



**INDIAN INSTITUTE OF INFORMATION TECHNOLOGY
AND MANAGEMENT – KERALA (IIITM-K)
THIRUVANANTHAPURAM**



**CONSTRUCTION OF IIITM-K CAMPUS AT TECHNOCITY,
THIRUVANATHAPURAM (KERALA)**

ACADEMIC & HOSTEL BLOCK (PHASE-I)

TENDER DOCUMENT

**TECHNICAL SPECIFICATIONS (VOLUME-III)
JANUARY 2014**



PROJECT MANAGEMENT CONSULTANT

DESIGN CONSULTANT



**CONSULTING ENGINEERING SERVICES (INDIA) PRIVATE LIMITED
PLATINUM TOWER, 184, UDYOG VIHAR, PHASE-I, GURGAON – 122 016**

**INDIAN INSTITUTE OF INFORMATION TECHNOLOGY AND
MANAGEMENT - KERALA (IIITM-K)
THIRUVANANTHAPURAM**

**CONSTRUCTION OF IIITM CAMPUS AT TECHNOCITY,
THIRUVANANTHAPURAM, KERLA
ACADEMIC & HOSTEL BLOCK (PHASE-I)**

**TECHNICAL SPECIFICATIONS
I N D E X**

SL. NO.	DESCRIPTION	PAGE NO.
1.	Index	Page No.1
2.	Civil Works	Page No. 2 - Page No. 41
3.	Plumbing Works	Page No. 42-Page No. 69
4.	Electrical Works	Page No. 70-Page No. 108
5.	HVAC Works	Page No.109 - Page No.146
6.	Fire-Fighting Works	Page No. 147 - Page No. 192
7.	List of Approved Make (Civil Works)	Page No. 193 - Page No. 197
8.	List of Approved Make (Plumbing Works)	Page No. 198 - Page No. 202
9.	List of Approved Make (Electrical Works)	Page No. 203 - Page No.207
10.	List of Approved Make (HVAC Works)	Page No. 208 - Page No. 209
11.	List of Approved Make (Fire-Fighting Works)	Page No. 210 - Page No. 213

**INDIAN INSTITUTE OF INFORMATION TECHNOLOGY AND
MANAGEMENT - KERALA (IIITM-K)
THIRUVANANTHAPURAM**

**CONSTRUCTION OF IIITM CAMPUS AT TECHNOCITY,
THIRUVANANTHAPURAM, KERLA
ACADEMIC & HOSTEL BLOCK (PHASE-I)**

TECHNICAL SPECIFICATIONS

SECTION - A (CIVIL WORKS)

1.0 GENERAL

- 1.1 **The work shall be carried out in accordance with the Architectural Drawings, Structural Drawings, all services drawings and other approved shop drawings. The Contractor is required to co-ordinate and co- relate all drawings and in case of any differences noticed the contractor shall immediately bring to the notice of the PMC/Engineer-in-Charge and shall obtain his final decision before proceeding with the concerned work.**
- 1.2 Unless otherwise specified in the schedule of quantities, the rates for all items of work shall be considered inclusive of pumping out or bailing out water throughout the construction period. This shall include water encountered due to any reason whatsoever.
- 1.3 The work shall be executed and measured in metric units given in the schedule of quantities, drawings, etc., (FPS unit wherever given is for guidance only).
- 1.4 All stone aggregate and stone ballast shall be hard stone variety to be obtained from sources and quarries approved by the Engineer-in-Charge/PMC.
- 1.5 Coarse sand shall be obtained from sources to be got approved by the Engineer-in-Charge. Whenever required, the coarse sand shall be screened and washed to suit the requirement of the specification. Nothing extra shall be payable on this account. Manufacture sand (M sand) can also be used which satisfied the criteria of CPWD specifications.
- 1.6 The rates for all items, unless clearly specified otherwise shall include all inputs of materials, labour, T & P, taxes, duties, scaffolding, wastages, profit, overhead, watch & ward, all incidental charges and shall also cover all obligations of the Contract.

- 1.7 Care shall be taken to avoid or reduce to the absolute minimum any cutting and demolishing of masonry work constructed to carry services pipes etc. Where pipes are encased in the hollows of double walls the outer wall shall be constructed after the piping or conduit works are complete in all respects and tested. In case it is found absolutely necessary to cut for taking any services, the same shall be made good during finishing to the satisfaction of the Engineer without any extra payment.
- 1.8 All works shall be carried out as per the CPWD specification 2009 unless given in this document.

2.0 DELIVERY, STORAGE AND HANDLING OF CHEMICALS

- 2.1 All chemicals (Anti- termite, Epoxy, Polymer, Water Proofing Compound, Plasticizers, etc.) shall be procured in suitable packing in sealed containers and to be stored in a condition as recommended by the manufacturer.
- 2.2 All such material shall be got approved and documents deposited with the PMC/Engineer-in-Charge. However, the material shall be in the custody of the contractor. Day-to-day account of receipt, issue and balance shall be regulated by the Contractor and proper account shall be maintained at the site of works in the prescribed form which shall be submitted to the PMC. The originals of the challan/cash memos of the quantity of various chemicals procured shall be made available on demand and a copy deposited.
- 2.3 Empty container shall not be removed from site till the completion of the project.
- 2.4 Contractor shall follow all safety norms pertaining to handling/storage and application of chemicals. Necessary protective and safety equipment, hand gloves, goggles, etc. shall be provided to all the concerned worker/ staff.

3.0 ENVIRONMENT PROTECTION

The following facilities shall be provided and maintained by the contractor at the site. No additional payment shall be made on this account unless otherwise provided for in the BOQ.

- 3.1 Provide sufficient level of sanitation / safety facilities for construction workers to ensure the health and safety of the workers during construction, with effective provision for the basic facilities such as sanitation, drinking water and safety of equipment/ machinery.

- 3.2 Identify roads on-site that would be used for vehicular traffic. Strengthen vehicular roads (if these are unpaved) by increasing the surface strength. This can be achieved by improving particle size, shape and mineral type that make up the surface base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075mm) to 10-20%. Limit vehicular speed on site 10km/h.
- 3.3 Ensure that water spraying is carried out by wetting the surface by spraying water on.
- i) Any dusty material.
 - ii) Areas where demolition work is carried out.
 - iii) Any unpaved main road and
 - iv) Areas where excavation or earth moving activities are to be carried out.
- 3.4 Cover and enclose by
- i) Providing dust screen, sheeting or netting to scaffold along the perimeter of a building.
 - ii) Covering stockpiles of dusty material with impervious sheeting.
 - iii) Covering dust emitting load on vehicles by impervious sheeting cover before they leave the site and.
 - iv) Transferring, handling/storing dry loose materials like bulk cement and dry pulverized fly ash inside a totally enclosed area/system.
- 3.5 Adopt measures to prevent air pollution within and in the vicinity of the site due to construction activities. Best approved practices shall be followed (as adopted from international best practice documents and codes).
- 3.6 The contractor shall ensure that there will be adequate water supply/storage for dust suppression, devise and arrange methods of working and carrying out the work in such a manner so as to minimize the impact of dust on the surrounding environment and deploy suitable trained and experienced personnel to ensure that these methods are implemented. Prior to the commencement of any work, the method of working, plant equipment and air pollution control system to be used on-site shall be made available for inspection and approval of the Engineer-in-Charge to ensure that these are suitable for the project. The following steps shall also be taken:-

All dangerous parts of machinery shall be well guarded and all precautions for working on machinery are taken,

Maintain hoists and lifts, lifting machines, chains, ropes and other lifting tackles in good condition,

Use of durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained,

Ensure that walking surfaces or boards at a height are of sound construction and are provided with safety rails and belts. Provide protective equipment such as helmets.

Provide measure to prevent fire. Fire extinguisher and buckets of sand to be provided in fire-prone area and elsewhere.

Provide sufficient and suitable light for working during night.

Ensure that measures to protect workers from materials of construction, transportation, storage and other dangers and health hazards are taken.

Ensure that all agencies appointed by the Contractor the construction firm / division / company has sound safety policies.

Comply with the safety procedure, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c).

Adopt additional best practices and prescribed norms as in NBC 2005 (BIS 2005).

Ensure that the vegetation is cleared only from the areas where work will start right away or area to be disturbed due to any sort of construction activity like for vehicular movement, stacking of materials, labour hutments, workshops etc. Vegetate / mulch areas where vehicles do not ply. Apply gravel / landscaping rock to the areas where mulching / paving is impractical.

Employ measures to segregate the waste on-site into 3 categories - inert, chemical or hazardous wastes. Recycle the unused chemical / hazardous wastes such as oil, paint, batteries and asbestos. The inert waste is to be disposed off at approved dump yard and landfill sites.

4.0 PRESERVATION AND PROTECTION OF LANDSCAPE DURING CONSTRUCTION

Following provision shall be made at the site by the contractor to preserve and protect landscape. Nothing extra shall be paid on this account unless specifically provided for in the BOQ.

4.1 Shall preserve the existing landscape and protect it from degradation during the process of construction to minimize the disturbance such as soil pollution due to spilling of the construction material and it's mixing with rainwater. The plan including soil erosion control management plan shall be prepared accordingly for each month and got approved from the Engineer-in-Charge. The application of erosion control measures includes construction of gravel pits and tire washing bays of approved size and specification for all vehicular site entry/ exists & protection of slopes greater than 10%. Sedimentation Collection System and run-off diversion systems shall be in place before the commencement of construction activity. Preserve and protect the existing vegetation by not-disturbing or damaging specified site areas during construction. The trees that are identified to be retained on site shall be protected during the construction period using the following measures :

- i) The damage to roots is prevented during trenching, placing backfill, driving or parking heavy equipment's. The dumping of trash, oil, paint and other material is detrimental to plant health. These activities should be restricted to the areas outside of the canopy of the trees.
- ii) The trees shall not be used for any vertical support and their trunks shall not be damaged by cutting and carving and by nailing posters and advertisements or in any other way.
- iii) The lighting of fires or carrying out heat or gas emitting construction activity within the ground covered by canopy of the trees is not permitted.
- iv) Young trees of saplings identified for preservation within the construction site shall be protected using tree guards of approved specification.
- v) The levels of soil around existing vegetation shall be retained. Lowering or raising the levels shall not be allowed unless specifically directed.
- vi) Maintenance activities shall be performed, as and when needed, to ensure that vegetation remain healthy.

4.2 A construction area shall be divided into two or more sections (staging) to minimize the area of soil that will be exposed at any given time. Staging shall be done to separate undisturbed land from land disturbed by construction activity and material storage. Measures shall be taken for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels and perimeter dike/swale shall be constructed to carry the pollutant laden water directly to the treatment device or facility. The plan shall indicate how the above was accomplished on site well in advance of the commencement of the construction activity.

4.3 Spill prevention and control plans shall clearly state measures to stop the source of the spill. Measures are to be taken to contain the spill and to dispose the contaminated material and hazardous wastes in approved manner. It shall also state the designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners and petroleum products.

4.4 A soil erosion and sedimentation control plan should be prepared by the contractor which shall be applied effectively. Measures for preservation of top soil shall be taken as described below:

Top Soil shall be stripped from the areas proposed for buildings, roads, paved areas and external services. It shall be stockpiled in designated areas and refilled during plantation of the proposed vegetation. The top soil shall be separated from the sub soil debris and stones larger than 50 mm in diameter. The stored top soil may be used for the finished grade for planting areas post construction or cordoned off undisturbed areas on site. Stockpiled top soil should not be compacted to help process of aeration. It should be stabilized on the top by temporary seeding or plastic sheets to avoid wind and water erosion.

5.0 ANTI-TERMITE TREATMENT

The work shall be carried out by trained personnel having experience in application of Anti-Termite Treatment. Material to be used shall be Herbal product called Osolin-AT-CT for construction and Osolin AT-WT for wood treatment or other approved brand.

i) OSOLIN AT-CT

Application

- a) Column Bed : The product shall be hand sprayed in evenly rammed & prepared foundation column beds before PCC, on to bottom & sides upto a height of 300mm Or 1 foot (In case of column & plinth beam foundation)without mixing water and applied @ 0.13 litres/sqm OR upto plinth level.
- b) Column or footings : The treatment shall be continued on all the sides of vertical & horizontal surfaces of the footings upto 300mm above plinth level.
- c) Plinth Beams : All the outer and inner plinth beams shall be treated by the product on all 4 sides, upto the interior flooring levels.
- d) Interior Flooring, Plinth protection and Flagging area: Osolin AT-CT shall also be sprayed over the rammed & prepared sub floor earth (ie before laying sub base PCC). The plinth protection and flagging area shall be sprayed @ 0.13 litres/sqm.
- e) In all the above said stages, the product should be carpet sprayed on to the specified surface only and need not be injected by drilling holes or by any other method.
- f) The sprayer nozzle may be set to Rain sprinkle spray so that the product can clearly reach the mud surface and cover up the surface homogenously.

ii) OSOLIN AT-WT (Wood Treatment)

- a) The product is to be applied by brush to cut section wood rafters and beams both in new construction and shall be sprayed on wide ply boards.

b) Application

New Frames and Furniture: Apply ATC(WT) by a brush to all wooden section surfaces coming in contact with the masonry work before primer, painting or varnishing. Apply the product on the needed surface keeping it in FACE UP position. Spray the product to wide wooden surfaces.

iii) Guarantee

The Contractor shall be responsible to keep the building including wood work and joinery free of Termite infestation for a period of 10 years from the date of completion of the project. A Guarantee Bond on Non Judicial stamp paper of appropriate value to this effect shall be submitted. During this Guarantee period of 10 years any defect with regards to termite infestation noticed shall be rectified by the Contractor

6.0 CEMENT

- 6.1 Unless otherwise specified or called for by the contract, cement shall be Portland Pozzolona Cement (IS : 1849) in 50 kg. bags. The use of bulk cement will be permitted only with the approval of the Engineer-in-Charge. Changing of brands or type of cement within the same structure shall not be permitted unless otherwise necessitated and approved by the Engineer-in-Charge.
- 6.2 Contractor will have to make his own arrangement for storage of adequate quantity of cement. Storage, handling, etc., of cement shall be as specified in CPWD specification.
- 6.3 Conformity of cement to IS specification is to be produced from the manufacturer by the contractor including manufacturer's test certificate. Should anytime, the Engineer-in-Charge has reason to consider that any cement is defective, then irrespective of its origin and or manufacturer's test certificate, such cement shall be tested immediately at a national / approved test laboratory and unless the results of such tests are found to be satisfactory, it shall not be used in the work. In case of such additional tests, the cost of testing shall be born by the contractor.
- 6.4 Cement brought to site and cement remaining unused at the completion of the work shall not be removed from site without the clearance from Engineer-in-Charge.
- 6.5 The record of cement received at the store, issued indicating the source of supply, brand name etc. and consumption shall be regulated and proper accounts maintained as per CPWD. The theoretical consumption of cement shall be worked out as per procedure.

7.0 STEEL

7.1 Contractor shall procure reinforcement bars (Fe 415 / Fe 500 / Fe 550) conforming to CPWD / BIS code. Manufacturer's test certificate as well as independent laboratory testing for samples as per BIS codes shall be provided. In case of non-conformity, the same shall be rejected and shall be removed from the site.

7.2 For checking nominal mass, tensile strength, yield stress, bend test, re-bend test, etc., specimen of sufficient length shall be cut at random at frequency as specified in the relevant IS code.

7.3 In case additional number of tests is required by the Engineer-in-Charge, the same may be ordered by the Engineer-in-Charge. In such case, the charges for the testing shall be born by the contractor / department in the manner indicated below :

- i) By the Contractor, if the results show that the steel does not conform to the specification.
- ii) By the Department, if the results show that the steel conforms to the specification.

7.4 The records of steel received at the store, issued to site of work, and consumption shall be regulated and proper accounts maintained as per CPWD. The theoretical consumption of cement shall be worked out as per procedure followed by CPWD.

8.0 CONCRETE AND RCC WORKS

The work in general shall be carried out as per the CPWD specifications.

8.1 CONCRETE

The concrete shall be procured from a Ready Mix Concrete Suppliers (plants) approved by the Engineer - in - Charge. Site batching plant produced concrete shall also be permitted on approval by the Engineer-in-Charge. The mix design and other parameters of the RMC including transporting and placing etc. shall be strictly as per the **CPWD SPECIFICATIONS 2009 FOR CEMENT MORTAR, CEMENT CONCRETE AND RCC WORKS**, unless specified otherwise which shall be informed to the RMC supplier by the Contractor .The Contractor shall be wholly responsible for ensuring the property of concrete, as required at site, irrespective of the fact that the RMC plant/supplier /batching plant shall be approved by the Engineer-in-charge. Engineer-in-charge or his representatives

shall be at liberty to inspect the operations, quality of various ingredient materials and take samples, if required, verify quantity of various ingredients being used at the RMC plant /batching plant and take samples of concrete at the RMC plant/batching plant and also at site, as desired. The Contractor shall satisfy himself that the quality of materials including various ingredients is as per the specifications. In case the aggregates tested do not comply with any requirement of specifications, the source for the same shall be rejected. The aggregates shall be stored in such a way as to prevent mixing with foreign material as well as intermixing amongst them. Different sizes of coarse aggregate shall be stored in separate compartment to prevent intermixing at the partition.

8.2 BATCHING OF CONCRETE

- i) Various ingredients of the plain cement concrete and Reinforced Cement Concrete shall be mixed by weigh batching only. The measuring equipments shall be maintained in clean and serviceable condition. The calibration certificate shall be made available from RMC supplier approved agency and calibration shall be subject to third party check also, as directed and decided by the Engineer-in-charge and this shall be mandatory and binding on the Contractor and his RMC supplier. The weigh batching shall be done by converting the proportion of ingredients into their masses considering their specific gravity, density, voids, absorption, bulking etc. The decision of Engineer -in- Charge in this regard shall be final and binding. The various grade of concrete to be used shall be as specified in item and as directed by the Engineer-in-charge.

The design mix for reinforced cement concrete shall be for 'MODERATE' exposure condition.

- ii) The Ready mix concrete plant / or site Batching plant should have the computerized weigh batching conforming to IS: 4925 with arrangement for automatic dosing of admixture and adequate production capacity. The minimum cement content in concrete shall be as specified in the relevant IS code.

8.3 CONCRETE TESTING

Samples from fresh concrete shall be taken as per IS: 1199. Random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested. At least one sample shall be taken from each shift of work. Samples of concrete for each batch shall have to be taken by the

RMC supplier also tested and results submitted to the department for record. Procedure of testing, its acceptance criteria etc. shall be regulated in accordance with the Specifications.

8.4 TRANSPORTING

- i) The period between mixing of concrete and placing it in final position shall be kept to a minimum and the delivery of concrete shall be coordinated with the rate of placement, to avoid delays in delivery and placement. The concrete shall be supplied / transported through transit mixers and general construction of transit mixer and other requirements shall conform to IS: 5892.
- ii) Concrete shall be handled from the place of mixing to the place of final deposit by methods, which prevent segregation, or loss of any ingredients and contamination.
- iii) Where concrete is conveyed by chutes, the chutes shall be made of metal or fitted with metal lining. The approval of the Engineer-in-Charge shall be obtained for the use of chutes in excess of 3 metres long and in such cases the concrete shall be remixed if so required by the Engineer-in-Charge or closed bottom buckets shall be used. If concrete is placed by pumping, the conduit shall be primed properly. Once pumping is started, it shall not be interrupted as far as possible. Concrete shall not be dropped in to place from a height more than 1.5m.

8.5 PLACING

- i) Concreting of any portion of the work shall be done in presence of the representative of the PMC/Engineer-in-Charge and shall be done only after approval.
- ii) Concrete can be laid using pumps, buckets, cranes, trolleys etc. as required as per the site conditions. However, nothing extra shall be payable on account of using any particular method of laying concrete.
- iii) Concreting shall be carried out continuously between construction joints shown on the drawings or as agreed by the PMC/ Engineer-in-Charge. The Contractor shall closely follow the sequence of concreting wherever it is specified in the drawings. If concreting is interrupted before reaching

the predetermined joint an approved construction joint shall be provided. Construction joints shall be minimized as far as possible. The surface film of the first placed concrete should preferably be removed while the concrete is still green to expose the aggregate and leave a sound irregular surface. However care shall be taken not to disturb the concrete already laid.

