxygen supply system
- Nitrous Oxide supply system
- Carbon dioxide supply system
- Medical Compressed air system
- Surgical compressed air system
- Medical Vacuum system
- Anesthetic gas scavenging system/ WAGD
- Integrated Zonal valve box with touch screen digital alarm
- Medical gas outlet points
- Pipe Distribution system
- Area Isolation Valve assemblies
- Master alarm panel
- Bed head panels/Bed head units
- Accessories

PRODUCT SPECIFICATIONS

OXYGEN SUPPLY SYSTEM: Should be as per HTM 2022/02-01, BSEN 7396-1-2016/DIN, ZED Certified and control panel will be fully automatic.

The manifold control panel shall be type tested for electrical safety to BS EN 60601-1, EMC tested for emission to BS EN 55011 and for immunity to BS EN 60601-1-2, full certification (From manufacturer) shall be provided with each manifold control panel Pressure regulators and line pressure regulators must be compliant to EN ISO 10524-2:2005, 2006 Fully automatic control panel must ensure complete seamless operation should be designed and certified for use with medical oxygen at (150 Kg/ Cm² or 2250 PSI @ - 10°C to 50°C) 300 bar +10° to +60°C degree Celsius. The rated flow capacity of the automatic control panel (with one of the second stage regulator in operation) should 2000 LPM at 4.2 bar max line distribution pressure to meet flow rate capacity (The changeover system should be of multiple 3 – 4 or more shuttle valve and should be operated pneumatically without any electricity to ensure uninterrupted oxygen supply in case of power failure, may be for long time). There shall be two separate stages of pressure regulation to enable high peak flow rates without a reduction in line pressure. The system shall be duplexed such that any single component failure will not affect the integrity of the medical gas supply. All regulators shall be protected against over pressurization by relief valves which shall be pre piped into the manifold exhaust line stub to enable gas to be vented out of manifold room. A Digital touch screen panel display's pressure in each cylinder bank left and right, the outlet pressure shall be permanently shown. Each of the pressure reducers must have isolation valves to isolate any of the supply sources without affecting the operation of the system in any way. 2 sets of two nos. of single stage line pressure reducers as per ISO 10524-2:2005 in 100% redundant configuration so that if one is in operation the other is in standby. It must be possible to isolate any of the line pressure reducers without affecting the operation of the automatic control panel. If a pressure parameter deviates significantly from the respective nominal pressure, an alarm should be activated immediately, to ensure that disturbances in the system are recognized. The bidder must ensure that the offered control panel should function and supply uninterrupted oxygen even in case of failure of power supply may be for long time. In case of failure of pressure regulator, the bypass system and manually operated valve to make the supply continue should be incorporated.

TWO-SIDED CYLINDER MANIFOLD BANK FOR OXYGEN

Fully complies to /as per HTM 2022/02-01/BSEN 7396-1-2016 shall, be CE marked as class categorized – medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number 2(A) The two-sided cylinder manifold for oxygen must be manufactured in ISO-9001-2015. ISO 13485:2016, EN ISO 13485:2016 under quality management system duly certified with copy of certificate. Cylinder racks shall be designed to securely support cylinders of varying diameters using chains. Manifold header racks shall be high-pressure rated >250 bar (hydraulic stretch test certificate up to 2 50 Kg/Cm² should be provided) with gas specific tailpipe connections. High pressure collecting pipes made up of annealed cupronickel copper pipes with integrated non-return valves for connection of gas cylinders on the left and right cylinder bank side each the high-pressure collecting pipe should be modular in nature with box nut and connector allowing any extension and combinations required in future. Collecting pipes including brackets and fixing materials should be gas type labelled and must be fully degreased for applications intended for and certified to this effect.

There should be middle frame manufactured from powder coated metal with wall bracket, chain & holder to hold each of the cylinders on both sides of the manifold Cylinder header racks for oxygen service shall be provided with connections of bull nose cylinder confirming to BS EN ISO 5359;2008-2012 standard.

There should be high-pressure valve with sintered bronze filter with replaceable filter element for particles between the manifold & the control panel on both the sides to protect foreign particles entering the control panel and also to isolate each manifold without closing individual cylinders.

OXYGEN FLOW METER WITH HUMIDIFIER

Fully complies to /as per HTM 2022/02-01/BSEN 7396-1-2016 shall, be CE marked as class categorised medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number

- Back Pressure Compensated flow meter will be of accurate gas flow measurement with
- Control within a range of 0 – 15 LPM with inlet pressure of 50-60 PSI
- It will meet strict precision and durability standard.
- The flow meter body should be made of brass chrome plated / Aluminium material
- The material should be polycarbonate, clear and autoclavable up to 120 ° C
- Flow Tube should have large and expanded 0 –15lpm range for improved readability at low flow
- The humidifier bottle is made of unbreakable & Reusable autoclavable material

NITROUS OXIDE SUPPLY SYSTEM

Fully complies to /as per HTM 2022/02-01 BSEN 7396-1-2016 shall, be CE marked as class categorised medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number or should be as per HTM 2022/02-01, BSEN 7396-1-2016/DIN, ZED Certified with fully automatic control panel.

- Each and every component of system shall be manufactured under ISO-9001-2015. ISO 13485:2016, EN ISO 13485:2016 quality management system duly certified with copy of certificate of country of origin. or
- For DIN Each and every component of the system must be in accordance with DIN EN ISO 7396-1.
- For NFPA -99 Latest edition it must be UL Listed as per medical gas categorization
- Two-sided cylinder manifold for Nitrous oxide must be manufactured under ISO-9001-2015. ISO 13485:2016, EN ISO 13485:2016 quality management system duly certified with copy of certificate

MEDICAL VACCUME SYSTEM

should be as per HTM02-01, NFPA 99 latest Edition, ISO 7396-1- , DIN Standard and UL Certify.
The Medical Vacuum system shall consist of following:

Vacuum Pumps

Control Panel for Vacuum Pumps

Bacteria and Secretion Traps

Vacuum plant as per NFPA-99 must be UL. listed

WARD VACCUME SYSTEM

The Ward vacuum units must be manufactured under ISO-9001-2015. ISO 13485:2016, EN ISO 13485:2016 10079-3-2009 and as per the DIN Standard. Quality management system duly certified with UL listed copy of certificate of origin to be provided for review.

Ward vacuum Unit as per HTM shall be made of durable break resistant, fire-retardant polycarbonate, ward vacuum unit be wall mounted and shall consist of following features: -

Suction Controller/Regulator whole body should be made of abs plastics strong it should be continuous vacuum regulator, compact and ergonomic device. Vacuum gauge should be protected by plastic housing. It should have manual adjustment of vacuum gauge for better visibility; it should have on/off switch button providing quick restoration of pre adjusted vacuum level. It should have central regulation knob with free rotation at the end of the course. It should have vacuum levels 0- 250mbar/ hPa for low flow vacuum unit and 0-1000 mbar/hPa (0-760mm/hg) for high flow vacuum unit. The vacuum regulator should be 3-in-1 system. It should have a device with a metal out let tubing nipple integrated in the body of the regulator for a better safety, emergency suction can even be processed. The jar should be made of poly (carbonate) sulphonate autoclavable Up to 134 degree C and unbreakable. The safety jar should be fixed by an easy-click rotation. The safety jar should be able to rotate to avoid any pinch of the tubing. The vacuum regulator will be step- less adjust able and have large vacuum gauge providing indication of the suction supplied by the regulator. Safety trap shall be provided inside the jar to safeguard the regulator from over flowing. Different colour options should be available. The unit will be consisting of reusable.

600 ml to 2000 ml shatter resistant bottle, each made up of poly sulphonate (Carbonate) material and fully autoclavable at 134 degrees centigrade and must be fitted with simple anti overflow safety device.