- iv) Concrete shall be deposited as nearby as practicable in its position to avoid re-handling and shall not be dumped in large quantities at any point.

8.6 CURING

Moist curing using jute, canvas, hessian or similar materials may be adopted.

8.7 MISCELANEOUS

- i) Cover blocks of same mix of concrete shall be used. No other type of cover blocks shall be permitted.
- ii) Cement slurry if added over base surface (or for continuation of concreting) for bond, its cost shall be deemed to have been included in the respective items, unless otherwise, explicitly stated and nothing extra shall be payable nor extra cement considered in the cement consumption on this account.
- iii) Centring and shuttering for concrete and reinforced concrete wherever required shall be in steel and / or plywood to produce a smooth and uniform finish on all exposed surfaces. However, all props, bracings, scaffolding etc., shall be in steel. The entire responsibility of planning, design, erection and safety of formwork shall lie with the Contractor.
- iv) The portion of shuttering in elevation (and not segmental) shall be measured for payment. For shuttering curved in elevation the steel / ply shuttering shall be fabricated to achieve the curved profile as per the architectural drawings.
- v) The crushed stone/ crushed gravel sand meeting relevant IS standards shall not be permitted to be used in work subject to the approval by the engineer in charge.

SOLID/HOLLOW CEMENT CONCRETE (CC) BLOCK WORK

- i) Precast CC blocks shall be procured from approved manufactures or manufactured at site. Nothing extra shall be payable on account of adding any admixture for making pre-cast blocks or for steam curing.
- ii) The CC blocks shall have nominal size of 400mm x 200mm x 100mm and 400mm x 200mm x 200mm respectively for 100mm and 200mm thick masonry wall, and shall confirm to IS 2185.
- iii) The samples of CC blocks (each sample consisting of 6 specimens) shall be chosen randomly from the lot and tested for various parameters specified below. One samples shall be tested for every 100 cum or part thereof.
- iv) Following parameters shall be tested.
 - a) Compressive strength.
 - b) Water absorption
 - c) Density
 - d) Dimensional Tolerances.

The material shall meet following parameters :

- a) Compressive strength shall be no less than 5.0 N/sq. mm.
- b) Water absorption shall not be more than 5%.
- c) Density shall be not less than 1500 kg/cum.
- d) Dimensional tolerance in the size shall be not more than ± 5 mm for length and ± 3 mm for height and width.

Top course of all plinth, parapets, steps and top of walls below floor and roofs shall be laid with solid blocks, properly radiated and keyed into position to form cut (meru) corner. Where blocks cannot be cut to meru corners, cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of the coarse shall be provided in lieu of cut blocks. No additional payment shall be made on this account.

Nothing extra shall be payable on account of chasing the CC block masonry work for embedding pipes, electrical boards / boxes etc. and also filling the chases with cement mortar 1:4 (1Cement:4coarse sand). The chasing shall however be carried out using machine cutters so as not to disturb the joints in the masonry and without any cracks being developed in the masonry.

All other specifications for 100 mm thick and 200 mm thick block work shall be as describes for full brick and half brick masonry work respectively.

For unsupported lengths of 100 mm thick walls exceeding 3.5 m, 100 x 200 mm wide R.C. mullions shall be provided at 3.5 m centre, tied to the lintels at door height. Similarly, continuous R.C. beam of size 100 x 150 mm shall be provided at door height for 100 mm thick wall. Such RC mullion/ bands shall be measured and paid separately.

8.9 **Wall Insulation**

Providing and fixing 60mm thick 64 kg/m³ density water repellent grade, mineral wool slab conforming to IS:8183 & type tested by CBRI for BS:476 part 4 for non-combustibility and encased in 200 gauge polythene sheet, on the Block wall with the help of mechanical fasteners and washers provided at each corners of the insulation slab and one at the centre.

Providing and fixing GI wire netting to the fastener to fill the insulation slabs in place.

Providing and finishing the wall insulation with a duly plastered Block wall without any air gap in between the insulation and inner Block wall.

8.10 **Specifications For Metal/ Wood, Factory Made Fire Resistant Door**

METAL FIRE RATED GALZED DOOR

Hollow metal fire rated glazed doors as per BS 476 part-22 for stability and integrity. Pressed Galvanized steel conforming to IS 277 with the following specification. Recommended glazed fire door shall have maximum rating of 120Mins, as a 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. Approved manufacturer Shakti Met-dor or approved equivalent. Door frame shall be double rebate profile of size 154 x 77 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement &

sand slurry necessary for fire doors on the clear masonry opening. Door leaf shall be of galvanized steel rails 47mm thick and 100mm. Door leaf profile shall be manufactured from minimum 1.2mm (18 gauge) thick galvanized steel sheet. The internal construction of the door should be rigid reinforcement pads the bottom rail shall be 200mm. The glass shall be minimum 6mm thick fire rated glass of make schott. Glazing and glass material shall be fixed on rails with steel GI beddings. The gasket shall be 4mm ceramic based of approved make. 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 for pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and fire rated hardware set as below :

120Mins Fire Rated Glazed (FD1) Double equal leaf door of size : 2000 x 2700mm with Hardware 6nos 100x75x3mm BB hinges, 2Nos heavy duty door closer with std arm, 1no. door Coordinator, Mortise sash lock with lever Handel & 2 Nos. concealed flush bolt & concealed door bottom seal of neoprene gasket, Hardware make-Guardian.(Location-Lift Lobbies & Corridor)

WOODEN FIRE RATED DOOR

8.11 Wood Work In Frames

- i) The work shall be carried out in accordance with the architectural drawings issued by the department. The architectural drawings shall at all times be properly correlated and architectural requirements have to be fully satisfied.
- ii) The surface of the frames abutting the masonry or concrete and the portion of the frames embedded in floors shall be given 'Herbal Anti-Termite Treatment Osolin - WT' as directed by the Engineer-in-Charge. Care shall be taken so that the treatment does not streak and does not come over to the exposed face of the wooden frames; otherwise the woodwork shall be rejected and redone by the Contractor at his own cost. Nothing extra shall be payable on this account.

- iii) Screws used for woodwork shall be fully threaded, counter sunk stainless steel screws, grade 304 and they shall be suitably concealed or plugged.
- iv) Hinges to be used for fixing shutters shall be brush finished stainless steel ball bearing hinges of minimum grade 304 and of the make as approved by the Engineer-in-Charge. The sizes and the number of the hinges per shutter shall be as per the item description.
- v) Wood used for manufacturing of the door frames, internal & external lipping, beading, etc., shall be seasoned as per the requirement of the CPWD specification.
- vi) The glue used for the joinery work in the woodwork, for ply wood board, for fixing the laminates/ veneers etc. shall be PVAc based adhesive, Fevicol SWR of Pidilite Industries Ltd. Or equivalent.
- vii) The frames shall have to be inspected and approved by the Engineer-in-Charge /PMC before being painted or otherwise treated and before fixing in position.
- viii) The frames shall be fixed to the abutting masonry or concrete with dash fasteners of approved quality and size at 600 mm center to center unless otherwise specified in the drawing.
- ix) Wherever required necessary recesses or openings shall be made for conduiting/ electrical switch boards etc. as per direction of Engineer-in-charge/PMC. Nothing extra shall be paid for making such openings nor shall any deduction be made for such openings.
- x) Wooden framework fixed in position shall be measured for finished dimensions without any allowance for wastage or for dimensions beyond those specified in the drawing. Length of each member shall be measured overall so as to include the projection for tenons and overlaps. Length, width and thickness shall be measured correct to a centimeter and volume shall be worked out in cubic meter.

8.12 **FACTORY MADE DOOR / WINDOW SHUTTERS**

- i) Factory made doors and windows shall be procured from one of the approved manufacturers as specified. The Contractor shall, within a period of one month after the issue of letter for commencement of work, intimate the name of manufacturer from which the factory made shutters for doors and windows are to be procured.

- ii) The work shall be carried out in accordance with the architectural drawings issued by the department. The architectural drawings shall at all times be properly correlated and architectural requirements have to be fully satisfied.
- iii) The exact size of different door and window shutters and their numbers shall be checked as per actual site dimensions before placing the order for manufacturing of door shutters.

iv) **SPECIFICATION FOR SHUTTERS**

- i) The factory made flush door shutters shall be ISI marked. For the flush door shutters with laminate and veneer, flush door shutters shall conform to ISI parameters except for laminate and veneer. The material used for manufacture of shutter shall be as follows :
 - a. **TIMBER:** As specified in the items and conforming to I.S: 2202 (Part-I). The Contractor shall obtain the species of timber to be actually used by the manufacturer of the shutters and submit the same for the approval of the Engineer-in-Charge.
 - b. The shutters shall have external lipping of second class teak wood of minimum 12mm thickness. The veneer / laminate shall mask the external lipping as per the details given in the architectural drawings. For the shutters fixed on floor springs, the thickness of the external lipping shall be 20mm including moulding and making necessary grooves as per the architectural drawings. The lipping shall be fixed using adhesive as specified and shall be factory pressed.
- ii) When the laminate and veneer finish is provided in combination on the surface of the door shutters the difference between the thickness of the laminate and the veneer shall be adjusted in the thickness of the ply veneering below the laminate and the veneers to ensure that the top surface of the laminate and natural wood veneer are in flush finish. Nothing extra shall be payable on this account.

iii) The contractor shall produce paid voucher & the test certificate from the door shutter manufacture in the kiln seasoning, chemical impregnation.

iv) **SEASONING AND PRESERVATIVE TREATMENT**

i) Timber shall be kiln seasoned by a suitable process conforming to IS: 1141 before being planed to the required sizes.

ii) The maximum permissible moisture content in timber shall be 10 percent except for frames where it can be upto 12%.

iii) The preservation of timber shall be done as per IS-401.

v) **DIMENSIONS AND TOLERANCES**

The shutters shall be supplied as per the specified size with allowable tolerance of 3mm over the specified dimension for which no extra payment shall be made. No tolerance on the lower side will be allowed on the overall dimensions of shutters. The manufacturing tolerance of individual members of shutters will be +/- 1mm in thickness and +/- 2 mm in width.

vi) **INSPECTION**

The Contractor shall get fabricated one shutters of each type of door / window and inform the Engineer-in-Charge who shall arrange for the visual inspection of the sample. The samples inspected by the Engineer-in-Charge or his representative shall be signed by him as a mark of identification. These inspected samples of each type will be delivered by the Contractor at site. Contractor shall give notice in advance before every consignment is ready at factory site for inspection and testing before dispatch. The final approval of the door and window shutters is subject to testing.

vii) **TESTING**

i) In any consignment all the shutters of the same type and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. Samples shall be selected and inspected separately for each lot for determining its conformity or otherwise, to the requirement of the specifications.

ii) **NUMBER OF TESTS AND CRITERIA FOR CONFORMITY:**

a) The numbers of shutters to be selected for inspection / testing from a lot shall be as in the table given below :

LOT SIZE	FOR CHECKING DIMENSIONS, TOLERANCE CONSTRUCTION, WORKMANSHIP AND FINISH		SAMPLE SIZE FOR TESTING OF MATERIALS.
	Sample size	Permissible no. of Defective shutters	
26 to 50	5	0	1
51 to 100	8	0	1
101 to 150	13	1	1
151 to 300	20	2	2
301 to 500	32	3	4
501 to 10000	50	5	8
1000 to above	80	7	10

- b) The sample size indicated in column 2 of table shall be inspected for dimension and tolerance construction and workmanship and finish. A lot shall be considered as having satisfied the requirements of the specifications in these respects, if the number of defective shutters in the sample does not exceed the corresponding permissible number of defective shutters given in column 3 of the table above. If the number of defective shutters exceeds the permissible number of defective shutters, the lot as a whole shall be rejected and the Contractor shall have no claim whatsoever on this account.

- c) The sample size as per column 4 of table shall be tested in an approved test house. The timber shall be tested for the moisture content (IS- 1708) and preservative treatment (IS-401 and other relevant IS standards). A lot shall be considered as having satisfied the requirements of the specifications in these respects only if all the tests are satisfactory. If any sample fails to meet the requirements of the specifications in respect of any test, the whole lot shall be rejected and the Contractor shall have no claim whatsoever on this account.

- viii) Flush doors shall be tested as per the relevant Specifications.

- ix) The opening for the vision / glazing panel in a flush door shutter shall be made as per the architectural drawings. Wherever vision / glazing panel are provided near the edge of the shutter, it should be kept minimum of 150 mm away from the edges .The opening shall be made by machine cutting, in a workman like manner. Further, the periphery of the opening shall be strengthened by providing additional wooden framing in the core. An internal lipping of second-class teakwood, minimum 3mm thick, shall be provided on the cut edges of the panel opening using stainless steel nails, screws, etc. Nothing extra shall be payable on this account.

VENEERS AND LAMINATES

- i) Each type of laminate and veneer shall be obtained from only one of the approved manufacturers as specified. Adequate spare quantity shall be ordered to cover for any damaged sheet and for replacement by the Contractor till the completion of the work.
- ii) The laminates shall be made out of superior quality paper impregnated with melamine and phenolic resin and shall have scratch/ wearing resistant melamine plastic surface. The laminates shall be resistant to boiling water, stain and chemicals.
- iii) The veneers shall be natural wood decorative veneers made out of hard and durable quality wood. The grains and colour of the veneers shall be well matched and there shall not be any visible variations. The thickness of the veneers shall not be less than 0.4 mm. The melamine polishing over the veneer shall be paid separately. The veneer shall conform to IS 1328.
- iv) The Contractor shall ensure that the edges of the laminates do not come out or chip / peel off during cutting and fixing of the laminates. Defective work on this account shall not be accepted and shall be redone by the contractor at his own cost.
- v) The wooden lipping, laminates, veneers, beadings etc. shall be fixed to the plywood board using high strength cross linked PVAc based adhesives, "Korlok 472 " of National or " Fevicol SWR " of Pidilite Industries Ltd.
- vi) **Veneering with natural wood veneers:-**The veneers shall be natural wood decorative veneers of approved finish made out of hard and durable quality wood. The grains and colour of the veneers shall be well matched and there shall not be any visible variations. The actual thickness of the veneer shall not be less than 0.5 mm and the composite thickness with ply backing shall not be less than 3.5 mm. The veneers shall conform to IS 1328-1996. The veneers shall be fixed to plywood board / panels by hot or cold pressing in approved pattern with necessary adhesive & nails etc. complete as per architectural drawings. Wherever required necessary recesses or openings shall be made for conduiting/ switch boards etc. as per direction of Engineer-in-charge. Nothing extra shall be paid for making such openings nor shall any deduction be made for such openings.

8.14 WOODEN FLOORING AND SKIRTING

The wooden texture laminated flooring shall be of approved make with bottom layer of poplar fibre underlay and PE film. The thickness of laminated plank should be 8mm-8.3mm thick with min. 189-289mm wide having joint guard joint protection system. The plank should have glueless click insulation system arrangement. All joints to be filled with click guard joint sealing system for extra joint strength and moisture protection.

TECHNICAL CLASSIFICATION REQUIREMENT

	Method	Units	Requirement	Typical Value
Abrasion Class	EN 13329		AC 4:IP \geq 9000	IP>9000
Impact resistance	EN 13329	N/mm ²	\geq 1C 1	IC2
Resistance to staining	EN 438.2.15	Rating(*)	Group 1 & 2:5	5
Resistance to cigarette burns	EN 438.2.18	Rating(*)	Group 3:4	4
Effect of furniture leg	EN 424	-	No damage	No damage
Effect of castor chair	EN 425	00	No damage	No damage

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

9.0 STRUCTURAL STEEL WORK

9.1 Scope of Work

The work covered by this specification consists of supplying, fabricating and erecting structural steel complete in strict accordance with this specification and the applicable drawings.

9.2 Shop Drawings

The shop drawings of structural steel work based on construction drawings shall be prepared by the contractor and submitted to the Engineer in charge/PMC. Necessary information for fabrication, erection, painting of structure etc. must be furnished in advance

9.3 **Painting**

Painting shall be strictly according to I.S. 1477 (Part I - Pretreatment) and I.S. 1477 (Part II - Painting).

Painting should be carried out on dry surfaces free from dust, scale etc.

One coat of shop paint (Zinc Chromate) shall be applied on steel except where it is to be encased in concrete or where surfaces are to be field welded.

10.0 **STAINLESS STEEL WORKS**

10.1 **Stainless Steel Frame Work and Hand Rail**

Providing, fabricating and fixing in position stainless steel frame/hand rails stainless steel pipes, plates, flats, etc., as shown on drawing, description and as directed by the Engineer-in-Charge. The work shall also include cutting, welding, grinding, bending to required shape and profile, hoisting, buffing and polishing, cutting chase, embedding in masonry / concrete, rigidly fixed etc. all complete at all floors and levels. All railings shall be measured in running meter for a particular type.

10.2 **Testing of Material**

The stainless steel sections shall be tested in an independent laboratory as approved by the Engineer-in-Charge. One sample of each type of stainless section shall be tested for SS grade. This sample shall be selected randomly from site or factory / workshop. If the sample fails the tests, the material shall be rejected and removed from site by the contractor and replace with satisfactory material at his on cost. One sample for each lot shall be tested. The cost of testing and sample shall be born by the contractor.

10.3 Stainless steel jali for door and window shall be made from SS grade 304.

11.0 **SPECIFICATIONS FOR FLOORING, WALL LINING / VENEER WORK**

The work shall be carried out by approved workmen specialized in the trade.

11.1 **Marble / Granite Work**

This section shall cover marble, granite and marble/granite veneering to walls, flooring and counter top work as detailed below.

11.2 **Material**

Marble/Granite shall be hard, sound, dense and homogeneous in texture in accordance to the sample & of the required size and thickness approved by the Engineer. It shall be reasonably uniform in colour, texture, pattern & shape and free from stains, cracks, decay and weathering and of specified quality, size and thickness. The slabs shall be pre-polished or matt flamed finished as specified in the factory before delivery. Before placing order samples of the flooring shall be installed at the site and got approved. The granite slabs in external and internal wall veneer work shall be mirror polished in the factory with Silicon Carbide abrasives starting from no. "00" upto no. 5 and then using buff/lead strip rolls with tin oxide for final mirror polish. For flooring and counter top the final tin oxide polish shall not be used.

11.3 **Specialist Sub-Contractor**

The supply & installation of the granite work shall be carried out by the approved renowned specialist agency experienced in the trade. The Specialist agency will be approved by the Engineer after executing necessary samples of relevant veneering, cladding and flooring works. The work will commence only after approval of relevant shop drawings for Marble / Granite.

11.4 **Marble/Granite Work (Wet Fixing)**

i) Preparation

Every stone shall be cut to the required size and shape, so as to be free from any waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be fine chisel dressed in both directions or polished as required to a depth of 6 mm so that when checked with a 60 cm straight edge no point varies from it by more than 1 mm. for veneering work. No dressing or polishing shall be done at the back of the stone, so as to ensure better grip with the backing. The dressed slabs shall be of the thickness, as specified with permissible tolerance of (\pm) 2 mm.

ii) Fixing with Mortar

Mortar for fixing shall be as specified in the description of the particular item and as per the specification of mortar mentioned in CPWD Vol. - II (specification).

iii) Laying with Mortar

The stone shall be wetted before laying. Before installing the stone slabs the backing shall be plastered, cured and all surfaces imperfections removed. Pre-polished stone of the required size shall then be installed in position. The adjoining slabs shall be secured to each other and to the backing by means of stainless steel cramps, pins & dowels and araldite. The material for cramps shall have high resistance to corrosion under condition of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

All the joints shall be full of mortar. Special care shall be taken to see that groundings for veneer works are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. The thickness of the face joints shall be uniform, straight and as fine as possible and pointed with mortar as specified.

The veneering shall be carried in truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical.

iv) Protection

The work shall also be suitably protected from damage, mortar dropping and all other extraneous materials and rain during construction.

11.5 Marble/Granite Flooring and Counter Top

i) Dressing of Slabs

Every stone shall be prepolished and accurately machine cut to the required size and shape so that a straight edge laid along the side of the stone is fully in contact with it. For patterned flooring actual dimensions shall be taken at the site and shop drawings in suitable scale prepared to identify correctly the sizes and shapes of all stones. Each stone shall be marked with a suitable identification number. All angles and edges of the granite slabs shall be true, square or angular as required and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be as shown in the drawing with allowable tolerance of ± 2 mm. In respect of length and breadth of slabs a tolerance of ± 5 mm will be allowed.

ii) Laying

Sub-grade concrete or the R.C.C. slab on which the slabs are to be laid shall be cleaned, wetted and mopped. For patterned work the stone shall first be laid in position loose to ensure achievement of the required pattern and any adjustments required shall be made and all stone shall be wetted and washed just before placing and the bedding for the slabs shall be with mortar as described in the item.

The average thickness of the bedding mortar under the slab shall be to suite the overall thickness of flooring specified and the thickness at any place under the slab shall not be less than 12 mm.

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The prepolished slabs shall first be laid on top of the mortar in accordance with the approved drawing and pressed tapped with wooden mallet and brought to proper level in continuity with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar shall be allowed to stiffen slightly & uniformly and white cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the slabs as given in the description of the item. The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level and line with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days.

The surface of the flooring as laid shall be true to falls and, slopes as required. The slabs shall be matched as shown in drawing or as instructed by the Engineer. Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster /skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness. Wherever required the flooring shall be laid in patterns and/or with brass divider strips as required.

iii) Curing and Finishing

The day after the slabs are laid all joints shall be cleaned of the cement grout with a wire brush or trowel to a depth of 5mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with white cement mixed with or without pigment to match the shade of the topping of the wearing layer of the slabs. The Plaster of Paris slurry shall be applied to the entire surface of the slabs in a thin coat to protect the surface from abrasive damage.

Before handing over the area, the protective cover shall be removed carefully and the surfaces cleaned and carefully rubbed with a "namdah" block to leave a clean & shining floor without any defects to the satisfaction of the Engineer. If any slab is disturbed or damaged, it shall be refitted or replaced and properly jointed. The finished floor shall not sound hollow when tapped with a wooden mallet.

12.0 SPECIFICATION FOR FALSE CEILING AND THERMAL INSULATION

12.1 Tile False Ceiling

The work shall be carried out through specialist agencies recommended by the manufacturers.

- i) The False Ceiling Tiles shall be procured from an approved manufacturer as per the list of Approved makes.
- ii) The tiles and the suspension system shall be as specified in the item nomenclature. The Contractor shall prepare the shop drawings for the False ceiling based on actual measurements at site and based on the architectural drawings, clearly indicating the typical panel as well as edge panel on all sides with details to adjust the minor variations in orthogonality. Also, junction details with different types of false ceiling materials shall be prepared and submitted for the approval of the PMC/Engineer-in-Charge before execution.
- iii) The installation shall be got done through a reputed Interior Contractor who shall be engaged by the Contractor. The details of earlier works executed by the Interior Contractor shall be submitted to the Engineer - in-Charge in advance. If required, those works shall be inspected to assess the quality of workmanship. The false ceiling shall be perfectly level after installation.

- iv) The Contractor shall prepare the mock-up at site for approval of material and quality of workmanship by the Engineer-in-Charge. Only after the approval of mock-up, the Contractor shall start the mass work.
- v) The tiles shall have precisely machined edges including edge treatment required for the installation depending on the type of suspension system grid as approved by the Engineer-in-Charge and as per the Architectural Drawings. The opening of the required size for light fittings, fire detection devices, sprinklers, AC diffusers, etc. shall be suitably made in the tiles frames and suspension system introducing additional frames wherever required by cutting in an approved and workmanlike manner. For the purpose of measurement, no deduction shall be made in the area of false ceiling on this account. Also, nothing extra shall be payable on this account. The end tiles shall be cut to the required size in a workmanlike manner as per the site requirement. Nothing extra shall be payable on account of any wastage in the material and /or account of providing grid at closer spacing than the general grid.
- vi) These tiles shall be fixed on to coordinate suspension ceiling system with supporting grids system that fully integrates with the ceiling tiles. It shall be ensured that the suspension system shall be suitable to take all the incidental and dead loads efficiently and shall not sag. The permissible sag shall be as per the British Standards BS 8290 - 1991. The Contractor shall provide a guarantee for 10 years against sag on account of defective material and/or workmanship.
- vii) The Contractor shall ensure that the grid system is designed and installed to carry all incidental loads and no other unauthorized load shall be transferred to this system. The luminaries, air grills/diffusers, signages, etc. shall be as far as possible independently supported to avoid any over loading of the ceiling system which may result in excessive deflection or twisting of grids. Any strengthening of grid system by providing additional hangers, fasteners, runners, cross tess, etc. or providing additional bracing may be carried out as required for any specific locations or for specific purpose for which nothing extra shall be payable. Perimeter trims/edge profiles of required size and shape, powder coated to required colour and shade, shall be installed at the suspension grid to completely enclose the ceiling and shall be properly secured to the walls at not more than 450mm centre to centre using stainless steels screws and PVC sleeves. It shall be neatly jointed at all external and internal angles and overlap sections in a workman like manner with mitred joints.

- viii) The ceiling should be set out such that the perimeter boards or tiles are in excess of half a module so that the edge panels on opposite sides are of equal sizes as far as possible. The tiles shall be cut to required size and shape with rebates as specified using hand tools or mechanically operated tools in a workman like manner but with all precautions as per the manufacturer's specifications regarding generation of dust and ventilation.
- ix) The entire installation shall have minimum half an hour fire rating and integrity as specified as per BS 476.
- x) The Contractor shall ensure that the material is procured and delivered at installation site without any damage. Adequate care shall be taken before installing as well as afterwards till handing over the building for occupation. It shall be protected from rains, excessive humidity, chemical fumes, vibrations, dust, etc. The Contractor shall ensure careful handling and storage and prevent any edge damage or breakage. Any tile with edge damaged or crack etc., shall not be allowed to be used in the work and shall be replaced by the Contractor at his own cost. Similarly, adequate care shall be taken by the Contractor while placing or removing and handling the tiles so as not to cause any damage. Also, the Contractor shall direct his interior contractors to take adequate precautions to prevent the tiles from any dirt, fingerprints, any other marks/splashes, etc. The ceiling shall not be wet cleaned. Abrasive cleaners shall not be used to clean the marks.

12.2 Calcium Silicate Tile False Ceiling

- i) The false ceiling tiles shall be made of hydrated calcium silicate and shall be resistant to water, temperature, etc., as per the manufacturer's specification.
- ii) The tiles shall be of size 595 x 595 mm. The ceiling should be set out such that the perimeter boards or tiles are in excess of half a module so that the edge panels on both the sides are of equal sizes as far as possible as per the architectural drawings and as per the site requirements.
The tiles shall have the following characteristics :

- a) Humidity Resistance : 100% RH
- b) Fire Performance : As per BS:476
- c) Noise Resistance Coefficient : 0.50, CAC of 32 db

- d) Light Reflectance : > 85%
- e) Thermal Conductivity : < 0.17 w/m^o kc
- f) Thickness of Tile : 15mm, densified edge

The Contractor shall obtain and submit to the Department the manufacturer's certificate for compliance of the false ceiling tiles and the suspension system as per the manufacturer's specifications and also copy of the manufacturer's test report for the record.

- iii) The suspension system for the calcium silicate board tiles shall be "**Slotted**" grid system of Armstrong or equivalent brand as approved, powder/coil coated on exposed face in white colour with black or white reveal. The suspension system shall consist of hangers, main runners, cross tees, perimeter trims, wall connectors, etc. The hangers shall be securely fixed to the structural soffits/slab/beams at spacing not more than 600mm centre to centre by using electroplated galvanized M.S. anchor fasteners of 8mm (minimum) diameter of approved make and of adequate capacity to carry the design loads. The main runners shall be fixed at spacing not more than 600mm centre to centre. The last hanger at the end of each main runner shall not be placed more than 450mm from the adjacent walls. Additional hangers shall be placed at a distance not more than 150 mm from the joint in the main runner on either side. Intermediate cross T of 1200 mm long shall be provided @ 600mm c/c. The cross tees 600mm long shall be centrally interlocked between two intermediate runners to form 600 x 600mm modules. Additional runners and hangers shall be provided where change of direction is required as per the site conditions. All the hangers, runners, tees, cleats, brackets, etc., required for fixing the false ceiling suspension system shall be of anti-corrosive hot dipped galvanized M. S. sections with zinc coating not less than 170gms per sqm. and shall be as per BS 2989. The galvanized MS runners, cross tees, perimeter trims / edge profiles, etc., shall be powder/coil coated (the coating as per manufacturer's specifications) matt finished of required colour and shade. The cross tees shall be connected to the main runner by stab and hook type (clip in) installation. The runners and cross tees shall have mechanical stitching and enhanced torsional resistance and shall have mitred inter-section. Further, the grid system with main runners and the cross tees shall have 24mm wide flanges with a 3mm central recess with reveal profile. The hangers shall be mechanically pre-straightened and shall not be less than 4mm diameter and of lengths as required for keeping minimum plenum depth as per the architectural drawings. It shall be suitably cut/tied off. The stainless steel level adjuster clips

(spring steel, butter fly clips having suitable number and diameter and of machine punched holes and bent to required profile) shall be provided on the hangers to achieve the level of the ceiling. The suspension hangers shall be vertical or near to vertical as far as possible. The hangers shall be suitably designed and shall have capacity to take incidental loads of fixtures, suspended signages, etc., within the tolerance limit of deflection as specified in BS 8290. Increased load, if any, may be accommodated by providing additional hangers.

- iv) The main runners shall be 24mm x 38mm and the cross tees shall be 24mm x 30mm roll formed from GI sheets (0.33mm thick), powder/coil coated with 3mm wide reval profile/wall moulding and should only rest on the edge profile/wall moulding. The edge moulding shall be 19 x 7 x 7 x 14 mm roll formed from 0.35mm thick GI sheet powder/coil coated on the exposed face to the matching colour and the shade.

12.3 **Aluminum linear False Ceiling**

Fixing 300 A Panel Reval Metal linear false ceiling of Hunter Duglus or equivalent of size 200 x 3000 mm with frame work of anodised aluminium sections for suspended false ceiling as shown on drawings and as per manufacturer Printed instruction, complete in all respect, weight 10Kgs/m² which is fixed by using concealed ceiling system and also including the cost of making openings for light fittings, grills, diffusers, cut-outs made with frame of perimeter channels suitably fixed, as per direction of the Engineer in Charge.

12.4 **Gypsum Board False Ceiling**

- i) The gypsum board false ceiling shall be done in different levels in linear and curvilinear pattern in plan and elevation and in combination with other types of false ceiling like mineral fibre board, wooden rafter, etc., as per the architectural drawings.

- ii) The gypsum board shall be of India Gypsum Ltd. or approved manufacturer as per the approved list of Makes. Unless otherwise specified all boards shall be 12.5mm thick, 1.5kg/m² weight, square placing ceiling board.

- iii) **Aluminum Tile False Ceiling System 600 mm x 600 mm Lay-in-Suspension**

Supply and installation of Aluminium coil coated false ceiling system, comprising tile size 600 mm x 600 mm manufactured out of 0.70 mm thick aluminium sheet, coil coated on the exposed side and a non woven acoustic material pasted on mill finish on the back coil. In

manufacturers standard color shades, with beveled edges and flanges produced in advanced equipment, which includes several leveling stages in the manufacturing process. Exposed side of the tile shall have 20 microns coil coated polyester finish and 5-micron back coat of alkyd primer.

All the tiles to be installed on a standard 600 mm x 600 mm module 24mm table concealed metal grid and are precision made to within plus or minus 0.25 mm. uspension system would be standard 24mm table concealed metal grid features main runners and cross tees rolled formed from galvanized steel to BS-2989Z-18 zinc coating. Grid system to be designed to satisfy ASTM C-653 loading and deflection criteria.

The main & cross runners to be provided with bavonet coupling for quick installation and shall have a height of 38mm. The grid is suspended from the roof with GI wire rods or quick adjustment suspension hangers at max 1200 mm along the main runners. The tiles would be designed for lay-in-mounting from below into the standard grid. The main runners shall normally be fixed at 1200mm and shall be in filled with 1200mm / 600 mm cross tees. Hangers to be fixed to roof by expansion fasteners. Wall angle to be 25mm x 25mm x 0.60 mm thick coil coated steel.

13.0 METAL ROOFING

13.1 Double Skin Metal Roofing Over Steel Structure

a) Material

Top Sheet Profile	Trapezoidal profiled sheet / Tile shape sheet as per description of item.
Bottom Sheet Profile	Plain sheet with slight ribs or perforated sheet as per the description of the item.
Panel Thickness	80mm
Facing Material	300 MPa Galvalume Steel on external sheet and 550 MPa for the inner sheet with 150 GSM Alu-Zn Coating
Facing Material Thickness	0.55 mm TCT
Facing Material Coating	DFT 20 microns colour coated SMP coating over 5 micron primer
Insulation	75mm thick noncombustible grade Rock Wool having density 64 kg/m3.
Sub grit	'Z' shape of 50mm x x75mm x 50mm X 1.6mm GI.

b) **Application Specification**

FIXING

- Metal Roof Panel shall be fixed on to the Purlin / Girt with hot dipped galvanized imported self-drilling fasteners with EPDM washers and with necessary overlap as per manufacturer's printed instructions.
- Panel shall be supplied in upto 1M effective width and in single length upto 12M without any joints depending on site requirements.

Outer Sheet : Tile profiled high tensile (Min.300 MPa yield stress) colour coated, zinc aluminium alloy coated steel sheet having crest height of 28-30mm at a pitch distance of 195-200mm between the 2 crests with steps at 200-300mm having height of 12-15mm. The sheet thickness shall be 0.55mm TCT (total coated thickness) comprising of base metal thickness of 0.5mm over which zinc aluminium alloy coating mass of 150 gms./m² on both sides (as per AS : 1397) with 20 microns Super Polyester / SMP paint over the 5 micron primer coat on the exposed side and 5 micron primer coat with 5 micron back coat on inner side of the sheet.

Inner Sheet : Trapezoidal profiled 0.55mm thick high tensile (550 MPa yield stress) colour coated, zinc aluminium alloy coated steel sheet having crest height of 28-30mm at a pitch distance of 195-200mm with 2 stiffening ribs between the 2 crests to give additional strength to the sheet. The sheet thickness shall be 0.55mm TCT (total coated thickness) comprising of base metal thickness of 0.5mm over which zinc - aluminium alloy coating mass of 150 gms./m² inclusive of both sides finished with 20 microns Super Polyester / SMP paint over 5 microns primer coat on the exposed side and 5 microns back coat over the 5 microns primer coat on the inner side of the sheet.

Coating Mass : The sheet is pre-painted having zinc aluminium alloy coating total mass of 150 gms/m² i.e. AZ 150 on both sides as per coil manufacturers test certificate and AS 1397-1993.

Specification for Colour Coating

a)	Paint Coating	:	Super Polyester XRW / SMP Paint
b)	Thickness of Paint i) Top coat ii) Bottom coat	:	20 microns 5 microns
c)	Hardness (Pencil) as per AS : 2728	:	HB or Harder
d)	Adhesion (T-Bend) as per AS : 2728	:	Minimum 5T (no cracking)
e)	Flexibility (T-Bend) as per AS : 2935	:	Minimum 7T (no cracking)
f)	Resistance to corrosion (Salt Spray Test as per ASTM B-117)	:	1000 hrs. at 35 deg.C \pm deg.C (passed)
g)	Scratch resistance as per AS : 1580.403.1	:	For 1500 gms. minimum (no scratch)
h)	Resistance to heat at 100 deg.C for 24 hrs.	:	No change in colour (passed)

Specification for Colour Coating

Self-drilling fasteners would comply as per following specifications :-

i)	Resistance to Corrosion	:	Neutral Salt Spray Test for 1000 hrs.
ii)	Humidity exposure test	:	1000 hrs.

Rockwool Insulation

Rockwool Slabs (Water Repellant Grade) of density 64 kg/m³ and thickness 75mm conforming to IS : 8183 having thermal conductivity value (K-value) 0.030 W/mK at 10 deg.C. Rockloyd Rockwool Slabs type tested shall conform to non-combustibility as per BS : 476 Part-4 from a reputed lab like CBRI, Roorkee. Rockwool slab shall have been tested for Noise Reduction Coefficient (NRC) from a Govt. lab and shall have NRC value not less than 1.

SINGLE SKIN METAL ROOFING OVER RCC/ STEEL STRUCTURE

Material : Permanently colour coated tile profiled sheet having depth of 28-30mm at min. 195-200mm pitch distance with steps at 200-300mm having height of 12-15 mm. Profiled sheets shall be min. 0.55mm TCT, high tensile zinc aluminium alloy coated steel (300 mpa) having a coating mass of 150 gsm zinc-aluminium alloy coating total of both sides as per AS 1397 : 1993 and finished with 20 microns colour coating of Super Polyester / SMP quality paint coat on exposed surface over a primer coat of 5 microns of approved colour and a alkyd back coat of 5 microns on the reverse side over a 5 microns primer coat. The rate shall include providing necessary ridge, gutter, flashing etc. as shown and required.

Coating Mass

The sheet is pre-painted having zinc aluminium alloy coating total mass of 150 gsm/m² i.e. AZ 150 on both sides as per coil manufacturers test certificate and AS 1397-1993.

Specification for Colour Coating

a)	Paint Coating	:	Super Polyester XRW / SMP Paint
b)	Thickness of Paint	:	
	i) Top coat		20 microns
	ii) Bottom coat		5 microns
c)	Hardness (Pencil) as per AS : 2728	:	HB or Harder
d)	Adhesion (T-Bend) as per AS : 2728	:	Minimum 5T (no cracking)
e)	Flexibility (T-Bend) as per AS : 2935	:	Minimum 7T (no cracking)
f)	Resistance to corrosion (Salt Spray Test as per ASTM B-117)	:	1000 hrs. at 35 deg.C + deg.C (passed)
g)	Scratch resistance as per AS : 1580.403.1	:	For 1500 gms. minimum (no scratch)
h)	Resistance to heat at 100 deg.C for 24 hrs.	:	No change in colour (passed)

Specification for Self Drilling Fasteners

Self drilling fasteners would comply as per following specifications :-

i)	Resistance to Corrosion	:	Neutral Salt Spray Test for 1000 hrs.
ii)	Humidity exposure test	:	1000 hrs.

LAYING SPECIFICATIONS

1. Providing & fixing "Z" section of 50x50x50x1.5 mm over the sloping RCC roof, horizontally at a distance of 1500 mm center to center with one each at the top & bottom edge.
2. Providing & fixing permanently colour coated sheet in tile profile over the "Z" section with self drilling fasteners having EPDM washers as per manufacturer's specifications.
3. Providing & fixing capping at the top edge of the sheet made from the same overlapping.

13.3 ALUMINIUM WORKS FOR DOOR, WINDOW & PARTITION

The work shall be carried out through specialist agencies.

13.4 The material for the work shall be procured from approved manufacturer only after getting approval from Engineer-in-Charge. Contractor shall submit samples of unanodised as well as anodized sections, neoprene gasket, glass, ss screws, anchor fastener, screw, sealant, etc. to the Engineer-in-Charge for his approval.