THEATRE SUCTION UNIT

Fully complies to/AS PER HTM2022/02-01/ BSEN 7396-1-2016 DIN shall, be CE marked as class categorized medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number manufactured under ISO 13485 quality management system 10(A) For HTM It must consist of the following: 1no. Vacuum Regulator and 2nos. 2000 ml poly (CARBONATE) sulphonate collection jar and both to be mounted on a trolley. Vacuum regulator: It should be continuous vacuum regulator, compact, strong and ergonomic device. It should have manual adjustment of the vacuum gauge for a better visibility. Vacuum gauge should be protected by a plastic housing. It should have on/off switch-button providing a quick restoration of the pre-adjusted vacuum level. It should have central regulation knob with a free rotation at the end of the course. It should have quick adjustment: It should have vacuum levels: 0-1000 mbar/hPa. (0-760mm/hg) The vacuum regulator should be 3-in-1 system. It should have a device with a metal outlet tubing nipple integrated in the body of the regulator for a better safety, emergency suction can even be processed. It should be supplied with a 100ml safety jar equipped with a mechanical anti-over flow safety valve and single use antibacterial plastic filter upfront. The safety jar should be made of poly (CARBONATE) sulphonate, autoclavable upto 134 degree C and unbreakable. It should have a unit serial number laser engraved on the body of each vacuum regulator ensuring its identifications and traceability. Poly CARBONATE/ sulphonate collection Jar of 2 litres with lid: it should be unbreakable and autoclavable upto 134°C must be fitted with an extremely simple anti over flow safety device

MEDICAL COMPRESS AIR SYSTEM

Fully compliant to HTM2022/02-01 BSEN 7396-1-2016, DIN, NFPA-99 must be UL listed Category 1 as per medical gas categorization Main components of Medical Air Plant must have screw compressors in compact super sound absorbing tower design complete with all required cooling, control and monitoring facilities for operations in system with screw compressors, a control panel, air receivers, 2 medical grade Dryer and filtration unit – 5 stage filters and adsorption dryer and a pressure reducer station. Each compressor having effective free air delivery at 8.5 bar pressure. The pressure reducing station should provide two outputs one at 4 bar for medical equipment and one at 7 bar for surgical equipment. The power rating of each compressor should be as per the diversified flow rate calculations of project. Compressor should be equipped with suction

filter, suction regulator for no load start. The system should be designed for minimum three compressors as duty and one as stand-by as the standard operating condition.

The medical air compressed systems will consist of following:

Air Compressors

The compressors should be complete and ready to connect condition in fully automatic operation with CE approval stamp. The compressors must have cooling air duct lined with sound insulation in dirt repellent material and integrated electrical control panel with minimum IP 54 protection grade. The compressors should be of super silenced types with the noise level not exceeding 75 dB. It should have cooling air inlet cabinet filter with cabinet filter fitted at cooling air inlet. The compressor unit must be isolated from mechanical vibrations. The automatic control of the compressor must ensure the most economical operating mode selection, regulation and monitoring systems with microprocessor control and individual fault message displays.

The motor and switch cabinet should be minimum of IP54 protection and should be continuously cooled ensuring the longest possible component life.

The compressor should ensure low compressed air outlet temperature due to high efficiency after cooler. The automatic control of compressor must ensure the most economical operating mode selection, regulation and monitoring system with microprocessor controlled and individual fault message display. Compressors shall be directly driven by EFC IPP 55 energy saving CEMEP class EFFI high efficiency electric motor.

The compressor section should be compact and easily accessible comprising of a multifunction intake regulator on the top and a horizontal pre-separation vessel located at the lowest point with an external spin-on final separator. The air-end should be flanged directly on to the pre-separation vessel. There should be a separate housing with the final separator cartridge and minimum pressure valve. The whole set should be mounted on a vibration damped sub-frame. Direct flanging of the air-end and oil separator block should eliminate the need for interconnecting hoses.

Control panel for Air compressor plant

The compressors must be controlled by a central control panel. The programmable control unit, must monitor the operational pressure and must switch the compressors as needed. The settings for the pressure switching levels should be settable from the front menu using the keys and display at the front panel.

Reservoir Tank

The Receivers Tank should be suitably designed with capacity at an operating pressure of

8.5 bar & test pressure 13.5 Bar. The receivers should be present in duplex configuration to handle the designed load requirement.

The vertical air receiver shall be vertically mounted and manufactured from heavy gauge fusion weld steel. The vertical air receiver shall be internally cleaned, double coat primer and epoxy coated white RAL 9010 or equivalent, fitted with automatic and manual drain valves and be protected by a pressure relief valve, fusible plug and include a pressure gauge. The vertical air receiver shall include inspection holes to provide full internal inspection. The receivers shall be connected to the dryer unit in parallel incorporating lockable valves for safe inspection such that operation can continue during receiver isolation for periodic internal inspection.

Duplex Medical Grade Dryer and Filter System

The duplex medical grade dryer shall incorporate having pre filters for particle removal to 1 micron. Coalescing filters for particle removal to 0.1 micron. The dryers shall consist of twin column heatless air regenerated desiccant dryer producing -67°C pressure dew point and dust filters for particle removal down to 1 micron, with active carbon element to remove vapor and hydrocarbon odour. A duplex filter/pressure regulating unit shall be fitted to the assembly. This shall comprise of sterile filters and non-relieving pressure regulators, which regulate the output pressure of the plant to 4 bar. Contaminants in delivered air downstream of bacterial filters shall be maintained at levels as follows Contaminant threshold H_2O 67 ppm v/v - atm. pressure), Dry Particulates 0.01 mg/m^3 Oil (droplets or mist) 0.1 mg/m^3 , CO 5 ppm v/v, CO_2 500 ppm v/v, SO_2 1 ppm v/v, NO 2-ppm v/v, NO_2 ppm v/v Medical Air Quality according to European Pharmacopoeia should be achieved. In this connection oil, water aerosols and solid particles should be removed from the compressed air.

Medical Air Plant

Medical air plant as per NFPA-99 must be UL listed Category 1 as per medical gas categorization I scroll Compressed Air System to provide total system capacity along with allied equipment, suitable tank and control panel The Skid Mount oil less Scroll Medical System is designed to provide medical breathing air. The plant multiplex oil-less scroll air compressors with one ASME tank, two medical desiccant air dryer system, safety & Pressure gauges, two set of four stage filtration system for breathing air, one dew point monitor, one carbon dioxide monitor and one medical control panel. The complete package will be pre-wired, pre-piped with single point connections for electrical, intake air, discharge air and condensate drain. The Skid Mount oil less Scroll Medical System is designed to provide medical breathing air. The plant multiplex oil-less scroll air compressors with one ASME tank, two medical desiccant air dryer system, safety & Pressure gauges, two set of four stage filtration system for breathing air, one dew point monitor, one carbon dioxide monitor and one medical control panel. The complete package will be pre-wired, pre-piped with single point connections for electrical, intake air, discharge air and condensate drain. Direct drive compressors will not be used. Composite PTFE tip seals rated at 10,000 hours operation will be used. Compressor bearings will be external to the air compression chamber. Compressors will have an integral radial flow fan for cooling and will not require any additional electric cooling fans. Each compressor pump will be provided with an electric drive motor, discharge check valve, a diverter isolation valve, an air cooled after cooler, moisture separator with automatic drain and a high discharge temperature shut down switch. Each compressor will be driven by a motor of ODP, and NEMA construction motor. The system will include an ASME air receiver rated 200 psi MAWP. The tank will be equipped with a pressure gauge, safety relief valve, block & by-pass valves and condensate sight gauge and automatic electronic tank drain with manual override. Vertical receiver will be internally lined with an FDA approved material for corrosion resistance. The system will include a UL listed control panel in a NEMA-12 enclosure will be supplied with H-O-A switch, magnetic starter with 3 legs over load protection, high temperature shutdown with audible and visual alarm, hour meter, and compressor run light. Standard features also include a PLC controller, a reserve compressor in- use alarm with visual and audible alarms, an externally operable circuit breaker disconnect, and a redundant control circuit transformers with visual indication of a main transformer failure. All alarms will have dry contacts on a labelled terminal strip for remote alarms. Provide manual reset for thermal malfunction shutdown. All control and alarm functions will remain energized while any compressor in the system remains electrically on- line. The lag compressor will be able to start automatically if the lead compressor fails to operate. The medical air system will include a dual inlet filter system with one filter on-line and one filter in reserve to enable servicing of the filter elements without shutting down any of the air compressors units or disrupting service to the facility. The inlet filter system will be located on the compressor package and plumbed up-stream of the compressor pumps. The air purification package will be sized in conformance with NFPA 99 specifications and consist of the following: Dual desiccant air dryers, dual filter and regulator bank with sample ports, Dew Point and CO Monitors with alarms, and all bypass piping. Piping to be brass, stainless, or type K copper, and cleaned for medical air use. All components will be mounted piped and wired to the air receiver.

Each twin-tower desiccant dryer will be sized for the peak calculated system demand to provide a pressure dew point of Zero-degree F. Dryer controls will include a depressurization cycle to prevent shocking of the desiccant bed prior to switching towers. An integral purge saving control system will be provided and will suspend the purge air loss during periods of low demand. When the dryer is in purge control mode, the tower switching valves will not operate, and only one desiccant tower will be on-line. The system-integrated hygrometer will be equipped with an LCD dew point display and high dew point alarm with dry contacts for remote monitoring. The dew point sensor (probe) will be of a rugged Hyper-Thin-Film Aluminium Oxide type, and installed so that the monitored airflow is downstream of the pressure regulator assembly. The monitor will include a self-calibration mode to enable calibration of the dew point sensor without the need to return the sensor to the factory for calibration. The carbon monoxide (CO) monitor is provided in a NEMA 4 enclosure with LCD display of CO concentrations. Total 4 stages of filters will be provided along with the compressed air system as follows:

Stage 1 (Coalescing & filters for General protection)

Stage 2: Compressed Air Separator / Filter (Particular filters for dust protection)

Stage 3: Compressed Air Coalescing Filter (High efficiency coalescing filters)

Stage 4: Compressed Air Oil Vapour Filter (Filter for removal of oil vapours and hydrocarbonodours)

Medical Air Receivers.

Receivers for medical air shall meet the following requirements:

- Be made of corrosion resistant materials or otherwise be made corrosion resistant.
- Comply with Section VIII, Unfired Pressure Vessels, of the ASME Boiler and Pressure Vessel Code.
- Be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator
- Be of a capacity sufficient to prevent the compressors from short-cycling

Medical Air Dryers

Medical air dryers shall meet the following requirements:

- Be designed to provide air at a maximum dew point that is below the frost point [0°C (32°F)] at any level of demand
- Be sized for 100 percent of the system peak calculated demand at design conditions
- Be provided with anti-vibration mountings installed as required by equipment dynamics or location and in accordance with the manufacturer's recommendations

Medical Grade Pipe Distribution System

Copper tubes and fittings must manufacture under BS EN 13485 Medical Devices: Quality Management Systems. Copper pipes (material): Copper Pipes used should be solid drawn, seamless, deoxidized phosphorus, non-arsenical, half hard, tempered and degreased. The mechanical properties of copper tube must be in accordance with BS EN 13348: 2008 in either R250 half hard or R290 hard. Degreasing of pipe shall be such that there is less than 20mg/m² (0.20mg/dm²) of hydrocarbons on the degreased

surface when tested by method specified by BS EN 13348: 2008. All copper pipes must be Third party certified with class categorization CE marked medical device 93/42/EEC / meet the provisions of regulation (EU) MDR 2017/745 Certification. For chemical composition & physical properties as per BSEN 13348. Batch numbering for traceability must be included on all pipes; All copper pipes should be certified for its chemical composition (Carbon and copper nickel content), mechanical properties (tensile strength, elongation, thickness), physical properties (Density, thermal conductivity, electrical conductivity, CUDHP (PHOSPHOROUS DEOXIDE COPPER Cu 99.90 and P .0015) to ISO 1190-1 complete with 024a to EN 1412-1996 as specified in BS EN 13348. All sizes from 12 mm to 108 mm shall be third party certified from same third party with CE mark and 4-digit number.

Safety parameters

- The internal cleanliness of medical gas and oxygen tubes is critical in order to prevent gas contamination and potential explosions. Oxygen under pressure may cause spontaneous combustion of residual organic drawing oils if they remain inside tubes after manufacture. Oil or other contaminants may also cause patients serious respiratory problems if not removed prior to installation.
- A unique manufacturing process must ensure the carbon cleanliness does not exceed 0.02g/m² total carbon as specified in BS EN 13348 for sizes up to 108mm.
- Tests are conducted using the combustion method as stipulated in BS EN 13348.
- After cleaning, all tubes are individually end-capped to maintain their internal cleanliness, then bundled and wrapped in plastic for maximum protection.
- When brazing joints, lines must be continuously purged with nitrogen or another appropriate inert gas.
- Pressure and contaminant testing should be performed on installed tubing before final approval and use of the system
- Copper to copper joints shall be made on site using copper, phosphorus and silver brazing alloy CuP 282 to BSEN 17672:2010. Brazing should be carried out using oxygen free nitrogen as an inert gas shield to prevent the formation of oxides on the inside of the pipe. Copper pipes shall be cut square with the pipe axis using a sharp wheel cutter where ever possible, and be cleaned to get rid of any cuttings or burrs.
- Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves which have been de-greased and fittings brought in polythene sealed bags shall be used at site.
- pipe line systems are required to be clearly identified with pipe line identification tape. 150 mm wide Colour banding should be applied near to valves, junctions; walls etc. A label every 3m should identify each gas and arrow tape showing the flow direction of gas.
- Pipelines shall be supported at intervals to prevent sagging or distortion.
- Colour coding as per HTM / DIN/ ISO.
- Copper tube and fittings as per NFPA-99 must be UL. listed Category 1 as per medical gas categorization

Range	Maximum interval between supports(m)
Upto15	1. 5
22-28	2.0
35-54	2. 5
>54	3.0
Note: Consideration should be given to additional supports near LVAs, elbows etc.where the Potential effects of inadvertently applied torque can result in severe pipeline distortion	

Master Alarm Panel:

Master alarm panel as per NFPA-99 must be UL. listed Category 1 as per medical gas categorization Master alarm management system should be designed to display alarm conditions from the source supply units indicating the broad status of the source equipment and manifolds as well as the master distribution status from the source supplies. Depending on the alarm priority, a visual and audible alarm should be initiated to indicate an alarm condition. The display should be in the form of light indicator or flasher on display, for each of the labelled alarm condition as listed below. It must be possible to freely configure the alarm priorities. Each display of alarm condition must be accompanied with audible alarm as well. There must be facility to mute the audible alarm for short pre-fixed durations by pressing of alarm silence / mute button. There must be facility to test all the display lamps on the alarm panel. All the electronic circuits should be mounted inside the cover frame. The master alarm management system must be certified as per Medical Device Directives (93/42/EEC) Annex II having the CE mark with notified number specified from certifying agency, copy of certificate of origin must be provided only in case of IMPORTED PRODUCTS. The Configuration of the Medical Gas Central Alarm panels shall be done via switches within the panel, allowing easy and flexible configuration. Each panel shall display and/or input up to five gas services or up to twenty-point alarms. Each gas service shall consist of a bank of five dual circuit indicators, one green (for a 'Normal' indication) and three yellow and one red (for four input conditions) as standard, although panels shall be customizable for individual requirements. The gas service inputs shall be connected to a five-way connector block. The alarm shall monitor the cable connection from the source equipment, and provide a fault alarm in the event of a short circuit or open circuit fault. This shall be distinguishable from a source equipment fault. There shall be a test facility to check the integrity of all the indicators on the panel, and the audible alarm. The test facility shall also provide diagnostic information to aid in fault finding. An adjustable volume audible alarm shall be fitted to the panel to allow installation in all environments, and there shall be a facility to connect the alarm to a remote sounding unit to repeat the audible alarm at other locations, for example a nurse base at the other end of a ward. There shall be a mute facility which silences the audible alarm for a period of fifteen minutes, or until another alarm condition occurs. There shall be a selectable option to indicate to other repeater panels around the system that an alarm condition has been acknowledged and appropriate action is being taken. A volt-free contact shall be provided to output normal/fault status for the panel. It should be wired on to a dedicated data transmission cable and shall

be permanently connected to the “Essential Supply” within the hospital via a 3A fused spur. Each gas service will display a green ‘Normal’ indication when all conditions are not in a fault condition. When an input condition fault, the respective indicators shall indicate the type of failure. Any data communication errors shall cause a