13.5 The contractor shall prepare and submit shop drawings giving details of various components. Manufacturer's test certificate also shall be submitted if asked for. No material shall be procured before getting approved of samples and shop drawings from the Engineer-in-Charge.

13.6 The contractor shall prepare finished samples of aluminium window along with glazing, finishing and fittings for approval of Engineer-in-Charge for workmanship.

- 13.7 The contractor shall get the necessary test carried out in an approved laboratory. One test for each lot or for each 1000 kg for one type of section which ever is more shall be carried out. Unsatisfactory material shall be removed from site. The aluminium extruded section with chemical composition and technical properties as per IS: 733 and IS: 1285.
- 13.8 For sectional weight, tolerance limit shall be as per manufacturer's specification. However, payment for extruded sections shall be based on unit weight as per manufacturer's catalogue. The length of each member shall be taken correct to half a centimeter. For glazing, the actual area of the glazing pane excluding the portion in the beading shall be measured in Sqm. upto two decimal places for payment.
- 13.9 All joints shall be accurately fabricated and shall hair line in appearance. All doors, windows, ventilators, partitions and glazing, etc., shall be water and air tight by providing neoprene gaskets and weather silicon sealants. Where in closed position, there should not be any flow of air through joints, beadings, rebates, etc. The jointing accessories shall not cause any bi-metallic reaction by providing separator, wherever required. Nothing extra shall be payable for the above.
- 13.10 Aluminium sections shall be as per IS code or anodized as per IS : 7088 as mentioned in the description of items or drawing. The thickness of anodizing shall be as specified. The exposed surface of the aluminium section shall be protected against surface damage by providing protecting tape. After fixing and assuring of proper functioning of window, door, false ceiling, etc., such tape shall be removed / cleaned out. Nothing extra shall be payable in this account.
- 13.11 All glass panes shall be retained with frame by using exterior grade neoprene gaskets. Glass edges shall be clean and ground. All rebates shall be square. Thickness and type of glass shall as mentioned in the drawing and item description. Quality of glass shall be as specified by CPWD.

14.0 WATER PROOFING WORK

14.1 General

The water proofing treatment shall be got executed through one of the approved agencies as per the list.

The contractor shall take prior approval of the Engineer-in-Charge/PMC before engaging specialist agency for water proofing work immediately after issue of letter of acceptance and submit following information to that effect.

- i) Name of the specialist agency / firm.
- ii) The trade name of the product to be used.
- iii) List of work where the same treatment has been used.
- iv) Quantity of chloride and sulphides b regulated by the Contractor and proper account shall be used.

14.2 **Waterproofing of Toilets and Kitchen**

The surface on which the waterproofing is to be done shall be cleaned including the vertical faces of the sunken floor portion upto 300mm above finished floor and expose the concrete surface. The surface shall be made free from all loose particles, dust, laitance, necessary groove cutting, where the treatment terminates in wall around, prior to application of slurry coat.

The prepared surface then shall be applied with one coat of Acrylic polymer modified cementitious slurry and continued upto the groove in all, followed by acrylic polymer modified cementitious brush topping when the former coat has dried.

The treated surface then shall be protected by providing a layer of 20mm thick cement sand plaster in proportion (1:4) after curing of the surface.

14.3 **Waterproofing of Basement Raft and Wall**

i) Raft

The Sub-base concrete (lean concrete) to be rendered smooth with Cement: Sand Mortar (1 : 3) while it is still green.

Application of two coats of Acrylic polymer Modified Cementitious Slurry coating over the properly rendered surface.

Providing 12mm plaster in the ratio 1 : 4 (Cement : Sand) over the Acrylic polymer Modified Cementitious applied surface, to protect the Acrylic polymer applied surface against probable mechanical damage due to dragging of reinforcement while placing them.

Placing and fixing 12mm N.B.M.S. threaded Nozzles of 75mm length with dummy rod for maintaining the hole upto required depth in an approximate grid pattern at a spacing not exceeding 1.5 M c/c on the entire raft prior to or during concreting. Similar threaded Nozzles along with dummy rod shall also be fixed at a regular interval not exceeding

1.5 M apart along the construction joints. Similar Nozzles shall also be post fixed at critical points, if required by drilling or making holes with suitable tools.

ii) Slab

Injection of NON- SHRINK POLYMERIC WATERPROOF GROUTING COMPOUND' admixed with Cement Slurry through the Nozzles under pressure by pump. The grout shall flow through all pores and voids thereby sealing them.

Sealing off the Nozzles after the injection operation is over with QUICK SETTING ADMIXTURE' admixed with cement wherever required.

After sealing the nozzles, the concrete surface to be cleaned from all debris, loose material, dust etc.

iii) Retaining Wall

Placing and fixing 12mm N.B.M.S. threaded Nozzles of 75 mm length in an approximate grid pattern in a spacing not exceeding 1.5 M c/c on the entire Retaining Wall after concreting by drilling or making holes with suitable tools upto required depth of the Wall. Similar threaded Nozzles shall also be provided at a regular interval not exceeding 1.5 M apart along the construction joints. Similar Nozzles shall also be post fixed at critical joints, if required by drilling or making holes with suitable tools.

Application of two coats of Acrylic Modified Cementitious Slurry Coating over the properly rendered external face of the Retaining Wall.

Providing 12mm thick plaster in the ratio 1:4 (Cement: Sand) on the external face of the retaining wall admixed with integral water proofing compound conforming to IS:2645, if backfilling is not done with Sand or Earth.

Injection of NON-SHRINK POLYMERIC WATERPROOF GROUTING COMPOUND' admixed with Cement Slurry through the Nozzles already fixed under pressure by pump. The grout shall flow through all pores & voids thereby sealing them.

Sealing off the Nozzles after the grouting operation is over with QUICK SETTING ADMIXTURE' admixed with cement wherever required.

iv) Durability and Performance

The contractor shall furnish proof of durability of the system carried out based on long term performance as basement raft slabs and walls, will be completed in two stages. The adequacy of the system to meet the above requirement shall be established by the above said agency.

v) Precautions

All water proofing shall be adequately protected during the progress of work and shall be kept dry until it is covered up.

vi) Guarantee

The Contractor shall provide performance guarantee of the water-proofing system on non-judicial stamp paper of appropriate value in approved format to the Dept. through the Contractor for a period of ten years after completion of the relevant treatment.

In the event of unsatisfactory performance of waterproofing treatment work, the contractor shall undertake to the Dept., to carry out necessary remedial / rectification work to render the structure free from leakage/seepage of waterproofing including all associated works that may be necessary in the opinion of the Dept. at no extra cost.

The contractor shall also give a bank guarantee for an amount equal to 10% of the gross amount of water proofing item valid for a period of 10 years from the date of final completion. 50% of this bank guarantee shall be released on satisfactory performance of waterproofing job for a period of 5 years and remaining amount of the bank guarantee shall be released on satisfactory performance for 10 years.

SECTION - B (PLUMBING WORKS)

1.0 GENERAL

1.1 Scope of work

The scope of work comprises supply, installation, testing and commissioning of internal and external water supply, sewerage, drainage, pumping system, solar water heating system, sanitary fixtures and C.P. fittings for proposed Phase-I, IIITM Campus at Techno City, Thiruvananthapuram. The scope of work includes supply of all materials as per specifications and drawings, laying, fitting, fixing, installation and commissioning the same.

- 1.1.1 All the water supply, drainage and sanitary works shall be carried out strictly as per latest printed central PWD Specifications on sanitary installation, water supply, drainage and miscellaneous works. The works related with other systems as mentioned in the scope of work shall be carried out as per relevant sections of these Specifications.
- 1.1.2 All the water supply and sanitary works shall be carried out by the licensed plumbers approved by the Local Authorities and skilled workmen, experienced in the trade.
- 1.1.3 All works shall be completely concealed either within shafts or chases or in fills and dropped ceilings unless specifically shown in drawings or required otherwise.
- 1.1.4 All works shall be adequately protected, to the satisfaction of the Engineer, so that the whole work is free from damage throughout the period of construction upto the time of handing over.
- 1.1.5 No work shall be covered without approval of the Engineer.
- 1.1.6 The Contractor shall be responsible for coordinating the work with works of other trades sufficiently ahead of time to avoid unnecessary hold-ups. Hangers, sleeves, recesses, etc. shall be left in time as the work proceeds whether or not these are shown in drawings.
- 1.1.7 All clamps, screws, brackets, hangers and all miscellaneous steel work needed in the work shall be fully galvanised.
- 1.1.8 Only specified brand of material will be used subject to the approval of the sample.

- 1.1.9 The Contractor shall submit as directed by the Engineer samples, manufacturer's drawings, equipment characteristics and capacity data etc. of all equipment, accessories, devices, etc. that he proposes to use in the installation, to the Engineer for approval.
- 1.1.10 The Contractor shall prepare and submit all shop drawings to the Engineer for approval before the work is commenced.
- These shop drawings in triplicate must be submitted by the contractor as soon as possible after the order is placed to give ample time for all the parties concerned to study and make comment thereon.
- The work shall commence only after the shop drawings are approved by the Engineer.
- 1.1.11 On completion of work the contractor shall submit to the Engineer one original and two copies of as-built drawings.
- 1.1.12 Before the work is handed over, the Contractor shall clean all fixtures removing all plaster, stickers, rust stains and other foreign matter of discolouration of fixtures, leaving every part in acceptable condition and ready for use, to the satisfaction of the Engineer.
- 1.1.13 All sanitary ware and fittings shall conform to I.S. standards. The Contractor shall submit samples of all fittings and fixtures proposed to be used to the Engineer for his approval. The approved samples shall remain with the Engineer till the completion of the work.
- 1.1.14 All workmanship shall conform to Indian Standard Codes of Practice. The fixing and finishing shall be neat, true to level and plumb. Manufacturer's instructions shall be followed closely regarding installation and commissioning.
- 1.1.15 Contractor shall provide four sets of catalogues, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment to owner.
- 1.1.16 All "Warranty cards" given by the manufacturers shall be handed over to the Engineer-in-Charge.
- 1.1.17 Contractor shall submit 5 copies of O & M manual.

2.0 General

2.1 Scope of work

2.1.1 Vitreous China Sanitary Ware

All glazed Vitreous China Sanitary ware fixtures shall conform to Indian Standard IS:2556. The details, make and type to be provided are given in the Bill of Quantities. The Vitreous China Sanitary ware shall be of first quality only. They shall be non-porous and fully vitreous, with all the visible portions perfectly glazed and should absolutely be free from hairline cracks, pin-holes and local depressions. It shall be perfectly symmetrical, uniform, smooth and curves.

2.1.2 Chromium Plated Fittings

All Chromium plated fittings shall be of brass/copper, heavy chromium plated, of the make and design approved by the Architects/Engineer. The fittings shall be cast fittings of screw type, machined and threaded properly for fixing to the supply pipes.

The plating shall conform to Indian Standard IS:482 (Electroplated coating of nickel and chromium of copper and copper alloys).

The fittings shall be supplied complete with chromium plated matching flanges, wall cover plates, nuts and extension pieces of required lengths. Metallic washers where required shall also be of chromium plated brass. All bib cocks and stop cocks shall conform to Indian Standard IS:781. Brass screw down pillar taps shall conform to IS:1701 and all other fittings shall match the supply fitting in construction and appearance. All fixing accessories and screws shall be similar to fittings. All washers shall conform to Indian Standard IS:4346.

All waste fittings (Waste, Chain, Overflow, Spreaders Caps etc.) shall be of brass/copper heavy chromium plated of the make and design specified and match the supply fittings. They shall conform to Indian standard IS:2963.

Bottle traps (for wash basins, sinks, urinals etc.) shall be deep seal (Min. 6 cm seal) cast brass bottle traps, heavy chromium plated. All bottle traps shall be provided with suitable cleaning eye, extension piece, flare nuts of all chromium plated.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass snugly fittings and the receiving pipes and shall be large enough to cover the punctures properly.

2.1.3 **Protection of Fixtures**

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

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

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

2.1.4 **Workmanship**

The sanitary fixtures and fitting shall be installed at the correct assigned position as shown on the drawings and as directed by the Engineer, and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Engineer's drawings.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architect requirements. Wherever necessary, the fittings shall be centred to dimensions and pattern as called for.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice. Manufacturer's instructions shall be followed for the installation of fixtures. Fixtures in all toilets shall be standard height mounting as called for on the drawings. Fixtures shall be mounted rigid, plumb, and true to alignment.

2.1.5 **Mock up and Trial Assembly**

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 manufactures 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/Engineer.

2.1.6 **Final Installation**

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on 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.

2.1.7 **Testing**

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

- a) The entire system shall be slowly filled with water, allowing any trapped air to escape.
- b) When all outlets are closed the system shall be checked for water tightness.
- c) Each outlet shall then be checked for rate of flow and correct operation.

2.2 **Internal and External Sewerage/Drainage**

2.2.1 The sewage/waste water generated from various sections of the buildings has been segregated into two streams as follows:-

- a) The waste water from toilet (Sewage)
- b) The waste water from kitchen, wash room, etc. (Sullage)

2.2.2 Pipes used for underground sewage shall conform to IS 15328 / 2003 (Brown colour).

2.2.3 Pipes used for underground drainage (Sullage) shall be as per IS 4985 - 2000 (Grey colour).

2.3 **PVC Pipes**

2.3.1 The unplasticised PVC-U rigid pipes shall strictly conform to IS 15328/2003 and as amended from time to time.

- 2.3.2 The contractor should procure the PVC-U rigid pipes from a reputed manufacturer.
- 2.3.3 The contractor should furnish the test certificate issued by the manufacturer.
- 2.3.4 In addition wherever felt necessary, the Engineer shall have the power to test the PVC pipes for its quality such as specific gravity, impact strength at 0°C, internal hydraulic pressure test, diameter, thickness etc. in TWAD Board laboratory. All testing charges shall be borne by the contractor.
- 2.3.5 The PVC pipe joints shall be with solvent cement of good quality, conforming to IS 14182 / 1994.
- 2.3.6 The Engineer in charge, shall verify, in addition to the test certificate, whether the pipes are as per BIS, by visual examination, diameter, weight, wall thickness, flexibility, colour etc.
- 2.3.7 All the PVC specials required for use in conjunction with PVC pipes, should be got approved by the Engineer-in-charge.

2.4 Trench Preparation

- 2.4.1 The trench should not be opened too far in advance of pipe laying and should be backfilled as soon as possible.
- a) The width of the trench at the crown of the pipe should be as narrow as practicable but not less than the outside diameter of the pipe plus 300mm to allow proper compaction of the side fill and at a height of 225mm above the crown of the pipe, the trench may be of any convenient width.
 - b) The excavated material should be deposited at a sufficient distance away from the edge of the trench to avoid damage to the pipes through falling stones or debris.
 - c) As with pipes of other materials, it is necessary to ensure with PVC pipes, that sharp edged objects such as large flints do not bear directly upon the pipes, and also that they are not placed in a way where they may come into contact with such tough objects with the passage of time.

- d) When pipelines are laid in hot climatic conditions it is advisable to fill the pipe with cold water to bring the pipe lengths to normal contracted dimension, before laying.

2.4.2 Trench Bottom

In all cases, the trench should be excavated to a depth, which will allow for laying the pipes on a prepared under bed. The trench bottom should be carefully examined for the presence of soft spots and hard objects such as stones, rock projections or tree roots, which should be removed and filled with well-tamped bedding material.

Where a delay in pipe laying is envisaged, the bottom layer of 300mm should not be removed until the permanent material is about to be placed in order to avoid deterioration of the formation. Widths set out in the following table.

Trench width requirements

Nominal Pipe Size (mm)	Width of Trench (mm)	
	Min.	Max.
110	450	600
160	450	600
200	600	700
225	600	700
250	600	700
315	700	850
355	750	900
400	800	950
450	850	1000

2.4.3 Spoil

The excavated spoil should be kept at least 0.5m away from the edge of the trench and all loose stones removed from the side of the spoil heap to a remote location away from the trench.

2.4.4 Depth of Cover

Normally, pipes should be laid with a cover, measured from the top of the pipe to the surface of the ground, of not less than.

1.2m under roads, 1.0m in agricultural land, 0.5m in gardens within boundaries of dwellings. Where such cover is not practicable, the designer should specify alternative methods of protection. The designer should take into consideration in his design, any conditions, existing or envisaged, which might adversely affect the performance of the pipes or the load on the pipes. When future landscaping or other development works are envisaged, sufficient depth should be allowed over the pipes to ensure that the load bearing capacity of the pipe line will not be exceeded due to surcharge and/or surface loads.

Bedding Material - Bedding material may be either : Granular material

Complying with the following requirements having maximum particle sizes not exceeding those as mentioned in the following table.

Processed granular bedding and side fill materials for flexible pipes

Nominal pipe bore	Nominal maximum particle size	Material specification
100mm	10 mm	10mm nominal single size
Over 110 to 160mm	15mm	10 or 14mm nominal single size or 14mm to 5mm graded.
Over 160 to 300mm	20mm	10, 14 or 20mm nominal single size or 14mm to 5mm graded or 20mm to 5mm graded.

Imported Sand or Sand / Gravel Mixture

In special cases when approved by the designer and client, imported sand or sand/gravel mixture not complying with the grading in a) but which, when determined in accordance with the appendix, (see page no. 51) and having a compaction fraction not greater than 0.3 may be used. The maximum particle size should not exceed 20mm.

When using material of this quality, it should be properly compacted so as to attain not less than 90% of the maximum dry density at optimum moisture content and provision should be made for field testing accordingly.

2.5 Pipe Laying

2.5.1 General

Pipes should be lowered into the trench with tackle suitable for the weight of the pipes using suitable lifting slings, preferably flat. On no account should chains or wire ropes be used. The position of the slings to ensure a proper balance should be checked when the pipe is clear of the ground. Any construction debris inside the pipe should be removed using a 'Pull-through'.

2.5.2 Laying Practice

Pipes should be joined in the trench and laid on the prepared bed so that they maintain substantially continuous contact with the bed. Small depressions should be made in the bed to accommodate the pipe joints.

When the pipe socket or pipe and coupler have been bedded, the depressions should be filled carefully, taking care that no voids remain under or around the joint.

2.5.3 Steep Gradient

If due to steep gradient or waterlogged conditions, the bedding tends to act as a drain for subsoil water, the insertion of water stops by means of puddle clay dams across the trench, may be necessary to resist the passage of water.

2.5.4 Special Precautions

2.5.4.1 Pipes Passing Through Walls

Where a pipe is required to pass through a wall or foundation of a building or other rigid structure, it should be enclosed in a suitable sleeve having a minimum radial clearance of 25mm. Alternatively, a lintel or relieving arch may be formed in the structure. Care should be taken to prevent water passing along the barrel of the pipe and through the wall, or the entry of surrounding granular material.

2.5.4.2 Movement Allowance

Where a pipe is rigidly fixed to a structure, two flexible joints should be used, one on each side, as close to the structure, as possible. Where substantial subsidence is anticipated, it is desirable to provide a short length of pipe (i.e. a rocker pipe) with a flexible coupler on each end, to allow movement.

A drain may run under a building if at least 100mm of granular or other flexible filling is provided round the pipe. On sites where excessive subsidence is possible, additional flexible joints may be advisable or other solutions, such as suspended drainage. Where the crown of the pipe is within 300mm of the underside of the slab, concrete encasement should be used integral with the slab.

2.5.4.3 Pipe laying at low Temperature

Particular care should be exercised when installing pipes at temperatures below 10°C.

Pipe laying should not be carried out when the temperature is below 0°C.

2.5.4.4 Pipe laying above Natural Ground Level

Expert advice should be sought in cases where pipes are to be laid above the natural ground level.

2.5.4.5 Pipe laying in Unstable Ground

The soft relatively unstable conditions of the trench bottom that may be encountered with softened clays, silts, very fine sands or peat are unfavourable to flexible pipes. This is because the buttressing effect of the side fill, which normally helps the pipe keep its shape, may be considerably reduced. This effect is aggravated if there is a high water table. In such situations, care is needed depending on the severity of the conditions and advice should be sought from the technical person, at site, overseeing the work.