‘System Fault’ alarm. The alarm panel shall be an open-end device like a freely configurable screen with capability to reproduce not only the minimum source monitoring as above but to reproduce the complete real-time status of the medical gas management system even from each area control stations. Integrated Zonal valve box with touch screen alarm as per NFPA-99 must be UL listed Alarm and Zone Valve Box panel shall be LCD touch screen microprocessor controlled and designed to comply with NFPA 99. The panel shall be 100% digital and shall not require re- calibration. The alarm panel shall be enclosed in a steel box and shall be designed to accept an electrical input range of 120-240 volts AC – 50-60 hertz. The source voltage shall be stepped down with a self-contained transformer. The panel shall contain audible and visual alarm indicators. The audible alarm may be silenced by pressing the alarm silence button, but the visual alarm indicator can only be cancelled by fault correction. The alarm shall detect and filter out transient (less than 0.6 seconds) signals created by R.F.I. The alarm shall be capable of displaying alarm history for all possible alarm conditions. Each combination area alarm and zone valve box shall contain up to seven gas services. Gas modules and valves can be arranged in accordance with project requirements. In addition, each alarm Module shall incorporate the following features: Each gas module can be easily identified to indicate the area being monitored using the database of NFPA 99 gas services and colour coding provided. Does not require re-calibration. Gas specific sensor with DISS nut & nipple. An error message will be displayed if incorrect sensor or no sensor is attached. User programmable pressure limits (Programmed from factory at 60/40 psig and 12 in Hg). Shall be capable of displaying gas readouts in PSI (in Hg), BAR or kPa. Gas specific sensor with DISS nut & nipple. An error message will be displayed if incorrect sensor or no sensor is attached. Gas audible alarm repeats feature factory set at 10 minutes, adjustable from 1 minute to 240 minutes, or off. Each valve boxes shall be include a gas specific demand valve connection which may be used for connection of the gas specific transducer or back feeding. Back feed port shall allow back feeding of gas without interruption of gas service, so that back feeding a piped gas system through a station outlet will not be necessary. Back feeding a piped gas system through a station outlet shall not be acceptable. The valves shall be bronze, ball-type, with Teflon (TFE) seats and seals. All valves shall be dual gauge ported, rated at a working pressure of 600 psi (29 in/Hg vacuum), and shall be operated by a lever-type handle, requiring only a quarter turn from a fully open position to a fully closed position. Valves shall incorporate an adjustable packing and a blow- out proof stem. Only full port valves having flow rates comparable to equivalent size of pipe shall be used. Valves shall be piped from left to right. Valves shall be provided with type K copper tubing extensions to facilitate installation. Valves shall be 3 piece in-line repairable type. Each valve assembly shall be supplied cleaned for oxygen service in accordance with current CGA standards. The valve tube ends shall be capped and sealed in a protective container to prevent contamination prior to installation. Gauges shall be 1 ½” diameter for monitoring pressure and vacuum, and shall state: “USE NO OIL”. A fully colour coded label package shall be supplied with each valve box assembly for application by the installer. The valve box shall be 16-gauge sheet steel construction powder coated to prevent rust. A single box shall house from one to seven valves. Box shall be supplied with a ¾” plaster flange. Valve box assembly shall be supplied with a formed steel decorative frame powder coated which encloses an easily removable flexible window. The window shall be a “smoked” translucent flexible plastic with a pull-out ring pre- mounted to the centre of the window. The window shall not be replaceable while any valve is in a closed position. Window shall be silk screened with the following statement “CAUTION: MEDICAL GAS SHUTOFF VALVES. CLOSE ONLY IN EMERGENCY

Medical Gas Outlet:

The terminal outlets for OXYGEN, NITROUS OXIDE, CARBON DI-OXIDE, MEDICAL AIR 4 BAR, SURGICAL AIR 7 BAR & CENTRAL VACUUM compressed air & vacuum, oxygen, AGSS, nitrous oxide, Carbon dioxide should be of 100% metal (Internal housing, block & probe) shall comply with

ISO 9170-1:2008 ISO 9170-2: 2008 Fully complies to /As per HTM2022/02-01 BSEN 7396-1-2016/NFPA 99/DIN shall, be CE marked as class categorized medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number. Probe roller pins shall be manufactured from stainless steel and positioned by the locking ring; these are tamper proof only serviceable using specialist tools. Probe roller pins held captive in cradle designs are not acceptable as this will cause dust settlement and malfunction the second fix check valve will comprise of the following components;

1 no. Brass Valve Body

1 no. Brass Valve Plunger 1 no. Spring

1. no. 'O' Rings 1 no. Probe Seal

The check valve should be capable of withstanding an inlet pressure of 60bar. The secondfix assembly will comprise of the following components;

1 no. Body (Gas Specific)

1 no. Locking Ring

1 no. Anti-swivel Pin

1 no. Gas Identity

The body and locking ring will be die cast from zinc alloy and Teflon coated/DIE CASTING ABS OF SPECIFIC GAS COLOR. It shall not be possible to insert a probe for a different gas into a body for any particular gas. Each body will also incorporate a gas specific coding hole to match the coding pin position in the first fix assembly. It shall not be possible to assemble a second fix assembly for any particular gas onto a first fix assembly for a different gas. The relevant gas symbol as defined by BS EN9170-1:2008 will be molded into the flange of the body e.g. Oxygen=O2

Matching Probe/adaptor

With one end suitable for Hose & other end suitable for terminal units as per technical specifications for Oxygen for Nitrous Oxide , for Compressed Air (4 Bar)_, For Compressed Air (7 Bar) , For Vacuum, For AGSS/WAGD □ Fully complies to as per/HTM2022/02-01 BSEN 7396-1-2016/NFPA99/DIN shall, be CE marked as class categorised medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number.

Duplex Anaesthetic Gas Scavenging System (AGSS)

AGSS System shall have twin standalone AGSS pump of 3 phase capacity each with built in flow indication and pressure regulation valve, mounted on single frame with control panel and separate warning label. One pump will be standby with the other in operation. Nominal Motor Power per Blower 1.1 KW and will be single stage. Starting Method will be DOL. 70 dB sound pressure level. 2" Pipe size and service connection 54mm OD pipe work. Anti vibrator mounts on all pumps Alarm and BMS outputs for remote status indication, 24-volt control interface for controllers Pre-set vacuum relief valve and low-pressure sensors Copper stubbed outlet and inlet pipe work for ease of connecting to MGPS The Package Consists: -

Two oil less side channel blowers, one control panel with vacuum gauge and alarm indications. AGSS Pump completely dry, permanently lubricated, and sealed and air-cooled operation. Control System: Provide automatic changeover from running to reserve with circuit breaker disconnects for each AGSS pump with external operators, full voltage motor starters with overload protection, control circuit transformers, visual reserve unit alarm, and isolated contacts for remote alarm Designed to safely remove exhaled anaesthetic agents from the operating environment and dispose of them to atmosphere, thus preventing contamination of the operating department and providing a

safe and healthy workspace for the personal. The anaesthetic gas scavenging system must be certified as per Medical Device Directives (93/42/EEC) Annex II having the CE mark with notified number specified and classified as a class IIb device.

AGSS will comprises of:

AGSS Plastic Remote Indicator

AGSS Reservoir

Transfer system

Isolation Lockable line valve

Fully complies to BS EN 7396 meeting the requirements of HTM02-01 BS EN 18082, It must be manufactured under BS EN 13485 medical devices quality management system shall, be CE marked as class categorised medical device 93/42/EEC with four digit notified body number / meet the regulations (EU) MDR 2017/745 with four digit notified body number DIN EN ISO 7396-1, The isolation lockable line valves must comprise of 2 piece full bore male threaded nickel plated brass ball valve, blow out proof stem, stem O-ring, and flat face copper stub pipe assemblies. It must be designed to have a tight shut off and blow out proof stem for protection against pressure gauges. The copper stub pipes must be of sufficient length to enable brazing directly to medical gas pipeline system. A brass padlock must be provided to prevent unauthorised or inadvertent operation of valves. It must be fully pressure tested for valve tightness and leakage and batch numbered for easy traceability.

Bed Head Panel

The horizontal BHP unit in the length of Type -1 1200mm and Type 2 1500 mm per bed for the patient care areas should have an unobtrusive, elegant design. The supply unit should be made up of high-quality extruded aluminum profile in a surface finish for the front surface in natural finish ensuring a feel-good atmosphere inside the clinical area for the patient and the care providers. The unit should have a seamless front profile in one single piece extending hygienic and smooth appeal to the clinical environment of the area. It must have physically isolated slots for installation of the medical gas / vacuum, electrical & low voltage communication lines along the length of the unit. The supply unit must be able to accommodate the desired number of medical gas, electrical and data outlet points. Bed head panel should be pre piped and pre wired, it should have complete piping to the central point by means of medical grade copper pipe complying with EN 13348 standards, the scope of supply should include the electrical sockets and the respective data points fully installed. The terminal outlets provision only as included in the master distribution chart of the respective areas should be installed to the system as per the desired configuration. The panel should have the space and provision to accommodate a standard nurse call system patient interface components inside the module without any physical damage or changes to the panel or to the wall at the clinical area. The supply unit must have the provision for electrical and data outlet points as mentioned below.

Minimum leak assemblies / Pressure Switches

Signal setting for low vacuum shall be at 12" HG. Signal settings for all pressure gases shall be; Low – 40 psig, High – 60 psig. Pressure switches shall be cleaned and sealed for oxygen service. Switches shall incorporate UL listed single-pole, double-throw, and snap-action switching elements. Switch shall automatically reset.

Medical gas hose assemblies with probes

Medical gas hose assemblies shall comply with BS EN ISO 5359, BSEN 5682. BS EN 7396- 2, BS EN 9170-1 NIST fittings compliant to BSEN ISO 18082. PVC hoses and hoses containing

phthalates are not acceptable. Hoses shall be colour coded throughout their length as specified in BS EN 5359 as follows:

Medical oxygen - white Nitrous oxide – FRENCH blue

Medical and surgical air - black Vacuum - yellow

Carbon Di-Oxide – White & black.

Skid Panel

For High Flow rate requirements in case of 60 litres per minute requirement. Skid Panel, with 6" dial high pressure gauge- 0-250kg/cm² with high pressure valve & fittings, 6" dial Line pressure gauge- 0-10kg/cm² The Oxygen cylinder skid Panel shall have a five-connection low pressure manifold 1 set with 4" dial pressure gauge having 5 nos. cylinder valve with IOX fitting connections and 5 nos. internal connection for copper piping. The Manifold should be supplied with pressure gauge 0-250kg and 0-10 kg with required quantity of fittings. The gauges should be calibrated High Pressure Copper Pipe size 25 mm x 2.63 mm thick Copper Pipes used should be solid drawn, seamless, deoxidized phosphorus, non- arsenical, half hard, tempered and degreased. The mechanical properties of copper tube must be in accordance with BS EN 13348: 2008 and R290 hard 40x 40 Oxygen manifold system with header and high-pressure connecting pipes, the manifold shall be designed and certified for use with oxygen at 300 bar and 60°C. The manifold shall provide a backup supply of medical gas from a high-pressure cylinder bank via a suitable arrangement of pressure regulators, providing a constant downstream nominal pipeline gauge pressure of 400 kPa. Emergency Standby Manifolds) comprise manifold header & rack, tailpipes Cylinder racks shall be designed to securely support cylinders of varying diameters using chains. Manifold header racks shall be high-pressure rated >250 bar with gas specific tailpipe connections. High pressure collecting pipes made up of annealed cupronickel copper pipes with integrated non-return valves for connection of gas cylinders on the left and right cylinder bank side each. The high-pressure collecting pipe should be modular in nature with box nut and connector allowing any extension and combinations required in future. Collecting pipes including brackets and fixing materials should be gas type labelled and must be fully degreased for applications intended for and certified to this effect

Double Arm Surgical Pendant

The surgeon pendant should be capable of both lateral and upward movement. Pendant shall have friction brake, pneumatic brake / electromagnetic brake as standard for arm system Pendant should have a compact service console, 900 mm in length and containing the following services, fully installed and tested:

Front Mounted 38mm Multifunction Rack, providing accessory mounting and docking solutions.

- 800/ 800 mm lateral movement arms
- 1000 mm Service head
- 5 No. Shelves and one drawer
- Rear Mounted Handle with Brake Controls.
- 8-10 No. 230V 5/15 amp A Socket Outlets
- 2 No. Medical Oxygen Terminal Units
- 1 No. Medical Nitrous Oxide Terminal Units
- 1 No. Medical Air 4 bar Terminal Units

- 1 No. Surgical Air 7 bar Terminal Units
- 2 No. Medical Vacuum Terminal Un
- 1 No. Twin RJ45 Data Outlet
- 2 No. Single Gang Provisions for Data Services

Single Arm Aesthetic Pendant

Pendant must be manufactured to comply with the standards of EN ISO 7396-1: 2007, EN ISO 11197:2016, EN ISO 7396-2:2007, EN ISO 9170-2: 2008 EN ISO 60601-1-2 2015 EN

ISO 9170-1:2008 The aesthetic pendant should be capable of both lateral and upward movement. Pendant shall have friction brake, pneumatic brake / electromagnetic break as standard for arm system. Pendant should have a compact service console 800 mm in length and containing the following services, fully installed and tested:

Front Mounted 38mm Multifunction Rack, providing accessory mounting and docking solutions.

- 800/ 800 mm lateral movement arms
- 800 mm Service head
- 3 No. Shelves and one drawer
- Rear Mounted Handle with Brake Controls.
- 8-10 No. 230V 5/15 amp A Socket Outlets
- 2 No. Medical Oxygen Terminal Units
- 1 No. Medical Nitrous Oxide Terminal Units
- 1 No. Medical Air 4 bar Terminal Units
- 1 No. Surgical Air 7 bar Terminal Units
- 2 No. Medical Vacuum Terminal Unit
- 1 No. AGSS Terminal Unit
- 1 No. Twin RJ45 Data Outlet
- 2 No. Single Gang Provisions for Data Services
- Pendant payload: 140 Kg

TECHNICAL SPECIFICATIONS FOR NURSE CALL SYSTEM

GENERAL

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning of Nurse Call System. Nurse Call System work shall be carried out as per rules & regulation of “CPWD GENERAL SPECIFICATIONS FOR NURSE CALL SYSTEM 2022” & respective IS codes that governs the requirement of installation of the Nurse Call System.

The scope of this specification cover works of Supplying, installation, testing and commissioning of Nurse Call System (FOR EACH BED) including the following components on turnkey job basis:

- (i) Main Controllers/ IP Controllers /System switches
- (ii) Nurse Station Terminal
- (iii) External Large LCD Display at Nurse Station or Corridors Display
- (iv) Small Nurse Station/ Duty Room Station
- (v) Patient Handset without voice facility with Connection Module/ Bed Head Unit – for Wards/ Multiple bedded rooms
- (vi) Patient Hand set with voice facility with connection module/Bed Head unit: for private rooms – say Single/Double Bed room/Suite Room/VIP Room
- (vii) Patient call-cancel button without handset – (for remote area hospital, where safety of handset is an issue/ less requirement/ attendant is always available)
- (viii) Pull cord unit for WC/ Bath area.
- (ix) Lamp Module/ Zone Light/ Directional Light: Outside room/ ward
- (x) Doctor Call & Cancel Button (Code Blue):
- (xi) Room terminal with LC display– For Private Rooms
- (xii) Nurse Call Server
- (xiii) Backbone / Network switches
- (xiv) Central Monitoring Station with event database software
- (xv) Integration with IPBX System

1. MAIN CONTROLLERS / IP CONTROLLERS / SYSTEM SWITCH

Controller shall be IP based & all the nurse station/ patient handset & other equipment shall be connected to main controller through CAT 6 cable through RJ45 connection port. Main controllers shall be networkable with other controllers. Fault in one controller shall not have the effect on the working of another controller. Each controller shall be able to work independently in case of a problem in network. Apart from controller, other devices in the room/ toilet/ outside room/ nurse station/Lamp module shall be POE based. Controller shall be wall mounted or rack mounted as per site requirement. For decentralized operations, one controller shall not be connected to more than 20 Rooms/ 30 beds.

2. NURSE STATION TERMINAL

Nurse station shall be IPBased and have large LC display minimum 7" (Minimum 4 calls can be displayed at a time in LC display) capable of showing multiple patient call at a time with bed/ ward no. & type of call. There shall be scroll down feature as well in case no. of patient call increase at a given time i.e. there shall not be any chance of missing any patient call. There shall be feature to priorities patient call depending upon patient condition, type of call & location (Bed or WC). Nurse station shall have voice facility. It shall be user friendly & have good aesthetic looks. All Nurse Stations shall be networked with other nurse station with facility of call forwarding/ diverting/ escalating calls in between nurse station. Nurse station shall be programmable so that emergency calls shall always be on top priority. Nurse Station shall have inbuilt sounder having volume & tone adjustment.