2.6 Use of Concrete

2.6.1 General Principles

Normally, flexible pipes should not be bedded in, or surrounded by concrete; that kind of use converts a flexible pipe into a rigid one, which is more liable to fracture resulting from ground movement. However, in certain circumstances, a designer or local authority may require the use of concrete bedding or surround, and in such cases, special precautions should be taken.

2.6.2 Encasement (Reinforced)

Where a pipeline is encased in concrete, it should be wrapped in a membrane such as felt or plastic sheeting. As differential movement is likely to occur at the ends of the concrete surround, the adjacent pipeline should comprise one or more short lengths of pipe, jointed by couplers. As U-PVC pipes are flexible, they can accommodate ground movement and pressure without damage. However, if the pipe needs protection, e.g. when laid with a cover of less than 1.2 meter under a road, concrete may be used above the pipeline as a protective raft, provided a cushion of fill is laid between the pipe crown and the raft. This will prevent unacceptable deflection of the pipe.

2.6.3 Backfilling

The material used for side fill and initial backfill should comply with the requirements for bedding material. For protection of the pipe, the side filling and initial backfilling operations should be carried out as soon as possible, after the pipes have been laid and tested.

The material should be placed and compacted by hand in layers not more than 100mm thick and should extend over the crown of the pipe to a depth of 100mm for 110mm pipe and 150mm for pipes of larger diameter. It should extend over the full width of the trench as excavated. If 'as-dug' material is free from stones exceeding 40mm, imported processed granular material is not needed above the pipe crown.

Cover the pipe crown with a minimum of 300mm of compacted 'as-dug' material. If 'as-dug' material contains stones larger than 40mm, or the pipe is deeper than 2 meters in poor ground, extend the processed granular material for at least 100mm above the pipe crown. In both cases, hand tamp the material fully at the sides of the pipe simultaneously, while tamping lightly over the crown. Continue hand tamping until a finished layer of 300mm has been placed over the pipe. Mechanical compactors, other than hand vibrators, should not be used until the total depth of backfill over the pipe is 450mm

Special consideration and selection of backfilling material will be necessary if the risk of surface subsidence is an important consideration, for example under roads.

2.6.4 **Joining**

All spigots on fittings are chamfered approximately 15°. Pipes cut on site must be clean cut at right angles to their horizontal axis. Chamfer the cut end to approximately half the pipe wall thickness and deburr it with a scraper.

- Make sure the spigot end and inside of socket is clean and the sealing ring is placed evenly in the socket.
- The pipes shall be jointed as per manufacturer's recommendations.

3.0 **PLANT AND EQUIPMENT**

3.1 **Scope of work**

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

The work shall include the following :

Supply, installation, testing & commissioning of

- a) Water supply & drainage pumping system.
- b) Tube well System
- e) All piping, valves and accessories.
- f) Electrical works related with water supply and drainage pumps.
- g) Painting of equipment and piping.
- h) Unloading of the equipment and placing in position at site.
- i) Foundation of equipment's as required.

General Requirements

- a) All materials shall be new and of the best quality conforming to specifications and subject to the approval of the Engineer.
- b) All equipment shall be of the best available make manufactured by reputed firms.
- c) All equipment's shall be installed on suitable foundations, true to level and in a neat workmanlike manner.
- d) Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- e) Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

3.2 Pumping & Water Treatment System

3.2.1 Water Supply Pumps

- a) Water supply pumps shall be single stage horizontal centrifugal pumps, centre line discharge volute type delivery casing unit with closed balanced bronze impeller, stainless steel shaft, and grease or oil lubricated heavy duty ball bearings suitable for direct drive to a TEFC electric motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficiently below and above the required working pressure.
- b) Pumps and motors shall be mounted on a common M.S. structure base plate.
- c) Each pump shall be provided with a totally enclosed fan cooled induction motor of H.P. and R.P.M. specified in schedule of quantities.
- d) Each pumping set shall be provided with a Gun Metal "Bourden" type pressure gauge with gunmetal isolation cock and connecting piping.
- e) Appropriate vibration eliminating pads shall be provided with each pump.

3.2.2 **Drainage Pumps**

All drainage pumps shall be submersible mono block non clog pumps with totally water & dust proof motor compact in design. The motor portion shall be isolated from the pump by intermediate casing with double mechanical seal in oil chamber. Volute shall be of precision casting with claws which allows coupling of pump set with duck foot bend, on lowering in the pit without bolting. The shaft shall be with die cast rotor on motor side & shaft protection sleeves on pump side and shall be with grease packed bearings and greasing pump. The motor housing shall be suitable for IP 68 protection. The motor shall be provided with built in temperature sensor enabling tripping of motor if temp rises above 150 Deg.C and restart at 80 Deg.C giving complete dry run protect.

The guide wire shall be of stainless steel with smooth surface. The pump & motor assembly shall be provided with MS galvanised lifting chain. Pump shall be of capacities & head as given in schedule of quantities.

3.2.3 **Level Controller/Indicator**

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

3.2.4 **Neoprene flexible pipe connectors**

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

3.2.5 **Piping**

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

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

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

Suction strainer or foot valve shall be gunmetal.

3.2.6 **Joints**

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

3.2.7 **Testing**

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

3.3 **Water Treatment System**

3.3.1 **Water Filter**

a) Water filter shall be sand gravel pressure filter downward flow type suitable for a rate of filtration given in schedule of quantities. The design fabrication and construction shall conform to the requirement of IS:2825.

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

3.3.1.1 **Under Drain System**

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

3.3.1.2 **Face Piping**

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

3.3.1.3 **Accessories**

- i) Air release valve with connecting piping.
- ii) 100 mm dia Dial Bourden type gun metal pressure gauges with gun metal isolation, cock and connecting piping on inlet and outlet, causing shall be with cast aluminium stored enamel black finish cases.
- iii) Sampling cocks on low water inlet and filtered water outlet.
- iv) Connection with valve for air scouring.

Each filter shall be provided with clean and washed filter media of type and depths as recommended by the manufacturer.

3.3.1.4 **Back Wash**

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

3.3.2 **Piping for Water Treatment Plant**

- a) Pipes shall be M.S. galvanised steel conforming to IS:1239 (medium class) with matching malleable cast iron fittings.
- b) Valves 80 mm dia and above shall be cast iron double flanged fullway gate valves to IS:780.
- c) Non return valve 80 mm dia and above shall be cast iron double flanged to IS:5312.
- d) Valves and non-return 65 mm dia and below shall be gun metal fullway and horizontal type, preferably conforming to 778.

3.3.3 **Flow Measurement**

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

- 3.3.4 The contractor shall supply one complete set of test kit for water treatment system.

3.3.5 **Painting and Clean-up**

- a) One completion of the installation contractor shall scrub, clean all pumps, piping, filter, softener and other equipment and apply one coat of primer.
- b) Apply minimum two coats of synthetic enamel paint. Type/make of paint shall be as per Engineer approval.
- c) Provide painted identification legend and direction arrows on all equipment and piping as directed by the Engineer.
- d) On final completion of the work, contractor shall clean up the site and pump room of all surplus materials, rubbish and leave the place in a broom clean condition.

3.4 **Electrical Works**

3.4.1 **Cables**

- a) Contractor shall provide all power and control cables from motor control centre to various motors, level controllers and other control devices.
- b) Cables shall conform to IS:1554 and carry ISI mark.
- c) Wiring cables shall conform to IS:694.
- d) All power cables shall be aluminium conductor PVC insulated/PVC sheathed FRLS armoured cables of 1100 volts grade.
- e) All control and wiring cables shall be copper conductor PVC insulated armoured and PVC sheathed 600 volt grade.
- f) All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

3.4.2 **Motor Control Centres**

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

- i) Incoming main fuse switch unit with HRC fuses of required capacity.
- ii) Isolation switch fuse unit one for each motor.
- iii) Fully automatic DOL/Star Delta starters appropriate for motor rating with ON/OFF push buttons and on/off indicating neon lamps for individual motor.
- iv) Single phase preventer of appropriate rating for each motor.
- v) Selector switch for pump operation.
- vi) Panel type ampere meters of appropriate rating one for each motor.
- vii) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- viii) Rotary switch for manual or auto operation for each pump.
- ix) Space for liquid level controllers specified separately in this contract.

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

3.5 Installation, Commissioning & Guarantees

3.5.1 Installation

- a) Contractor shall supply three copies of foundation drawings giving weight, vibration and other loads required for the proper designing of the foundations.
- b) All equipment shall be installed in a true workman like manner true to level and grade in accordance with the best current practice.
- c) Contractor shall employ sufficient and proper equipment for lifting and placing of heavy equipment and in a manner, which shall not strain or cause damage to the existing structures. If any damage is done, the same shall be made good to the satisfaction of the Engineer without any additional cost.

- d) The contractor shall submit detailed shop drawings showing detailed layout of the system showing dia piping, valves etc. for approval of the Engineer. The work shall be started only after approval of shop drawings submitted by the contractor.

3.5.2 **Commissioning**

- a) On completion of the work in all its aspects, the contractor shall start up the plant in a manner normally done for the continuous operation for a period of not less than 48 hours and shall rectify and adjust the equipment for leakages and balancing the system.
- b) After satisfactory commissioning of the plant, the contractor shall conduct performance tests on the pumps to satisfy the Engineer that all equipment's are performing to the rated outputs any or all pumps and equipment shall be rectified or replaced if the same is not performing in accordance with the specifications.

3.5.3 **Guarantees**

- a) On award of the work contractor shall submit a guarantee covering the quality and performance of all materials supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.
- b) Contractor shall specify a suitable procedure to test the rated performance of the equipment and shall provide all necessary equipment, gauges etc. for conducting such tests.
- c) The guarantee shall cover a period of one year from the date of installation and handing over and commissioning of plant.

3.5.4 **Completion**

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

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

- b) Five sets of operating and maintenance instructions with spare parts list and their manufactures and/or suppliers.
- c) Five sets of catalogues and drawings for all equipment supplied.

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

4.0 TUBEWELL

4.1 Scope of work

The scope of work comprises construction and development of one number 300 mm bore tubewell including drilling of borehole, collecting and recording well data, supply and installation of well assembly development of the tubewell and carrying out various tests as specified.

4.2 Selection of Site

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

4.3 Geological Data

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

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

4.4 Drilling Time Log

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

4.5 Lowering of Pipe Assembly

- 4.5.1 Housing pipe is provided in upper portion of the tubewell in which pumps and motor assembly shall be accommodated. The pipe shall be of heavy duty and provided at least 0.6m above the ground level to have good and strong foundation.
- 4.5.2 Blind pipe: It shall be provided in non-aquifer portion and below housing pipe and upto slotted pipe. The length of blind pipe should be decided on the basis of non-aquifer portion or unwanted aquifer portion which are to be cased.
- 4.5.3 Slotted Pipe or Screen : The screen or slotted pipe shall be provided against the required thickness of aquifer in order to allow ground water to be pumped into the tubewell.
- 4.5.4 The housing pipe, blind pipe and slotted pipe to be used in the tubewell shall be of mild steel ERW pipes conforming to IS-3589-1991 (or revised thereof). In order that the well assembly be centrally lowered in the bore, the housing and casing pipe to be fitted in alluvium or over burden portion of the tubewell with centralised guides specially approved by the Engineer-in-Charge. These guides shall be fitted at every 10 metre subject to minimum of 4 guides on each tubewell.
- 4.5.5 The slotted pipes to be used shall have lined slots of required size to give an area of 15 to 22%. The slot size should not exceed the thickness of slotted pipe. The slot size shall be within limits of 1 mm to 3 mm thickness. The length of the slot can also vary from 50mm to 80mm within the prescribed percentage area of opening allowed. The length of the slotted pipe/strainer shall not be less than 3 metre. The slotted pipe shall be attached to the housing pipe or blind pipe by means of a strong M.S. coupling and reducer of quality and design approved by the Engineer-in-Charge.
- 4.5.6 1.5 metre long tail of M.S. blind pipe to be provided with close bottom and lifting hook of 20mm dia bars or tail plug of approved type shall be provided at the bottom of screen pipe.
- 4.5.7 Painting - Before placing into the bore holes, two coats of anti-corrosive paint over a coat of red oxide primer shall be given to all mild steel pipes and other parts of the well assembly, both inside and outside.
- 4.5.8 Gravel Packing - Uniform gravel shall be used adjacent to the well screens. The gravel must be fine enough to prevent the passage through its pores, the particles from the formation materials and coarse enough to give a lesser resistance so that the head loss in flow of water through it should be relatively small.

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

4.6 Drilling

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

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

4.7 Lowering of Well Assembly

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

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

4.8 Development

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

4.9 Step Draw Down Test

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

4.10 Yield Test

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

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

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

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

4.11 Quality of Water

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

4.12 Sanitary Sealing

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

4.13 Handing Over of the Tubewell

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

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

- i) Strata chart of the bore hole indicating the different types of soil met with, at different depths and granular zones.
- ii) Samples of strata collected, neatly packed and correctly marked in sample bags;
- iii) Chart of actual pipe assembly lowered indicating the sizes of pipes, depth ranges where slotted pipes have been used, depth and diameter of housing pipe; reduced level of the top of the housing pipe, and the diameter and depth of bore hole;
- iv) Hours of developing by compressed air, pump sets or by other means;
- v) Results of mechanical (sieve) analysis of samples of aquifer material, wherever applicable;
- vi) Recommendation on the safe pumping yield, pump-setting and specification for suitable pump set;
- vii) Report on the chemical and bacteriological tubewells water.
- viii) Annexure-A, giving the required details indicated in the proforma.

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

1. Agency constructing the tubewell
2. Location of the tubewell
3. Method of drilling adopted
4. Date of starting
5. Date of completion
6. Pilot hole or test hole _____ Bit type _____
Hours _____ from _____
to _____.
7. Coring done _____ Bit size _____ Bit
type _____ Hours _____ Recovery _____
From _____ to _____.
8. Reaming _____ Bit size _____ Bit type
_____ Hours _____ From _____ to _____.
9. Total depth of the bore hole _____
10. Lithological log

From	To	Formation
_____	_____	_____
_____	_____	_____
11. Electrical log
12. Assembly of production well _____ Size _____
Length _____ Type _____
Perforation per meter _____ Housing
pipe _____ Blind pipe _____
_____ Strainer _____
_____ Bail plug _____.

13. Top of tubewell above / below ground level _____
_____.
14. Size of gravel _____ Quantity used before development
_____ quantity used during development
_____.
15. Method used for development _____ Testing
_____.
16. Total hours of development _____ total hours of
testing _____.
17. Step draw down test: Time of test _____ Speed
RPM _____ Discharge _____ Period run
_____.
18. Aquifer performance test : Time of test _____
_____ Speed _____ rev/min
Discharge _____ 1/min.
19. Static water level _____
_____.
20. Rated discharge in 1/min _____
_____.
21. Depression head of the production well _____
_____.
22. Sand contents in ppm at the rated discharge after 20 minutes of the start of the
pump _____.
23. Sand contents in ppm at 1.5 times the normal depression after 20 minutes of the
start of the pump or 20 percent in excess of rated discharge if 50 percent extra
depression cannot be arranged _____.
24. Recommendation with regard to a suitable pump _____
_____.

25. Further details required :

- a) Samples of strata, neatly packed in sample bags.
- b) Chart of pipe assembly lowered.
- c) Results of mechanical analysis of samples of unconsolidated strata
- d) Vertically test on prescribed form
- e) Chemical and bacteriological analysis of tubewell water

26. Remarks :

Owner _____

Driller _____

INFORMATION TO BE FURNISHED BY THE DRILLING AGENCY

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

- i) Suitability of the site proposed. If a more suitable point, other than the one proposed exists or is available, it should be suggested.
- ii) Whether a test bore hole is proposed and, if so, its diameter and depth; and Depth of tubewell proposed;
- iii) Likelihood of increasing or decreasing the depth given at (b) above;
- iv) Method of drilling;
- v) Sizes and types of pipes, strainers, or slotted pipes, etc. proposed to be used;
- vi) Probable yield of water to be obtained;
- vii) Guarantees with regard to the verticality of tubewell and sand content in discharge in parts per million at the time of handing over the well; and
- viii) Any other information and condition.

SECTION - C (ELECTRICAL WORKS)

1.0 Additional Conditions

- 1.1** The works will be executed to comply with the General Specifications for Electrical works and conforming to the Indian Electricity Act & rules, BIS & Direction of Engineer-in-charge.
- 1.2** The items of work shall be executed as per detailed technical specifications and scheme. In case of contradiction between schedule of work with its Additional Specification and the General Specification, the former shall prevail.
- 1.3** The works will be executed to comply with the CPWD Technical Specifications for Electrical works Part-I Internal (2013), Part II External (1994), Part-IV Substation (2013) and with up to date amendments and to conform to the Indian Electricity Act & rules, BIS& Direction of Engineer-in-charge/PMC.
- 1.4** The work will be executed as per general arrangement drawing and detailed fabrication drawings duly approved by the Engineer-in-charge. The various items of equipment will be ordered only after the drawings are approved and quantities in detail of various items are ascertained as per actual requirements. Therefore the actual quantities / measurement may vary from the stipulated quantities, which are only estimate.
- 1.5** The Lift & Escalator manufacturer shall ensure that all basic equipment's like Drive units, Car body & Doors, Ropes, Controllers, Guide rails, Balustrade, Steps etc are sourced from their manufacturing facilities/ Vendors abroad. The material shall be of best quality and shall be offered for inspection before dispatch from the manufacturing facilities, as per respective clauses in the tender.
- 1.6** Contractor shall obtain permit / approval from concerned authorities before commencement of work. All documents/ drawings required for such permit / approval shall be prepared by the contractor.
- 1.7** The contractor/agency will engage suitable qualified/experienced/ licensed engineering supervisor for the work and suitable skilled personnel with required license for doing the erection work. Required special tools to be operated in the execution of the job.

- 1.8** The work will be performed as per the day to day instruction and approval of the engineer-in-charge. All materials/ equipment will be used after taking approval of the Engineer-in-charge.
- 1.9** Equipment will be duly inspected in the manufacturer's works / premises before dispatch to the site, as per instructions of Engineer-in charge.
- 1.10** The rates are to be inclusive of all taxes, levies, insurance, freight, octroi etc. except service tax which will be reimbursed by the department, in full, on presentation of receipted original deposit slip, against the work. Nothing extra will be paid.
- 1.11** The work will be executed as per the programme of completion of the project. The delivery & erection schedule of various materials/ equipment will be as per approval of Engineer-in-charge.
- 1.12** This contract holds the contractor responsible for the entire job as per relevant specifications. If any item is left out within the schedule of work but if it is considered essential for the completion of the job, the contractor has to carry out the items within the tendered amount & nothing extra shall be paid.
- 1.13** The contractor shall have to make arrangements, at his own risk and cost, for transportation of materials from the point of issue of stores to site of work, if any.
- 1.14** The contractor shall ensure that the staff employed by him for execution of the electrical work, possess the valid electrical license issued by competent authority. Consequences arising due to the default of the contractor in not complying with the above condition shall be the entire responsibility of the contractor.
- 1.15** All concealed work and earthing shall be done in the presence of the Engineer-in-charge or his authorized representative.
- 1.16** The schematic diagram/dimensional drawings of the various electrical cubical panels shall be got approved from the Engineer-in-charge before fabrication and shall comply with specifications and Indian Electricity Rules. The panels shall conform to IS: 8623/1993. All panels shall be powder coated inside out, in shade approved by the Engineer-in-charge.
- 1.17** All panels/DB shall be suitable for 45°C ambient temperature.