Nurse station shall have other settings also like brightness control, multiple tones to adjust tone as per type of call, fault or failure indication etc. It must be POE based & shall not require separate power cable/ power supply. The important functions are:

- Displays date and time
- Permanent indication of the quantity of calls, reminders and occurring faults, outstanding at the time
- Displays all presences that are marked, depending on staff category listed on a desk (in the corresponding colours in accordance with VDE 0834/ UL/ Health Technical Memorandum 08-03: Bed head services-based nurses call systems and with a unique symbol),
- Displays all calls with their relevant colours in accordance with VDE 0834/ UL/ Health Technical Memorandum 08-03: Bed head services based nurses call systems and clear symbols for each type of call,
- All call indications are automatically shown in accordance with the priorities for indication which are stored in the system, starting with the highest priority call:
- The following information must be able to be imparted in this case: the exact type of call with information about the bed number or WC call, doctor call etc. the exact call location with information about the individual room name and the care group to which it might have been assigned to.
- For calls across more than one ward the relevant ward name must also be indicated.
- Emergency calls must always be shown flashing,
- Colour graphic LC display, for displaying all details
- Integrated SIPVOIPtelephone
- Asmash-resistant glass panel placed in front of the display,
- Microphone and loudspeaker for hands-free speaking (incl. volume adjustment)

Note: The main nurse station is mandatory to be used with speech system so that nurses can attend voice call from patient handset.

3. EXTERNAL LARGE LCD DISPLAY AT NURSE STATION OR CORRIDORS DISPLAY

For large nurse station counter, there shall be external LCD/ LED connected with nurse call system to display the calls on external larger screen of minimum 20" so that nursing staff can see the incoming call including details like type of calls, bed no., ward etc. from long distance.

The monitor may be mounted on wall or hung from ceiling using standard accessories as per site requirements. The external monitors are standard monitors & existing monitors in the hospital can be used subject to compatibility of input/output ports etc.

Note: There shall be option to use either main nurse station or external large display or both on single nurse station terminal as per client/ hospital requirement. For without speech system & large nurse station, hospital may require wall mounted external large LCD instead of main nurse station for easy viewing.

4. SMALL NURSE STATION/ DUTY ROOM STATION

The wards having few nos. of beds (Max. 10 beds) & having nurse station counter inside the ward only like Pre-OP/ Post Op/ Triage/ recovery room etc., a small nurse station having smaller LC display showing pin point location of call shall be used. The Nurse Station shall have voice facility as well as scrolling function to see multiple calls, if any.

- Whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside.

- 1 call button (red with nurse symbol) including a finder/reassurance light,

- 1 presence/ cancel key (green) including control LED - Green colour button must be

programmable to use as presence button as well as call cancel button. It shall be possible to generate emergency staff call by pressing presence button + Call button. Emergency staff call must be locked with presence button to avoid false emergency call.

- Moisture protected

- Fungicidal membrane keypad

- Interfaces/system connection: 2 × RJ-45 sockets for connection

- Protection class: IP 44, VDE 0834 Environmental class II/ UL/ Health Technical

Memorandum 08-03: Bed head services based nurses call systems

a. PATIENT HANDSET WITHOUT VOICE FACILITY WITH CONNECTION

MODULE/ BED HEAD UNIT– FOR WARDS/ MULTIPLE BEDDED ROOMS

Whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside in the patient handset. On pressing the button, the alarm shall annunciate at the Nurse Station by local sounder informing the nursing staff about the bed no. / Room no. with customized text along with type of call (Bed call or WC call or Doctor call) for their necessary action. Patient handset shall have call button and shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial/ antifungal coating to avoid infection transfer, shall be shock & spill proof and have suitable color & symbol for nurse call button on the handset. The patient handset shall have connection cord to connect with connection module. There shall be programmable Call button, Nurse Presence, Cancel and emergency button available in the room. The finder light & reassurance light should be available on patient handset & bed head unit to assure patient that call has been generated after the call button is pressed. The Nurse Presence, cancel button or doctor call button should not be available on patient handset to avoid the self-cancellation by patient or confusion to the patient. The patient handset shall have min. 2.8 meter cord and also have 2 nos. lighting buttons to integrate with electrical devices if required. The bed head unit must have diagnostic port also to connect/ integrate with 3 party

medical devices to take their input in nurse call system to generate the call automatically as per requirement on the basis of input received from the 3 party medical devices.

Protection class: IP54, VDE 0834 Environmental class III VDE0834/UL/Health

Technical

Memorandum 08-03: Bed head services based nurses call systems

Ambient temperature: 0 °C to +40 °C

Relative air humidity: up to 95 % without condensation Cable: 2.8 m with 200 N strain relief (relating to the device)

b. **PATIENT HANDSET WITH VOICE FACILITY WITH CONNECTION MODULE/ BED HEAD UNIT: FOR PRIVATE ROOM ONLY – SINGLE/ DOUBLE BED ROOM/ SUITE ROOM/VIP ROOM**

Patient handset shall be directly on IP with VOIP feature & having dial pad like IP telephone.

Patient handset shall be connected to whenever the patient needs the attention of any

“Nurse”, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be enunciated at the Nurse Station informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. Patient handset shall have call button (red color button/indication with nurse symbol) and shall be connected to bed head unit through plug in cable. The patient handset shall have connection cord to connect with connection module. There shall be “Voice over IP” speech facility in both patient handset & nurse station with suitable inbuilt microphone & speaker. Patient handset shall have necessary keypad to dial nos. for intercom or Local/ STD calls as permitted by the hospital. Nursing staff shall receive the call from nurse station itself & respond to the patient queries. It will reduce the nurse staff movement to patient room. However, if required, nurse staff shall visit the patient room as when needed by patient. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial/ antifungal coating to avoid infection transfer, shall be shock & spill proof and have suitable color& symbol for nurse call button on the handset. The finder light & reassurance light should be available on patient handset. The Nurse Presence, cancel button or doctor call button should not be available on patient handset to avoid the self-cancellation by patient or confusion to the patient. The patient handset shall have min. 2.8meter cord and also have 2 nos. lighting buttons to integrate with electrical devices if required.

The bed head unit shall have diagnostic port also to connect with 3rd party medical devices to take their input in nurse call system to generate the call automatically as per requirement on the basis of input received from the 3rd party medical devices. Also, additionally there shall be service call button also to generate call for ward boy/ toilet assistance.

Headphone's socket: 3.5 mm jack plug

Infrared receiver: 36 kHz receiver for RC5 signals

Display: Fully graphic LC display (128 × 64 pixels) with backlight Protection class: IP54,

VDE 0834 Environmental class III / UL/ Health Technical Memorandum 08-03: Bed head services-based nurses call systems.