- 1.18** The MCB shall be of the same make as that of MCB DB's. Contractor shall obtain approval of the Engineer-in-charge before procurement of MCB DB's. All DB's shall be double door type confirming to minimum IP-43 degree of protection.
- 1.19** Miniature Circuit Breaker shall comply with IS -8828-1996 / IEC 898. Miniature Circuit Breakers shall be quick make and break type for 230 / 415 V A.C., 50Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10KA at 415V A.C. The MCB shall be DIN mounted. The MCB shall be current limiting type (Class - 3).
- 1.20** MCB shall be classified (B, C, D ref. IS standard) as per their tripping characteristics curves defined by the manufacturer. The MCB shall have the minimum power loss (watts) per pole defined as per the IS / IEC and the manufacturer shall publish the values.
- 1.21** The MCB housing shall be heat resistant and having high impact strength. The terminal shall be protected against finger contact to IP20 degree of protection.
- 1.22** All model of modular accessories required for the work shall be got approved from the Engineer-in-charge among the approved makes. The base plate shall be preferably in sheet steel or otherwise in unbreakable polycarbonate. The cover plates shall be screw less type in shade approved by the Engineer-in-charge. The GI box shall be of the same make as the modular accessories.
- 1.23** Contractor shall have to check the site order Book for any instructions of Engineer-in-charge or his authorized representative and sign the site order book. He shall be bound to ensure compliance with the instructions recorded there in.
- 1.24** All the MCCB's shall have microprocessor based trip unit for reliable protection and accurate measurement. The rated Service breaking capacity (kArms) shall be 100% of Ultimate breaking capacity (kArms). All MCCB's shall be current limiting type with features as per relevant IS codes and specification. All MCCB's shall be rated for minimum operating voltage of 415 V and minimum insulation voltage of 750 V. There has to be total discrimination between the incoming and outgoing MCCB's and MCB's, as required, at the MDB's and DB's level.
- 1.25** MCCB's shall be used with rotary handle and terminal spreaders and all terminals shall be shrouded to avoid direct contact.

- 1.26** Mechanical Castle key interlock shall be provided among the incomer MCCB's, wherever, as applicable, two different incomer sources are provided in the panel as per the directions of the Engineer in charge. The same is deemed included in the scope of work.
- 1.27** All measuring and indicating instruments shall be protected through MCB's of 0.5 Amps rating.
- 1.28** General arrangement drawing of the switchboard shall be got approved by the Engineer-in-Charge before commencement of manufacturing.
- 1.29** Conduit layout as per switching arrangement shall be prepared by contractor and got approved from the Engineer-in-Charge before slab casting. At all expansion joints in the building suitable arrangement shall be ensured during conducting.
- 1.30** Ratings, sizes and quantities shall be checked and considered for satisfactory operation of electrical system complete in all respect. Ratings, sizes and quantities mentioned in Bill of Quantities and drawings are indicative and minimum.
- 1.31** Conduits, Switchboards, Sockets to be provided on walls shall be recessed type unless specifically approved by Engineer-In-Charge.
- 1.32** Conduits on ceiling in existing system may be provided on surface and in new construction shall be recessed type.
- 1.33** Breaker shall have LCD display to show the metering and protection parameters.
- 1.34** The firm shall deploy only licensed personnel as required under IE Rules, for execution of the electrical works. The firm shall be liable to submit the list of such personnel along with the attested copy of the licenses at the time of execution.
It is important that every equipment is tested fully before dispatch.
- 1.35** All materials for the work shall be supplied from approved list of manufacturer and any item, not covered in approved list, shall be supplied after getting approval from Engineer- in-charge or his authorized representative.
- 1.36** Any materials brought for work which is not matching with specification will be rejected and the rejected materials shall be removed from site on the same

day.

- 1.37** All fees payable to concerned authorities and other local bodies if any shall be paid by the contractors and the same shall be reimbursed by department on production of documentary evidence.
- 1.38** Contractor shall have a valid "A" class contract licence with HT installation issued by appropriate authorities.
- 1.39** Test certificates both type test and routine tests wherever required shall be furnished along with supply for all Electrical/Mechanical items.
- 1.40** Inspection / acceptance, in no way shall absolve the contractor from supplying material as per standards / codes and warranty or other obligations under the contract.
- 1.41** The agency shall have the following testing/measuring equipment in addition to standard tools.
- i) Insulation Tester, 500V, 1000V, 5000V.
 - ii) Earth tester with kit, 0, 10,100 ohms with selector switch.
 - iii) Tong tester with (1) Ammeter 0-800 A with different ranges and selector switch.
 - iv) Voltmeter 0/300V/600V with different ranges and selector switches.
 - v) Phase sequence tester.
 - vi) Multimeter / Avometer: - Digital to measure 0/10/100 mV, mA, ohm, Kilo ohm resistance.
 - vii) Frequency meter 45 to 55 Hz.
 - viii) Portable PF meter (0.5 lag-unity-0.5 lead).
 - ix) Lux meter to measure upto 2000 lux with selector switches.
 - x) Micrometer(digital).

xi) Vernier Caliper(digital).

1.42 All electrical works shall be tested by the contractor in the presence and to the entire satisfaction of Engineer-in-Charge and IE Rules.

1.43 Data to be furnished by the bidder after award of work.

1.) The contractor shall submit following detail shop/fabrication/layout drawings, datasheets and calculations.

a) Internal Electrical Works

i) Conduit layout with number of wires in each conduit, circuiting.

ii) Phase balancing calculation.

iii) DB, SDB load calculation.

iv) Cable and submain wire sizing.

v) Conduit layout and wiring diagram with equipment layout drawing for LAN, EPABX, CCTV and digital light control, stage lighting, conference system, etc.

vi) Electrical, UPS & Server.

vii) Equipment datasheet and GA drawing.

a) MDB

b) Floor DB

c) SDB

d) Light Fittings

e) Wires and cables

f) Switches and sockets

g) Conduit, Junction box

h) Lux level calculation

i) Datasheet and catalogue.

j) Bus duct and light fitting fixing arrangement

k) Earthing Layout

- b) Lift Works
- c) Drawings
 - i) Cable laying arrangement
 - ii) Equipment layout
 - iii) Earthing layout with soil resistivity test report
 - iv) Lighting layout
 - v) Duct layout
 - vi) Trench Layout

Note : For complete execution and satisfactory performance of installation, drawings / documents for all items whether or not mentioned above shall be submitted for approval.

2.) Six Set of copies of installation, operation and maintenance manuals, descriptive bulletins etc., shall be furnished prior to / at the time of despatch of all materials. Manuals shall include the following aspects:

- a) Outline dimension drawing showing relevant cross sectional views, earthing details and constructional features including foundation drawing.
- b) Rated voltage, current, duty cycle and all other technical information which may be necessary for correct operation of the switchgear.
- c) Storage details for prolonged duration.
- d) Unpacking.
- e) Handling at site.
- f) Erection
- g) Pre-commissioning test.
- h) Operating procedure.
- i) Maintenance procedures.
- j) Precaution to be taken during operation and maintenance work.
- k) List of spares for two years trouble free operation.

3.) Test Certificates :

- a) Type/Routine test certificate for all types of equipment, cables, etc. included in the order.
- b) Specified number of copies of the approved test certificates

shall be furnished to the Engineer-in-Charge before despatch of all materials / equipment and cables, etc.

- 4.) On completion of work the contractor shall submit six sets of all drawings, manuals and test certificates, etc. for all equipment / materials ordered and as specified by the Engineer-in-Charge.

2.0 LT SWITCHGEAR PANEL

2.1 SCOPE

This specification covers manufacture, assembly factory test, supply, delivery, field test and installation of L.T. Switchgear panel of voltage not exceeding 1000 V AC complete in all respect with all equipment fittings and accessories for efficient and trouble free operation as required here under.

2.2 CODES & STANDARDS

The design, construction, manufacture and performance of equipment shall conform to latest applicable standards and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed. Nothing in this specification shall be construed to relieve the BIDDER of this responsibility.

Equipment shall conform to the latest applicable Standards as mentioned. In case of conflict between the Standards and this specification, this specification shall override.

IS:60947 (Part 2&5), 1993 -Low voltage switchgear & control gears

IS:2147, 1966-Degree of protection

IS:60947 (Part 4, Sec.I),1993

BS:60947-4-1, 1992:IEC:158-Contactor for voltage not exceeding 1000V AC.

IS:375, 1993-Marking and arrangement of bus bars

IS:694, 1990 & IS:8130, 1984-PVC Insulated cables and aluminium conductor

IS:1248,1991-Direct acting electrical indicating instruments

IS:13703, 1991 -Low voltage fuses

IS:13118 (All parts), 1991 -Alternating current circuit breakers

IS:2705 (Part 1 to 4), 1992-Current transformers

IS:3156 (Part 1 to 3), 1992-Voltage transformers

2.3 POWER SUPPLY SYSTEM

The incommen power supply shall be 415V, 3 phase, 4 wire, 50 Hz, effectively earthed AC system. The fault level for the switchgear shall be as indicated in BOQ and drawings.

Variation of voltage and frequency from their rated values shall be as per IE rules.

2.4 AMBIENT CONDITIONS

The following site conditions shall be considered for the design of panels :

Reference temperature : 45°C

2.5 SHEET METAL WORK

The switchgear frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2.0 mm & all cable gland plate steel of thickness not less than 3.00 mm.

Frames shall be enclosed by sheet steel of thickness not less than 2 mm cold rolled, smoothly finished, levelled, and free from flaws. Doors and covers shall be made of sheet steel of thickness not less than 1.6mm cold rolled. Angle iron Stiffeners shall be provided wherever necessary.

All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Cut-outs shall be true in shape and avoid sharp edges.

The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

2.6 PAINTING

All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with applicable standards

Oil, grease and dust shall be thoroughly removed by hot emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

A smooth coat of powder coating of minimum 70 micron to be provided of approved colour.

Finished painted appearance of equipment shall present an aesthetically pleasing appearance like Siemens grey, free from dents and uneven surfaces.

2.7

CONSTRUCTIONAL FEATURES

Switchgear panel shall be of Form IV (Type – 4 and above) :

- a) of the metal enclosed, indoor, floor mounted modular type
- b) made up of the requisite vertical sections
- c) of dust and vermin proof construction
- d) provided with a degree of protection of IP-42 for indoor panels and IP 54 for outdoor feeder pillar.
- e) easily extendable on both sides by the addition of vertical sections after removing the ends covers.
- f) provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.
- g) with labels on the front indicating the switchgear designation.
- h) of uniform height of not more than 2400mm and operating handle of the highest unit shall be at a height not more than 1.7 mtr.
- i) of single front execution
- j) provided with self adhesive PU foam type/neoprene gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.
- k) provided with aluminium bus bars running at the top, as required, all along the length of the switchgear in a separate sheet steel enclosure.
- l) Feeder pillars/kiosk shall be fabricated from 2.00 mm thick CRCA steel and conform to IP: 54 degree of protection.

Operating devices shall be incorporated only in the front of the Switchgear.

The switchgear shall be provided in distinct vertical sections each comprising :

- a) A completely metal enclosed bus bar compartment running horizontally.
- b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
- c) Enclosed vertical bus bars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical bus bars.

- d) The cable alley shall be of adequate size.
- e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.
- f) Each outgoing feeder compartment having 3 P MCCB shall have neutral link of suitable rating at the MCCB compartment.

Each vertical section shall be equipped with space heaters with thermostat and CFL lamp with power socket.

One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal bus bar compartment. However, each shipping section shall have metal sheets at both ends.

All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

For draw out type, ACB modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdraw-able chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing. Control circuit must have separate compartment and separated from power circuit.

Current transformers shall be mounted with suitable base and shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

The withdrawal chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

Cable alleys shall be provided with suitable hinged doors. Adequate number of slotted cable support arms shall be provided for dressing the cables.

All doors shall be provided with concealed type hinges and captive screws with locking arrangement and suitably earthed with 2.5 sq. mm copper conductor flexible cable.

The withdraw-able chassis housing circuit breakers shall be of the fully draw out type.

The withdraw-able chassis housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully-draw out, or fixed type.

Interchange-ability

All identical equipment and corresponding parts including chassis of draw out modules of the same size shall be fully interchangeable, without having to carry out modifications. For trouble free interchange-ability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

Components and equipment that are not fully interchangeable are liable for rejection. BIDDER shall replace all such equipment by fully interchangeable equipment at his cost.

The draw-out contacts shall be only between copper/copper alloy faces, which are silver or tinplated.

Switchgear shall be designed in such a way that all component equipment and bus-bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubicle, with reference ambient temperature outside the switchgear cubicles.

All dummy cubicles necessary to meet the requirements of this specification shall be included in the Bidder's scope.

No equipment/devices associated with a particular circuit shall be mounted in any other circuit module.

2.8 MAIN BUSES & TAPE

Switchgear shall be provided with three phase bus bars and neutral.

Bus bars shall be of uniform cross section throughout the length of the switchgear.

The bus bars shall be made of high conductivity electrolytic Aluminium, suitable to withstand a fault current as specified in BOQ and SLD.

Bus bars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase, 4 wire system.

All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection; impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phases. The dielectric strength and properties shall hold good for the permissible temperature rise.

Bus bar shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Bus bar supports shall be made of glass reinforced moulded plastic material (DMC/SMC).

Separate supports shall be provided for each phase of the bus bars. If a common support is provided for all three phases, antitracking barriers shall be incorporated.

Bus bar joints shall be complete with high tensile steel bolts, washers and nuts. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary bus bars and necessary connections to the supply transformers and associated circuits shall be in the Bidder's scope.

2.9 MOULDED CASE CIRCUIT BREAKER

The Moulded case circuit breaker (MCCB) shall conform to latest IEC-60 947-2/ IS13947- 2. The circuit breaker shall comply with the isolation function requirement of IEC 60 947-2 section 7.1.2 to marked as suitable for isolation/ disconnection to facilitate safety of operating personnel while the breaker is in use.

Moulded case circuit breakers shall be fixed type, Thermal Magnetic or microprocessor release having adjustable O/L & fixed S/C settings with trip-free, manually closing mechanism, accommodated in a Moulded housing of robust and vermin-proof construction matching with switchboards.

MCCBs shall be provided with Microprocessor based release should have inbuilt Earth Fault protection. All TP MCCBs with Microprocessor release / thermomagnetic should be provided with external Neutral CT to avoid nuisance tripping due to unbalance loads and Neutral Overload protection.

MCCBs used in APFC Panels shall be Thermal Magnetic Type with adjustable O/L & adjustable S/C protections.

MCCBs used for Motor feeders shall be Motor duty type (only magnetic protection) selected as per Type II coordination chart of manufacturer.

All MCCBs shall be designed and tested to IS /IEC- 60947 Part II to breakers shall be provided with an inverse time delay electronic over current trip device. The trip device shall be direct acting.

The MCCB shall have rated operating voltage = 415V with Rated Insulation voltage = 750V and rated impulse withstand voltage = 8KV.

MCCB shall be provided with double Insulation between front cover & internal

power circuits to avoid any accidental contact with live current carrying path with the front cover open.

The tripping devices shall be ambient temperature compensated type. The insulating case and cover shall be made of high strength heat resistant and flame retardant thermosetting insulating material.

They shall have line load reversibility. 3-phase breakers shall be designed to break all the poles simultaneously and they shall have a single mechanism.

They shall have auxiliaries and accessories whenever required for signalling, interlocking, shunt trips, under voltage release, castle lock, etc.

All the circuit breakers used shall have guaranteed breaking capacities sufficient for the maximum short circuit duties that could possibly be imposed on the different breakers. The MCCBs fixed in main switchboard shall have breaking capacity as indicated in BOQ & SLD.

The MCCB shall have a rated short circuit breaking capacity of not less than 35 kA at 415 volts AC or as specified in BOQ. MCCB shall have $I_{cs} = 100\% I_{cu}$ for the entire range as per BOQ and rated at ambient 45°C.

The short circuit breaking capacity and operation of MCCB shall be supported by test certificates of neutral independent authority (CPRI / ERDA).

MCCB's shall be used with rotary handle and Copper terminal spreaders (above 63A), phase barrier and all terminals shall be shrouded to avoid direct contact.

2.10 MINIATURE CIRCUIT BREAKERS (MCB)

MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.

MCB shall be provided with overload/short-circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 10 kA r.m.s. at 415V AC. It shall comply to Class III energy limiting class.

MCB shall comply with IS - 8828 - 1996/IEC 898. MCB shall have minimum power loss (watts) per pole defined as per IS/IEC and the manufacturer shall publish the values.

The MCB housing shall be heat resistant and heavy a high impact strength. The

terminal shall be protected against finger contact to IP 20 degree of protection.

All MCBs should have ON & OFF status indication on front facia.

2.10.1 **Measuring Instruments, Metering & Protection**

2.10.1.1 **General**

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

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

2.10.1.2 **Digital Ammeters**

Ammeters shall be digital type 7 segment LED display. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

2.10.1.3 **Digital Voltmeters**

Voltmeter shall be digital type 7 segment LED display. The voltmeter shall be provided with MCB of suitable capacity.

2.10.1.4 **Multi-Function Meter**

It shall be suitable for measuring, saving and supervision of electrical parameters in low and medium voltage mains.

The Meter shall have following Features.

- ❖ Clear LCD Display.
- ❖ Visualization of all the three phase grid parameters like V, I, PF, Active & reactive power & energies, Percentage loading, Maximum demand etc with Min/Max/Measured/average.
- ❖ The meter shall have communication port of RS 485 and shall be compatible with SCADA System.
- ❖ It shall come along with the software for data acquisition.
- ❖ It shall be compatible with PLC.
- ❖ The accuracy class shall not be more than 0.5%

2.10.1.5 **Current Transformers**

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

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

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be done with minimum 2.5 sq. mm copper conductor, ZHFR wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

2.10.2 **Miscellaneous**

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

Indicating lamps shall be of the LED type.

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

2.10.3 **Cable Terminations**

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

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

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

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

2.10.4 **Labels**

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

2.10.5 **Test At Manufactures Work**

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

Type test for one LT panel as per department's choice shall be arranged by the contractor which shall be witnessed by department officials/authorised agency. Nothing extra shall be paid for this type test.

2.10.6 **Testing and Commissioning**

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays

adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following :

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

2.11 PUSH BUTTONS

Push buttons shall be :

- ❖ of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- ❖ fitted with self-reset, 2 NO and 2 NC contacts.
- ❖ provided with integral escutcheon plates marked with its function.
'Start', 'Open', 'Close' push buttons shall be green in colour.
'Stop' push buttons shall be red in colour.

All other push buttons shall be black in colour.

Emergency stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

2.12 INTERNAL WIRING

Wiring inside the switchgear/panel shall be carried out with 1.1 kV grade, zero halogen FR stranded conductor wires. Minimum size of conductor for power circuits is 4 sq mm copper. Control circuits shall be wired with copper conductor of at least 2.5 sq. mm for CT circuits and 1.5 sq.mm for other circuits.

Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on screw less terminal blocks upto 4 sq. mm size.

Not more than two connections shall be made on any one terminal.

2.13 TERMINAL BLOCKS

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification.

Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks.

Screwless, cage clamp type terminal blocks shall be used for cable sizes upto 6 sq. mm. Screw type terminal blocks shall be used for cables above 6 sq. mm.

2.14 EARTHING

Each Panel shall be provided with an earth bus bar running along the entire length of the board. Material and size of the earth bus bar shall be as per IS. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the earthing conductor.

Earth bus bars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the

switchboard and earth bus bar shall be provided by using insulated copper wires/bare bus bars of cross section equal to that of the bus bar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth bus bar using 650 V grade, 2.5 sq. mm stranded, copper ZHFR, earthing conductor.

All tests shall be carried out on all associated equipment as per relevant standards.

Certified copies of all test certificates shall be submitted for the approval of Engineer-in-Charge before despatch of the switchgear.

Routine test shall be witnessed at the manufacturer's works by the representative of Engineer-in-charge.

DATA SHEET FOR LT PANELS / FEEDER PILLAR

A) SWITCHGEAR PARTICULARS

1.	DESIGNATION	:	
2.	BUS BAR MATERIAL	:	ALUMINIUM
3.	TP/TPN	:	4 POLE/TPN
4.	TYPE	:	INDOOR
5.	CABLE ENTRY	:	FROM TOP/BOTTOM

B) SWITCHGEAR AND BUS BAR RATING

1.	SUPPLY SYSTEM	:	415V, 3-phase, 4W, 50HZ EFFECTIVELY EARTHED
2.	MAX SYSTEM VOLTAGE	:	433 ± 10%
3.	BUS BAR RATING	:	AS PER BOQ/SLD
4.	ONE MINUTE POWER	:	

FREQUENCY VOLTAGE

A.	POWER CIRCUITS	:	2500 V
B.	CONTROL CIRCUITS	:	1500 V
C.	AUX. CIRCUITS	:	2000 V

CONNECTED TO SECONDARY OF CTS

- 5. REFERENCE AMBIENT TEMPERATURE : 45°C
- 6. MAX. TEMPERATURE OF BUS BARS AND DROPPERS : 85°C
- 7. SHORT CIRCUIT WITHSTAND

A) SHORT TIME (1 SEC) : 50/35 KA (RMS) as required.

C) SWITCHGEAR CONSTRUCTION REQUIREMENTS

- 1. THICKNESS OF SHEET STEEL (COLD ROLLED)
 - A. FRAME : 2.0 MM
 - B. DOORS : 1.6 MM
 - C. COVERS : 1.6 MM
- 2. DEGREE OF PROTECTION : IP-42/IP- 54 OF IS-2147 as required as per BOQ.
- 3. COLOUR FINISH AS PER IS-5)
 - A. INTERIOR : GLOSSY WHITE
 - B. EXTERIOR : LIGHT GREY, SEMI-GLOSSY, POWDER COATING.
- 4. CLEARANCES IN AIR OF LIVE PARTS
 - A. PHASE TO PHASE : 32.0 MM
 - B. PHASE TO EARTH : 26.0 MM
 - C. PHASE TO NEUTRAL : 26.0 MM

3.0 LIGHTNING CURRENT ARRESTOR (CLASS B) AND SURGE PROTECTION DEVICE (CLASS C)

3.1 LIGHTNING CURRENT ARRESTOR (CLASS B)

3.1.1 Lightning Protection Device shall provide the following :

1. A lightning arrester of class B type (as per IEC 61312, 62305) with triggered spark shall be used.
2. The lightning arrester components shall have a protection level of <2.5 KV for systems with nominal voltage < 330V AC. Tested as per IEC 61643 -1 : 2005
3. The lightning arrester components shall have a maximum continuous voltage across the SPD 350V AC.
4. The lightning arrester components shall be tested to withstand at least 50 KA of lightning test current of a 10/350 μ s waveform described by IEC Standards. Line follow current I_{fi} - 25 KA r.m.s
5. The lightning arrester components shall have a response time of <100 nano sec.
6. The lightning arrester components shall have an operating temperature range of -40°C to +85°C.
7. Connection made in parallel by using connecting cables of at least 16 Sq. mm. between each phase of the device and the neutral to the device as per TT configuration.

3.2 SURGE PROTECTION DEVICE (CLASS C)

3.2.1 Surge Protection Device shall provide the following :

1. The SPD component shall be designed to withstand a onetime surge of up to a 40KA test current of a (8/20) μ s waveform according to IEC 1024 application guide A and ANSI/IEEE C62.41.1 Category C Area.
2. The SPD component shall have a SPDT contact rated for 250 V AC, 1A used for remote indication/ visual indicator of circuit integrity.
3. The SPD component shall have a rating of IP 20 according to IEC.

4. The SPD component shall have modular with field replacement capacity without the removal of any wires nor shall it interrupt the power to be protected equipment. Bases shall have the ability to be coded to accept only the correct voltage plug.
5. The SPD component shall have integral label holder to mark each terminal block.
6. The SPD component shall have an operating temperature range of at least -40°C to +85°C.
7. The SPD component shall have a response time <math><25\mu\text{s}</math>.
8. The SPD component shall be testable with check master.
9. Connection made in parallel by using connecting cables of at least 10 sq. mm. for class C between each phase of the device and the neutral to the device as per TT configuration.

4.0 LIGHT FITTING AND ACCESSORIES

4.1 SCOPE

This specification covers the design, material specification, manufacture, testing, inspection and delivery to site and installation & commissioning of lighting fittings and their associated accessories.

4.2 STANDARDS

The lighting fittings and their associated accessories such as lamps/tubes, reflectors, housings, ballasts, etc. shall comply with the latest applicable standards as specified. Where no standards are available, the supply items shall be backed by test results shall be of good quality and workmanship & any supply items which are bought out by the VENDOR shall be procured from approved manufacturers acceptable to the PURCHASER/ENGINEER.

4.3 LIGHTING FITTINGS - GENERAL REQUIREMENTS

Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and rain-proof type.

The fittings shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

Connections between different components shall be made in such a way that they shall not work loose by small vibration.

For each type of lighting fitting the VENDOR shall supply the utilization factor to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

All fittings shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage.

The fittings and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant standards.

All mercury vapour and sodium vapour lamp fittings shall be complete with

accessories like lamps, ballasts, power factor improvement capacitors, starters wherever applicable, etc. These shall be mounted as far as possible in the fitting assembly only. If these cannot be accommodated inside, then a separate metal enclosed box shall be included to accommodate the accessories and in addition with a fuse and a terminal block suitable for loop-in, loop-out connections. Outdoor type fittings shall be provided with outdoor type weather-proof box.

All fluorescent lamp fittings shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters and capacitors for correction of stroboscopic effect.

Each fitting shall have a terminal block suitable for loop-in, loop-out and T-off connection by 650/1100V, 3 core, PV insulated Cu conductor cable of 2.5 sq.mm in size unless otherwise specified in Data Sheet A1. The internal wiring shall be completed by the MANUFACTURER by means of stranded copper wire and terminated on the terminal block.

The mounting facility and conduit knock-outs for the fixtures shall be as specified.

All hardware used in the luminaire shall be suitably plated or anodized and passivated for use in chemical industrial and power plants.

4.4 EARTHING

Each lighting fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.

All metal or metal enclosed parts of the housing shall be bounded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

4.5 PAINTING/FINISH

All surfaces of the fittings shall be thoroughly cleaned and degreased. The fittings shall be free from scale, rust, sharp edges and burrs.

When enamel finish is specified, it shall have a minimum thickness of 2 microns for outside surface and 1.5 microns for inside surface. The finish shall be non-porous and free from blemishes, blisters and fading.

The housing shall be stove-enameled/epoxy stove-enameled-vitreous enameled

or anodized as indicated on flame-proof fittings is prohibited.

The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90° over 1/2" dia. mandrel.

The finish of the fittings shall be such that no bright spots are produced either by direct light source or by reflection.

4.6 DECORATIVE TYPE FITTINGS

Decorative fluorescent fittings shall be provided with mounting/housing channel cum reflectors of CRCA sheet steel, stove enameled.

Diffusers or louvers shall be provided as required. Diffusers shall be of translucent white opal acrylic or depending upon the type of fitting.

Fittings shall be suitable for the number of lamps of specified wattage, for directly mounting on ceiling/conduit suspended or for recess mounting in false ceiling, as specified.

Decorative incandescent fittings when required shall be suitable for 60/100/150W lamp, suspended or recess mounting in false ceiling. The fitting for recess mounting shall be provided with copper anodized finished cylinder, ceiling mounting ring and translucent acrylic crystal ring.

4.7 INDUSTRIAL TYPE FITTINGS

These fittings shall be suitable for use with incandescent/fluorescent/ mercury vapour lamps as per requirements and generally as described below.

The angle or cut-off for fittings with filament lamp shall not exceed 70° and that for fittings with fluorescent tubes shall not exceed 79°.

The distribution of light shall be such that at least 80% of the total luminous flux from the fitting shall be in the lower hemi-sphere.

Fluorescent lamps to be mounted in the false ceiling so as to form a continuous luminous ceiling, shall have an inside reflector of non-fluorescent power occupying 2/3 of inner surface of the tube so that the lamp radiates light mainly in the direction determined by the position of the reflective material.

4.8 FLUORESCENT LAMP/CFL FITTINGS

For general industrial use in humid atmosphere, the fittings shall be provided with CRCA sheet steel mounting/housing channel vitreous enameled and with vitreous enameled reflector of minimum 20 SWG thicknesses.

For dusty and vapour prevalent atmosphere, the fittings shall be dust and drip proof type, totally enclosed in sheet steel housing with a heat resistant toughened glass cover or clear acrylic sheet. The housing shall be epoxy stove-enameled and neoprene gaskets shall be provided for sealing.

For atmosphere where chemical vapours/fumes are corrosive, the material of fitting housing/mounting, reflectors and end-plates shall be of cast aluminium/aluminium sheet and finished in epoxy stove enamel to resist corrosion. Control gear housings, starters and tube holder assemblies shall be provided with neoprene gaskets to make it proof against entry of corrosive vapours.

Fittings shall be suitable for the number of lamps of specified wattage, for directly mounting on ceiling/wall and or conduit suspended.

4.9 INCANDESCENT/MERCURY VAPOUR LAMP FITTINGS

4.9.1 Bulkhead and Well glass Type

Bulkhead, weather-proof type fittings for use in corridors, staircase landings, covered porches and low ceiling factories, shall be suitable for direct fixing to wall/ceiling and to accommodate up to 150 watts incandescent lamp. The fitting shall be provided with housing of cast aluminium alloy with stove enameled finish, prismatic heat resistant glass cover hinged on to the housing and fixed by screws. Neoprene gaskets shall be provided to make the fitting weather-proof. For mechanical protection to glass cover, a protective wire-guard of 3 mm galvanized wire with stove enameled finish paint shall be provided.

Well glass, weather-proof type fittings for use in building exteriors and compound walls, shall be suitable for conduit mounting and to accommodate up to 200 watts incandescent lamps. The fitting shall be provided with stove-enameled cast aluminium housing with top conduit entry, heat resistant clear glass cover unit hinged to the housing and fixed by screws. The fittings shall be provided with neoprene gaskets and wire guards as started in above item.

4.10 ACCESSORIES FOR LIGHTING FITTINGS

4.10.1 Reflectors

The reflectors shall be made of CRCA sheet steel/aluminium/silvered glass/chromium plated sheet copper as indicated for above mentioned fittings, unless otherwise specified.

The thickness of steel/aluminium shall comply with relevant standards specified. Reflectors made of steel shall have stove enameled/vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled/mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

Aluminium paint on the reflectors of flame-proof lighting fittings is prohibited.

Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflection coefficient such as to ensure the overall light output specified by the MANUFACTURER.

Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

4.10.2 Lamp/Starter Holders

Lamp holders shall comply with relevant standards. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with in normal installation and use.

Lamp holders for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp is in working position.

Lamp holders for incandescent and mercury vapour lamps shall be of bayonet type upto 100W and Edison Screw type for higher Wattage lamps.

Starter holders for fluorescent lamps shall conform to the standards specified.

All material used in the construction of the holder shall be suitable for tropical use.

The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

4.10.3 **Ballasts**

The ballasts shall be designed, manufactured and supplied in accordance with the relevant standards. The ballasts shall be designed to have a long service life and low power loss.

Ballasts shall be mounted using self-locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dusting, non-combustible enclosures.

4.10.4 **Starters**

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference capacitor.

The starters shall generally conform to the relevant standards.

4.10.5 **Capacitors**

The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

The capacitors shall be suitable for operation at supply voltage and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag or better.

The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

4.10.6 **Lamps**

Incandescent (GLS) lamps shall be provided with bayonet caps up to 100W and E.S. type for higher wattage. Lamps shall be of 'clear' type unless otherwise

specified.

The fluorescent lamps shall be 'Day-light colour' type unless otherwise specified and shall be provided with features to avoid blackening of lamp ends.

Mercury vapour lamps shall be of high pressure, colour corrected type.

The constructional features of gas discharge lamps for special applications or for instant start fluorescent lamps if specified shall be clearly brought out in the bid.

The lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/electrodes shall not break under such circumstances.

Lamps/tubes shall conform to relevant standards and shall be suitable for supply voltage and frequency specified.

4.10.7 **Spare Parts**

Unit prices of the items shall be quoted together with catalogue numbers.

The unit prices shall not however be limited to the above items. The VENDOR may recommend additional spare items and quote the unit prices of the respective items.

4.11 **TESTS AND TEST REPORTS**

Type tests, acceptance tests and routine tests for the lighting fittings and accessories covered by this specification shall be carried out as per the relevant standard for the respective fittings and their accessories.

The MANUFACTURER's type and routine test certificates shall be submitted for tests conducted as per relevant standards for the fittings and accessories. The BIDDER shall submit with his proposal copies of available test certificates of the fittings offered.

5.0 CABLE MANAGEMENT SYSTEM - WALL AND FLOOR

5.1 CABLE TRUNKING

Supply, installation, testing and commissioning of cable trunking system above and below working plane to distribute Power, Data and Telecom cables. The system shall comply with all relevant sections of the 16th edition of IEE wiring regulations and shall be CAT 6 compliant.

Cable trunking shall comprise of base & lid with snap-fit lid and allied accessories such as Separate partition, Plastic Chip on Partition, body joint for base, cover joint internal angles, external angles, cable dividers, cable retainers, tee, flat tee etc. The main carrier should be pre-drilled at 300mm centers with a divider knockout after every 100mm intervals.

System shall be non-corrosive and shall have excellent resistance to mineral acids, alkalis and detergents.

Material used are non flame propagating and a Class 1 spread of flame achieved when tested in accordance with the requirements of BS EN 50085 -1:1999 and BS EN 61386-1:2004.

Cable trunking system shall have provision to accept mounting boxes that snap fit in to the profile.

Colour	:	Ivory
Material	:	U-PVC

5.2 UNDER FLOOR CABLE TRUNKING

Made up of Continuously Hot Dipped, Pre Galvanized metal coated steel sheet of 275 GSM.

Material Specification as per BS 2989 British Standards (Equivalent Indian Standards IS 277-2003)

Specially treated corrosion proof rectangular profiles for high tensile strength. Maximum Tensile Strength of 500N/m².

Rectangular formed with top & bottom plates double folded and spot welded together to the full height of Track to provide the required rigidity and at the same time to prevent seepage of concrete or screed water.

Aluminum painting covers at all the welding spots to avoid corrosion.

Corrosion resistance test complying IS 3854:1997.

Standard Thickness - 1.6mm, Standard Length - 2.5 meters,

5.3

CROSSOVERS

Crossovers are made of very high quality materials to withstand heavy load and corrosion. Manufactured from high-pressure die cast material for strength & durability.

The trap lid is self-adjustable to any floor finish thickness using the leveling screws on all the four corners.

The Trap cover is made of 2.5mm thick pre-galvanized steel plate to provide rigidity & added strength. The Trap covers to have flexibility for quick mounting on to the base box requiring minimum maintenance. The Trap cover must have 8mm recessed for installation of carpet and tiles.

The Cross Over shall have provision to Power, Data & Telecom services. The system must accommodate to run Mains Voltage & Extra Low Voltage cables. The trap cover screws must be made from Stainless Steel for extra protection. The system must have Positive Double Earthing connections. Earth wire connector shall be provided in all the boxes, and complies with the requirement of current IEE regulation. The complete system must have excellent protection against rust.

Four side blanks are made with removable perforations to suit ducts installation of up to 38-mm height. The one-piece base frame design ensures minimum openings to prevent concrete seepage into the box during casting of concrete or screening.

The system must comply with the relevant specification & IEC 61084 standards.

6.0 LIFTS

6.1 General

This specification covers manufacture, testing as may be necessary before despatch, delivery at site, all preparatory work, assembly and installation, commissioning putting into operation of Lifts.

6.2 Location

The Lifts will be installed at Indian Institute of Information technology and Management, Kerala

6.3 Technical specification

The technical specification shall be as per CPWD Technical Specifications for Electrical Works (Part III Lifts & Escalators-2003) and latest editions of relevant IS codes.

6.4 Power Supply

The lift shall be suitable for power supply of 415 V, 3 Phase, 4wire, 50 Hz, AC.

6.5 Compliance with Regulations and Indian standards

All works shall be carried out in accordance with relevant regulation, both statutory and those specified by the Indian Standards related to the works covered by these specifications. In particular, the equipment and installation will comply with the following :

- i.) Factories Act.
- ii.) Indian Electricity Rules
- iii.) I.S.& BS Standards as applicable
- iv.) Workmen's compensation Act
- v.) Statutory norms prescribed by local bodies like NDMC etc.

6.6 Detailed Technical Parameters for the lifts to be supplied

The proposed lifts are gear less and machine room less. The hoisting equipment shall be kept inside the shaft and machinery unit shall be compact & highly energy efficient. The hoisting equipment shall be gearless type with 3 phase AC motor with permanent magnet technology. Motor efficiency shall be 70 % - 75 % and power factor shall not be less than 0.8. The bearings shall be of spherical roller type and main suspension ropes shall be of round steel wire.

The detailed technical parameters are as follows:

A - 1	General :	
1.1	Type	Passenger Lifts
1.2	Number of Elevators	1
1.3	Capacity	1360 kgs (20 Passengers)
1.4	Speed	1.0 mps
1.5	Machine Type	PMSM Gearless
1.6	Number of Landings	5
1.7	Hoistway Size available	2500mm W X 2400mm D
1.8	Floor Markings	G, 1 - 4
1.9	Travel	15 mts
1.9.1	Overhead available in mm	4500 mm
1.9.2	Pit Depth available in mm`	1600 mm
	Machine Room	
1.10	Machine room location	Machine Room Less
1.11	Control	ACVVVF (AC Variable Voltage Variable Frequency Drive)
1.12	Operation	Simplex full coollective
	Car	
1.13	Car Enclosure	SS (Stainless Steel) Vandal Proof Vandal Resistent Finish Panels.
1.14	Car Ceiling	SS Vandal Proof False ceiling with pressure blowers and LED Lights.
1.15	Car Floor	20 mm recess to be provided (For Granite Flooring
1.16	Car Door (WxH)	Automatic power operated centre opening of size 1000mm x 2100mm . Car Door in SS (Stainless steel) Vandal Proof Finish
1.17	Landing Doors (WxH)	Automatic power operated centre opening Doors of size 1000mm x 2100mm . Ground Floor door in SS (Stainless Steel) Hairline finish.
1.18	Car Size (WxD)	To be furnished by tenderer (shall not be less than as specified in IS)
1.20	Car Operating Panel	Stainless Steel Hairline finish Car Operating Panel inside car

A - 2	General :	
1.1	Type	Passenger Lift
1.2	Number of Elevators	1
1.3	Capacity	884 kgs (13 Passengers)
1.4	Speed	1.0 mps
1.5	Machine Type	PMSM Gearless
1.6	Number of Landings	7
1.7	Hoistway Size available	1900 mm W X 2500 mm D
1.8	Floor Markings	G, 1- 6
1.9	Travel	19 mts
1.9.1	Overhead available in mm	4500 mm
1.9.2	Pit Depth available in mm`	1600 mm
	Machine Room	
1.10	Machine room location	Top of Hoistway
1.11	Control	ACVVVF (AC Variable Voltage Variable Frequency Drive)
1.12	Operation	Simplex Full Collective
	Car	
1.13	Car Enclosure	SS (Stainless Steel) Vandal Resistent Vandal Proof Finish Panels.
1.14	Car Ceiling	SS Vandal Proof False ceiling with pressure blowers and LED Lights.
1.15	Car Floor	20 mm recess to be provided
1.16	Car Door (WxH)	Automatic power operated centre opening of size 800mm x 2100mm . Car Door in SS (Stainless steel) Vandal Resistent vandal Proof Finish
1.17	Landing Doors (WxH)	Automatic power operated centre opening Doors of size 800mm x 2100mm . Landing Door in SS (Stainless Steel) Hairline finish.
1.18	Car Size (WxD)	To be furnished by tenderer (shall not be less than as specified in IS)
1.20	Car Operating Panel	Stainless Steel Hairline finish Car Operating Panel inside car

A - 2 PARAMETERS COMMON TO ALL LIFTS		
Machine		
1.1	Power Supply	415V/220V, 50 Hz
1.2	Acceptable Voltage Fluctuation	+10 to -10%
1.3	Rate of Acceleration/Deceleration M/s ²	0.6-1.5
1.4	Jerk(m/sec ³)	0.7-1.6
1.5	Vibrations in Car Horizontal /Vertical mG	18 MG Maximum
1.6	Noise level in Car (running) dBA	52 dBA Maximum
1.7	Door Noise while closing and opening at a distance of 1 meter from car door and 1.5 meter height from floor level dBA	52 dBA Maximum
1.7.1	Noise level in machine room at 1 mtr from machine	62 dBA maximum
1.8	Leveling Accuracy	+/- 5mm
FIXTURES / SIGNALS INSIDE CAR		
1.9	Door open/ Door Close	Door open and Door Close buttons with markings
1.10	Automatic Rescue Device Operation in Car	To be provided
1.11	Emergency Alarm Button	Emergency Alarm button to be provided
1.12	Auto Light/Fan Cutoff	Ventilation fan ON/OFF switch with auto switch off feature after 120 seconds of Lift idle.
1.13	Attendant Operation	Two position Key operated Attendant switch for With/without attendant operation
1.15	Intercom	Three Way Intercom
1.16	Car Display	7 segment LED Based Dynamic Car Direction display & Digital position indicators
1.17	Emergency Light	To be provided
1.18	Emergency Alarm	To be provided
1.19	Over load warning	warning indicator to be provided.