Ambient temperature: 0 °C to +40 °C

Relative air humidity: up to 95% without condensation Cable: 2.8 m with 200 N strain relief.

c. **PATIENT CALL-CANCEL BUTTON WITHOUT HANDSET – (FOR REMOTE AREA HOSPITAL, WHERE SAFETY OF HANDSET IS AN ISSUE/ LESS REQUIREMENT/ ATTENDANT IS ALWAYS AVAILABLE)**

Patient call cancel button with membrane keypad consisting of,

- 1 call button (red with nurse symbol) including a finder/reassurance light,
- 1 presence key (green) with a control LED
- 2 RJ45 sockets for connecting the data circuits including a mounting frame for screw less attachment to an installation case

5. PULL CORD UNIT FOR WC/ BATH AREA

PULL CORD CALL HAVING PRESENCE & CANCEL BUTTON: FOR DETACHED/ COMMON TOILET, PHYSICALLY HANDICAP TOILET

- There shall be nurse call button with suitable length (min. 2.8 meter) of pull cord with color/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit for hygiene reason. The buttons shall be moisture protected & suitable for bath areas.
- Interfaces/system connection: 2 × RJ-45 sockets for connection
- Protection class: IP44, VDE 0834 Environmental class II
- Intended for use in wet rooms
- Integrated locating and reassurance light
- Actuating the pull cord has the same effect as pressing a call button (red)
- Fast-exchange pull cord (approx. two meter) with snap hook
- Red grip with nurse symbol
- Germ inhibiting membrane keypad

6. PULL CORD CALL BUTTON FOR ATTACHED WC (FOR PRIVATE ROOMS)

- There shall be nurse call button with suitable length (min. 2.8 meter) of pull cord with color/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit for hygiene reason. The buttons shall be moisture protected & suitable for bath areas. 3.9.2.2 Interfaces/system connection: 2 × RJ-45 sockets for connection
- Protection class: IP44, VDE 0834 Environmental class II Intended for use in wet rooms
- Integrated locating and reassurance light
- Actuating the pull cord has the same effect as pressing a call button (red)
- Fast-exchange pull cord (approx. two meter) with snap hook
- Red grip with nurse symbol
- Germ inhibiting membrane keypad

7. LAMP MODULE/ ZONE LIGHT/ DIRECTIONAL LIGHT: OUTSIDE ROOM/ WARD

Lamp module shall be POE based, shall not require separate power cable/ power supply & installed outside the room/ ward above the door for visual indication of different type of call. There shall be 5

different colour (white, red, blue, yellow, green) section in the lamp module for indication of different type of calls.

Once the patient annunciates the alarm, the signal shall go to the nurse station. The lamp outside the patient room/ ward shall also glow simultaneously red providing a visual alarm. Lamp shall have different colours light to inform about the type of call like red light for bed call, blue light for code blue call, green light for nurse presence, white light for WC call, yellow light for other services.

- Lighting intensity: max. 2500
- Brightness: Lux 250 cd per m square to 750 cd per m square
- Interfaces/system connection: 2 × RJ-45 sockets for connection

8. DOCTOR CALL & CANCEL BUTTON (CODE BLUE):

Each ward/ room shall have one code blue button (Doctor Call) having doctor call & doctor presence & Doctor call cancellation button. Doctor call button shall be used only by nurse staff & programmed in such a way to avoid direct code blue call by patient. It shall be a separate programmable button with presence & cancel button. It shall not be in patient handset with nurse call button & shall have separate presence & cancel button.

Once nurse press code blue button, call shall go to every nurse station of the hospital or as programmed as per site requirements with room no. & bed no. information so that code blue team available at any nurse station shall be informed & they can reach the patient room on immediate basis.

- Interfaces/system connection: 2 × RJ-45 sockets for connection
- Protection class: IP44, VDE 0834 Environmental class II

9. ROOM TERMINAL WITH LC DISPLAY– FOR PRIVATE ROOMS

The room terminal should be installed in each private room having patient handset with speech facility. The room terminal shall have Membrane keypad for operation, comprising of:

- Call button (red with nurse symbol) with integrated finder and reassurance light
- Doctor call button (blue with doctor call symbol) with integrated reassurance light,
- Nurse Presence & cancel button (green) with control LED,
- Doctor Presence & cancel button (blue for the doctor) with control LED,
- LC Display
- Room terminal shall display the nurse call from other rooms/ patients, in case nurse acknowledge the call from room terminal.

10. NURSE CALL SERVER:

Server used during the commissioning of the system for reading in the system topology, for uploading the firmware and the system configuration, for operating interfaces to foreign systems, for logging of all system events and as a central location for system configuration and remote maintenance. The system must consist of:

- All necessary software and hardware for handling the complete nurse call system and all beds call points.
- It should support the redundant architecture as a optional feature

- 1 x 1000 base -TX LAN port for connecting in to Customer LAN Network
- 1 x 1000 base - TX LAN Port as a back-end service port
- It should support the additional mini server architecture if system has a more than 1 VLAN
- 4 x 1000 base -TX LAN ports for further extending the Nurse Call Network-Pre soaked System Software
- 2 x DB 9 serial connection for Interface
- 2 x USB Ports
- Three status LEDs serve for indication of the operative states. A reset button is also located on the front.
- Suited for 19 inch 1 HE/HU Network Rack Size

11. BACKBONE / NETWORK SWITCHES:

This switch is used to connect the system server to the communications network, for connecting all the other servers and foreign systems to be connected to the network, which exchange data with the network via an IP interface. Furthermore, backbone switches are also to be used for bridging large distances between the individual servers, foreign systems and peripheral modules. General requirements for all the types should be as per manufacturer recommendation and it should be minimum layer 2/ 3 Switch with DTP and VLAN trunking layer 2 protocol.

The system shall be able to use hospital existing backbone switches also or same make as other hospital backbone switches to have better warranty & maintenance support.

12. CENTRAL MONITORING STATION WITH EVENT DATABASE

SOFTWARE

Complete nurse call system shall be centrally connected to a PC having a software recording of all the different type of call & cancel with date & time. The vendor needs to consider server/ back bone / network switches etc. As the nurse call system is on IP, it should work on client existing LAN infrastructure as well, if required without any additional charges/ software/ license. However, servers for nurse call system shall be supplied & configured by the OEM only. The software shall record the date & time of call generated by patient & call presence & cancel by nurse with type of call. Software shall be able to generate report on real time basis as per requirement. It shall also be possible to put reminder/ highlighted on calls if nursing staff do not attend/ cancel the patient call with in specific time decided by the hospital management. The fault in central monitoring station shall not affect the working of nurse call system in the hospital. The software shall show the pin point address & location of any fault in the system like any fault in cable or any nurse call module. The software shall be for life time & there shall not be any separate license charges later on.

13. INTEGRATION WITH IPBX SYSTEM

The nurse call system shall be integrated with hospital IPBX system through SIP protocol.

The nurse station & patient handset with speech shall have their dedicated IP so that both can be used as IP telephone. There shall be dial pad in nurse station & patient handset with speech to make call to intercom, or mobile phone/ STD etc. as permitted in the IPBX system.

Specific Conditions of Contract - Operation & Maintenance

1. General:-

- a. The scope of Operation & Maintenance (O&M) of various Civil & E&M works at Government Medical colleges to be executed by the EPC Contractor has been detailed in the Specific Conditions of Contract- General, which may be referred to.
- b. The proposed completion period for construction of Government Medical colleges is 18 months for construction (staggered in various phases) plus 12 months towards defect liability period. O&M activities shall be provided for different phases from the completion of work and handing over of respective phases and upto the expiry of the defect liability period of complete project which shall be 12 months beyond the overall completion of the total project.
- c. Contract Agreement for O & M Services shall be executed directly between Administrative Department & OEM operator under a separate agreement to be executed at appropriate stage.
- d. The Operation, CMC & AMC for various components of work shall be carried out as per following table:

SR. NO.	DESCRIPTION OF WORK	CMC	AMC	OPERATION
1	Electrical Substations HT/ LT works	-	R	R
2	DG Works including HSD Storage & Fuel Pumping System	-	R	R
3	Lifts	-	R	-
4	STP cum ETP/STP	R	-	R
5	Fire Fighting System	R	-	R
6	LV works i.e. CCTV /Access Control/ LAN/ IPABX/ information Display/ Audio Visual System Stage Lighting/ Public Address/ Fire Alarm/BMS/ NCS/SCADA etc.	-	R	R
7	Civil & Internal Electrification, Street Lighting, Boom Barrier, Horticulture and Landscaping	-	R	-
Note:- R= Required Services				

1. Phase Wise Segregation of Various Buildings with DLP & Completion Period

- a. The period for completion of construction of different milestones with phases of work shall be as given in Volume1
- b. The commencement of DLP shall start after completion of construction of respective milestones with phases of work as given in Volume1
- c. The DLP for respective milestone/phases and overall completion of project shall be upto 12 months from the date of overall completion of project or extended period thereof.

FORMATS FOR GUARANTEES**GUARANTEE TO BE EXECUTED BY THE CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT OF WATER SUPPLY AND SANITARY INSTALLATIONS****(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)**

The agreement made this..... Day of Two thousand and between

S/O..... (hereinafter called the GUARANTOR of the one part) and the (hereinafter called the UPPWD of the other part). WHEREAS THIS agreement is supplementary to the contract. (Herein after called the Contract) dated... and made between the GUARANTOR OF THE ONE PART

AND the UPPWD of the other part, whereby the contractor interalia, undertook to render the work in the said contract recited structurally stable workmanship and use of sound materials.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said work will remain structurally stable and guarantee against faulty workmanship, finishing, manufacturing defects of materials and leakages etc.

NOW THE GUARANTOR hereby guarantee that work executed by him will remain structurally stable, after the expiry of maintenance period prescribed in the contract for the minimum life of ten years, to be reckoned from the date of completion of work, to be reckoned after the expiry of maintenance period prescribed in the contract.

The decision of the Engineer- in- charge with regard to nature and cause of defects shall be final.

During the period of guarantee the guarantor shall make good all defects to the satisfaction of the Engineer- in- charge calling upon him to rectify the defects, failing which the work shall be got done by the UPPWD by some other contractor at the guarantor's cost and risk. The decision of the Engineer -in- charge as to the cost payable by the Guarantor shall be final and binding.

That if the guarantor fails to make good all the defects, commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage cost expense or otherwise which may be incurred by him by reason of any default on the part of THE GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the UPPWD the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf

of the UPPWD on the day, month and year first above written.

Signed sealed and delivery by OBLIGATOR in the presence of:

- 1.
- 2.

SIGNED FOR AND ON BEHALF OF-----BY in the present of:

- 1.
- 2.

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR ANTI TERMITE TREATMENT.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and between S/o
(hereinafter called the GUARANTOR of the one part) and the-----

(hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor interalia, undertook to render the building and structures in the said contract recited completely Anti Termiteproof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely Anti Termite proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that Anti Termite treatment given by him under agreement Item No., will render the structure completely Anti Termite proof and the minimum life of such Anti Termite treatment given by him will render the structures completely leak proof and the minimum life of such Anti Termite treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Building or alteration and for such purpose:

- a. misuse of Building shall mean any operation which will Anti Termite treatment to the Building.
- b. Alteration shall mean construction of any addition or construction adjoining to existing Building whereby Anti Termite treatment is removed/damaged in parts;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the Anti Termite proof treatment of the building to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the Anti Termite treatment, or commits breach thereunder then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by by for and on behalf of on the day, month and year first abovewritten.

Signed sealed and delivered by OBLIGATOR in presence of:

1.

2.

SIGNED FOR AND ON BEHALF OF BY In presence of:

1.

2.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING
TREATMENT FOR BASEMENTS.**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and between S/o (hereinafter called the GUARANTOR of the one part) and the-----

(hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor inter alia, undertook to render the building and structures in the said contract recited completely water and leakproof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given by him under agreement Item No., will render the structure completely leak proof and the minimum life of such water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Basement or alteration and for such purpose:

- a. misuse of basement shall mean any operation which will damage proofing treatment to the basement of the Building.
- b. Alteration shall mean construction of any addition or construction adjoining to existing basement whereby proofing treatment is removed in parts;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTOR'S cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

- 1.
- 2.

SIGNED FOR AND ON BEHALF OF BY In presence of:

- 1.
- 2.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING
TREATMENT FOR ROOF.**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and _between S/o _____ (herein after called the GUARANTOR of the one part) and the----- (hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated _____ and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor inter alia, undertook to render the building and structures in the said contract recited completely water and leakproof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given by him under agreement Item No....., will render the structure completely leak proof and the minimum life of such water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Basement or alteration and for such purpose:

- a. misuse of roof shall mean any operation which will damage proofing treatment like chopping of fire wood and things of the same nature which might cause damage to the roof of the building.
- b. Alteration shall mean construction of any additional storey or part of the roof or construction adjoining to existing roof whereby proofing treatment is removed in parts;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

1. 2.

SIGNED FOR AND ON BEHALF OF BY in presence of:

- 1.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING
TREATMENT (UNDER FLOORS).**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and between S/o (hereinafter called the GUARANTOR of the one part) and the -----

(hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor interalia, undertook to render the toilets, terraces and such related areas of the building in the said contract recited completely water and leakproof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the said toilets, terraces and such related areas will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment under the floors in toilets, terraces and such related areas given by him under the contract, will render the areas completely water and leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work i.e. to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of floors or alteration and for such purpose:

- a. misuse of such floors shall mean any operation which will damage proofing treatment and things of the same nature which might cause damage to the such floors of the building.
- b. Alteration shall mean construction of any addition or construction adjoining to existing such floors whereby proofing treatment is removed in parts;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

1. 2.

SIGNED FOR AND ONBEHALFOF BY In presence of:

1. 2.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT
OF ALUMINIUM WORKS.**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only))

The agreement made this day of two thousand and between S/o (here in after called the GUARANTOR of the one part) and the-----

(hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor inter alia, undertook to render the Aluminum Works in the said contract recited safe against water leakage, unsound material and workmanship and defective anodizing etc.

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Aluminum Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for TEN years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Aluminum Works executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for TWO years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Aluminum Work or alteration and for such purpose:

- a. misuse of the Aluminum Work shall mean any operation which will damage the Aluminum Work executed by him;
- b. Alteration shall mean construction of an addition to the Aluminum Work executed by him or part thereof or construction adjoining to the existing Aluminum Work whereby the Aluminum Work is likely to be effected/damaged;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the Aluminum Work to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

1.

SIGNED FOR AND ON BEHALF OF BY In presence of:

1.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT OF
STRUCTURAL GLAZING/ CURTAIN WALLSYSTEM/WORKS.**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and between S/o (hereinafter called the GUARANTOR of the one part) and the-----

(hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor interalia, undertook to render the Structural Glazing / Curtain Wall System/ work under agreement Item No_ safe against water leakage, unsound material and workmanship and defective anodizing etc.

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Structural Glazing/ Curtain Wall System/Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for FIVE years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Structural Glazing/ Curtain Wall System /Work executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for FIVE years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Structural / Curtain Wall System/ Work or alteration and for such purpose:

- a. misuse of the Structural Glazing / Curtain Wall System /Work shall mean any operation which will damage the Structural Glazing / Curtain Wall System /Work executed by him;
- b. Alteration shall mean construction of an addition to the Structural Glazing / Curtain Wall System Work executed by him or part thereof or construction adjoining to the existing Structural Glazing / Curtain Wall System / Work whereby the Structural Glazing / Curtain Wall System/Work is likely to be effected/ damaged;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found to render the Structural Glazing / Curtain Wall System /Work to the satisfaction of the Engineer-in-Charge at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if Guarantor fails to rectify the Structural Glazing / Curtain Wall System /work or commits breach there under then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the Guarantor in performance and observance of the supplementary agreement. As to the amount of loss and/ or damage and/or cost incurred by UPPWD, the decision of Engineer will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

1.

SIGNED FOR AND ONBEHALFOF BY In presence of:

1.

**GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT OF SEISMIC/
MECHANICAL JOINT WORKS.**

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this day of two thousand and between S/o _____ (hereinafter called the GUARANTOR of the one part) and the (hereinafter called the UPPWD of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated _____ and made between the GUARANTOR OF THE ONE PART AND the UPPWD of the other part, whereby the contractor interalia, undertook to render the Seismic/ Mechanical Joint System/Work under agreement Item No _____ in the said contract recited safe against water leakage, unsound material and workmanship and defective anodizing etc..

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Seismic/ Mechanical Joint System/Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for TEN years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Seismic/ Mechanical Joint System/Works executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for TWO years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Seismic/ Mechanical Joint System/Work or alteration and for such purpose:

- a. misuse of the Seismic/ Mechanical Joint System/Work mean any operation which will damage the Aluminum Work executed by him;
- b. Alteration shall mean construction of an addition to the Seismic/ Mechanical Joint System/Work executed by him or part thereof or construction adjoining to the existing Seismic/ Mechanical Joint System/Work where by the Seismic/Mechanical Joint System/Work is likely to be effected/damaged;
- c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found to render the Seismic/ Mechanical Joint System/Work non-functional to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer –in-charge calling upon him to rectify the defects failing which the work shall be got done by the UPPWD by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the Seismic/ Mechanical Joint System/Work, or commits breach there- under then the guarantor will indemnify the principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or cost incurred by the UPPWD on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator and by for and on behalf of on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:

1. 2.

SIGNED FOR AND ONBEHALF OF BY In presence of:

1. 2.