	Landing Indicators	
1.21	Hall Buttons	LED Based push buttons
1.22	Landing display	Combined 7 segment Car position and direction of travel display and Lift under maintenance display.
1.23	Hand Rails	SS hairline finish Hand rails on rear side of elevator at a height of 900mm from the floor level covering entire width of car.
1.24	Infra red door protection device	Full length 2D Multi beam infrared protection device.
SAFETY FEATURES & OTHER INCLUSIONS		
1.25	Fire Man Switch	Fire man's switch for at Ground floor level. Lifts to have fireman mode stage 1 & 2
1.26	Door Protection	Full length 2D Multi beam infrared protection device.
1.27	Over Load Device	Overload non-start and overload protection device.
1.28	Safety Governor	Electro-Mechanical type Safety governors for Car.
1.29	Controller / Drive / Motor Protection	Over current, Under Voltage and Over voltage protection
1.30	ARD (Automatic Rescue Device)	ARD to be provided.
1.31	Fascia Plates & Sill angles	Fascia Plates and Sill angles to be provided
1.32	Pit Ladder	MS Pit ladder to be provided and securely fastened inside the pit.
1.33	Correction Run	In case of power failure or some other reason of lift stoppage in between floors, lift should start its operation from the stoppage landing instead of lowest landing once it start functioning normally
1.34	Safe Landing feature	If a car has stopped between floors due to some equipment malfunction, the controller checks the cause, and if it is considered safe to move the car, the car will move to the nearest floor at low speed and the doors will open.
Associated Civil and structural items		
B	Free Comprehensive Maintenance	
1.35	One Years Free Comprehensive Maintenance post successful installation and completion of all lifts in satisfactory operating condition.	

SECTION - D (HVAC WORKS)

1.0 SYSTEM DESIGN DATA

1.1 General

The basis of design, system selection, estimated requirements and other relevant data are outlined in this section.

1.2 Scope of Work

The scope of work includes supply, installation, testing and commissioning of central air-conditioning and ventilation system to provide designed conditions in the following areas of institutional building:

Description of Area	AC System	Mechanical ventilation
Academic Block	Class Rooms, Offices, Committee Rooms, Seminar Rooms, UPS / Server Room	Stores, toilets, records, MRSS Room, Pump Room, etc.
Student hostel	---	Dining Hall and Kitchen

1.3 Basis of Design

1.3.1 Site Location : Thiruvananthapuram

1.3.2 Outside Temperature :

Summer : 33.3 deg C DB 26.7 deg C WB
Monsoon : 29.4 deg C DB 26.7 deg C WB

1.3.3 Inside design Conditions :

Sl. No.	Area Description	Inside condition	
		DB	RH
1	Academic Block	26 ± 1°C	< 60%

1.4 Design Parameters

1.4.1 Lighting Load

The lighting load will be considered as per the actual from the electrical drawings or as under :

Sl. No.	Area Description	Lighting Load
1.	Academic Block	9.0 Watts / Sq.M.

1.4.2 Fresh Air in A.C. areas (As per ASHRAE Standard 62.1-2007/NBC)

Fresh air shall be provided as per the ASHRAE, 62.1-2007.

Heat recovery units have been considered to recover the energy from exhaust air.

1.4.3 Occupancy (As per ASHRAE/Actual layout)

Sl. No.	Area Description	Occupancy
1.	Academic Block	10 Sq.M. / Person

1.4.4 Equipment Load

Sl. No.	Area Description	Equipment Load
1.	Academic Block	21 Watts / Sq.M.

1.4.5 **Roof thermal insulation** : 40mm thick PUF or equivalent under deck insulation in exposed roof slab.

1.5 Energy Conservation Techniques

1.5.1 Use of Air cooled variable refrigerant flow (VRF) system using inverter scroll compressors operating on environment friendly refrigerant R-410A for the areas opted for air-conditioning system.

1.5.2 Use of variable frequency drives on AHU's complying with section 5.3.1.1 of ECBC.

1.5.3 Use of Heat Recovery Units in all the areas.

1.5.4 Motors shall be energy efficient as per ECBC.

1.6 Cooling Loads

Based on above parameters the cooling loads of various areas have been calculated as under :

Sl. No.	Area Description	Load (TR)
1.	Academic Block	308.8

1.7 System Design

A central Variable Refrigerant Flow (VRF) air-conditioning system has been proposed for environment control in the building. The total air conditioning load of the building is estimated to be 308.8 TR in Academic Block for summer season.

VRF system has been selected with outdoor units installed at the roof level to meet the building load requirements. Separate circuits have been considered in the design depending on the accessibility of the units.

The indoor units have been selected based upon operational requirements. The large, high occupancy areas have been considered with air-handling units (AHUs) where more fresh air and large dehumidified air quantities are required. The small areas of the building have been conditioned through cassette units of appropriate size.

Refrigerant piping for the AHUs and cassette units will be routed above the false ceiling to interconnect between outdoor and indoor units.

Heat recovery unit has been used to recover the energy on fresh air load for all the air handling units.

The conditioned air through air handling units shall be uniformly distributed through insulated GI sheet metal ductwork and powder coated aluminum grilles / diffusers. Return air shall be brought back to the A.C. unit room through sheet metal ducts.

All the LT panel rooms, pantry, toilets and stores in the building shall be provided with mechanical ventilation.

Smoke extraction system with combination of motorized dampers has been designed for Common corridors and lobbies to extract smoke from the space in case of fire. Provision shall be kept to trip the air handling units on getting signal from fire panel to stop the air circulation and automatically start the smoke extraction fans for exhaust of smoke, using motorized dampers.

The air conditioning system shall be integrated with fire protection system to avoid spreading of fire through air conditioning ducts. The system shall ensure automatic stopping of all the A.C. units on getting a signal from fire alarm system.

Elimination of noise is the major consideration. Acoustic lining of sheet metal ducts equipment rooms, etc. shall be considered in the system design. It is contractor's responsibility to take into account all the vibration/noise isolating accessories for air conditioning equipment to eliminate transmission of vibration and noise through building structure.

Note : Phase - I, The scope includes sheet metal works and mechanical ventilation in Academic block and ventilation system in Hostel block. The equipment for the Academic block shall be installed in phase -II.

1.8 Items not included in HVAC Tender

The following related items of works shall be provided by other agencies and are not to be included in the scope of work of air-conditioning contractor :

- i.) Provision and termination of main 3 phase, 50 Hz, 415 volts electric supply including main earth upto AC panels for VRF system units at terrace level.
- ii.) Provision and termination of potential free supply from the fire panel to LT panels to trip the panel in case of fire.
- iii.) Provision of single phase power supply within two meters of exhaust fans and indoor units.
- iv.) False ceiling to cover the ducts and frames for fixing grilles and diffusers.
- v.) All the works for isolation of AC and non-AC areas wherever required.

1.9 Specifications

The CPWD - General specifications for HVAC Works - 2007 shall be applicable for the items, whose specifications are not covered in the enclosed specifications or wherever the specifications enclosed are not adequate. The chapter-1 - General and Chapter-17 - inspection, testing and commissioning shall be read, as applicable, in conjunction to these specifications.

1.10 Drawings

The drawing forming a part of these specifications indicate broadly the proposed scheme for equipment layout and location. The contractor shall have to execute the scheme as proposed. However, minor changes in outdoor units, indoor units, piping - cabling routes, etc. may be permitted to suit the equipment offered and actual conditions, subject to the engineer's approval. The fabrication and working drawings shall be prepared by the Contractor and got approved from the engineer before erection.

1.11 Test Data

The plant shall be tested as per the specifications given elsewhere and complete 'Test Performa' shall be furnished on prescribed sheet.

1.12 Technical Data

The Contractor shall furnish complete technical data on the equipment offered by him as required under the heading 'Technical Data'.

1.13 Performance Data

The contractor shall guarantee that the air-conditioning system performance and shall maintain the designed inside temperature and the relative humidity as specified.

The Contractor shall also guarantee that the capacity of various components as well as the whole system shall not be less than specified.

1.14 Foreign Exchange

No foreign exchange shall be provided for import of any item for this work.

2.0 VENTILATION FANS

2.1 General

The ventilation fans listed below shall be complete in all respects and shall comply with the specifications. The fans shall be supplied as applicable or as specified and shown elsewhere.

2.2

Centrifugal Fan

Centrifugal fans shall be in DIDW construction arrangement complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators and steel base frame type. Direction of discharge, and rotation position shall be as per the job requirement.

- i) **Housing** shall be constructed of 14 gauge sheet metal welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger fans and neoprene gaskets shall be provided throughout split joints to make it air tight.

Minimum 18 gauge galvanized wire mesh inlet guards of 5 cm openings shall be provided on both inlets. Housing shall be provided with standard clean-out and door with quick locking tension handles and neoprene gasket. Thick brass plate(s) showing rotation arrow and make, model number and duty conditions of the fan shall be riveted permanently on the housing.

- ii) **Fan Wheel** shall be forward/Backward curved type as required in Schedule of Quantities. Fan wheel shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 10.16 mps (2000 fpm).

- iii) **Shaft** shall be constructed of steel, turned, ground and polished.

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

- v) **Motor** Fan motor shall be suitable for $415 \pm 10\%$ volts, 50 cycles, 3 phase power supply, squirrel cage, totally enclosed fan cooled motor, provided with class F/H insulation. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1500 rpm. The sound level of fan and motor combination selected for the required performance shall not exceed 95 db within 1 meter distance of air inlet or discharge point.

- vi) **Drive** to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belt shall be of oil resistant type.

- vii) **Vibration Isolation** Steel Mounting base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation with vibration isolators. Vibration isolators shall be as manufactured by Dunlop Metalastik/Emerald. The concrete foundation shall be at least 15 cm above the finished floor level.
- viii) **Painting** Complete fan assembly, base frame and other steel components shall be epoxy painted.

2.3 Tube axial fans/Axial flow fans

Fan shall be single stage long casing type. The fan capacity, static pressure, speed, etc. shall be as indicated in the schedule of equipment, relevant drawings or as required.

The fan casing shall completely enclose fan blade and the motor. The casing shall be fabricated out of heavy gauge steel sheet for vibration free operation. The casing shall be complete with fan and motor supporting arrangement, foot plates, weather-proof electric terminal box, flanged and connections, etc. The casing and all corrode able components shall be epoxy painted as per paint manufacturer's recommended instructions.

The fan hub and wings shall be cast in high tensile aluminum alloy and shall be examined by X-Ray to ensure flawless castings. The fan impeller shall be of adjustable pitch type to obtain desired pitch angle. The fan impeller shall be statically and dynamically balanced. The selection of the fan shall be on the most efficient part of the fan performance curve.

In case of supply air fans the motor shall be totally enclosed squirrel cage induction motor to withstand 45 °C ambient temperature with standard class 'F' insulation and IP-55 construction. For air exhaust application fan motor shall have class 'H' insulation suitable to operate for minimum 2 hours at 250 °C temperature.

Manufacturer shall furnish test certificate from Warrington fire research Institute, UK or equivalent for the performance of smoke exhaust fans - as per BS-7346 Part-II-1990.

Motor ratings shall have at least 10% over load limit plus transmission losses if any. The motor bearings shall be of heavy duty construction.

Access panel wherever applicable shall be provided on the casing for the inspection of components.

2.4

Inline Fan

Inline fan shall be complete with centrifugal impeller, casing, direct driven motor and vibration isolators. Direction of discharge, and rotation position shall be as per the job requirement and shall be marked on the fan assembly. In case of lower ceiling heights the unit shall be with swing out motor type fans.

- a) **Housing** shall be constructed of hot rolled GSS sheets in double skin/single skin construction with FRP corners.

Housing metal parts shall be either spot welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing.

- b) **Fan Wheel** shall be backward curved type. Fan wheel shall be statically and dynamically balanced.

- c) **Bearings** shall be completely maintenance free and can be used in any mounting position, at maximum indicated temperature. The bearing lubricant shall be suitable for low temperature applications. The life expectancy at maximum indicated temperature shall be minimum 40,000 hours operation.

- d) **Fan motor** shall be suitable for $415 \pm 10\%$ volts, 50 cycles, 3 phase/1 phase power supply, squirrel cage, totally enclosed fan cooled motor (IP-44/IP-55), provided with class B or F insulation. Motor shall be with built-in thermal contact which will open and break the power supply at critical high temperature point.

- e) **Drive** to fan shall be direct/ belt driven.

- f) **Painting** : Complete fan assembly, and other steel components shall be epoxy painted.

2.5

Propeller Fans

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

- a) **Mounting Plate** shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with epoxy paint finish. The mounting plate shall be of standard size, constructed of 2 to 18 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 aluminum or steel. Fan hub shall be of heavy duty welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the factory.
- c) **Shaft** shall be of steel, accurately ground and shall be of ample size for the load transmitted. The shaft shall not pass through first critical speed through 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 maximum speed of 900 rpm for fans 300 mm dia or larger and 1440 rpm for fans lesser than 300 mm dia. The fan motor upto 500 watts ratings shall be suitable for 220-240V, 1 ph, 50 cycles power supply whereas motors above 500 watts rating shall be suitable for 415V, 3 ph, 50 cycles power supply. Motors shall be suitable for either horizontal or vertical services.
- e) **Accessories** The following accessories shall be provided with the propeller fans as per the application and as required by engineer.
 - i) Wire guard on the fan inlet side and bird screen at the fan outlet.
 - ii) Gravity operated/fixed louvered shutter, built into a steel frame as per "Schedule of Quantities", to be provided at the fan outlet.

2.6 Installation

- a) The Contractor shall supply all foundation bolts, base frame wherever required, vibration isolators and other accessories and shall assure that the components are placed securely in proper position while the foundation is cast.
- b) Vibration isolators shall be provided with an efficiency of not less than 80%.

2.7 Testing

All the fans shall be tested for performance at the factory in accordance with the guidelines laid down by ASHRAE/AMCA standards and the following test results shall be furnished.

- a) C F M
- b) Static pressure at the specified flow rate
- c) KW input to motor and its P/F

3.0 AIR SCRUBBER

3.1 Scope of Work

The specification for package type double skin scrubber for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

3.2 Type

The scrubber shall be double skin spray type system & shall be draw through type as specified in the BOQ.

3.3 Housing

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m³) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 22 gauge plain GI sheet. The entire framework shall be mounted on an aluminium alloy or galvanized steel (depending on size) channel base as per manufacturer's recommendation. The panels shall be sealed to the frame work by heavy duty 'O' rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed. Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. Recirculation tank shall be fabricated from 18 gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.

3.4 Fan

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the recommendation of the drive supplier. The fan shall be AMCA certified for sound and performance.

3.5 Motor

The TEFC motor shall be suitable for $415 \pm 10\%$ volts, 3 phase, 50 Hz $\pm 5\%$, A.C supply. The motor shall be with class B/E insulation conforming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

3.6 Spray Arrangement

The wet section will have 18 G SS Tank and body with folded construction with the bolted openable sides also in 18 G GI sheet. Spray arrangement shall be 2 bank air washer with 1/8" (3 mm) bore bronze nozzles with brass plug complete with GI pipes and spray headers. Minimum number of nozzles shall be 1 / sqft of face area. Face velocity not to exceed 500 FPM (2.5 m/s). PVC drain/overflow and bleed off outlet are to be provided on all wet sections.

3.7 Pump

The unit will have a single phase 220 volts + 10% 50 c/s power supply monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper water distribution. The pump capacity will be such that it can take care of the bank of Nozzles provided and the rigid media.

3.8 Installation

The fans, pumps, scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

3.9 Transit Damage

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

3.10 Testing

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.

4.0 DUCT WORK AND OUTLET

4.1 General

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

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

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

The factory fabricated ducts shall be manufactured and supplied in 'L' shape. The duct accessories and supports shall be as per SMACNA and approved by the Engineer.

4.2 Duct Materials

The ducts shall be fabricated from galvanized steel coils conforming to IS:277 (latest edition) with grade of coating not less than 20 or aluminum sheets conforming to IS:737 latest edition (wherever aluminum ducts are specified). The material for the factory fabricated duct works shall be of lock forming quality with mill test certificate.

All duct work, sheet metal thickness and fabrication unless otherwise directed shall strictly meet requirements, as described in IS:855 -latest edition.

The thickness of all four sides shall be determined by the thickness required for the longest side of the duct.

The ducts are to be fastened through clinching, rivets, bolts or sheet metal screw. The sealant shall be non-hardening, water and fire resistant. Duct hanger rods shall be minimum 8mm galvanized having threading on one end/both ends/full length as per the requirement.

4.3 Duct Construction

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

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

4.3.3 All edges shall be machine treated using lockformers, flangers and roller for turning up edges.

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

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

4.3.6 All transverse connectors shall be the Rolamate 4 bolt slip – on flanges system.

4.3.7 The specific class of transverse connector and duct gauge for a given duct dimensions shall be as per Table-1 below for the 1" (250 Pa) pressure class.

TABLE-1

FOR SELECTION OF ROLAMATE FLANGE CLASS AND DUCT GAUGES AT 1200MM SPACING						
Duct Dimension (in mm)	1''(250)*5	2''(500)	3''(750)	4''(1000)	6''(1500)*4	10''(2500)
	Reinforcement Class - Duct Gauge					
150 - 250	*3E-26	E-26	E-26	E-26	E-26	E-24
251 - 300	E-26	E-26	E-26	E-26	E-24	E-24
301 - 350	E-26	E-26	E-26	E-26	E-24	E-22
351 - 400	E-26	E-26	E-26	E-26	E-24	E-22
401 - 450	E-26	E-26	E-26	E-26	E-24	H-20
451 - 500	E-26	E-26	E-24	E-24	E-24	H-20
501 - 550	E-26	E-26	E-24	E-24	H-24	H-20
551 - 600	E-26	E-26	E-24	E-24	H-22	H-20
601 - 650	E-26	E-26	E-24	E-24	H-22	H-20
651 - 700*2	E-26	E-26	E-24	H-24	H-22	H-18
701 - 750	E-26	E-26	E-24	H-24	H-22	J-18
751 - 900	E-26	E-24	H-22	H-22	H-20	J-18
901 - 1000	E-26	H-24	H-22	H-20	J-18	J-16
1001-1200	E-24	H-22	H-20	H-18	J-18	
1201-1300	*3H-24	H-20	J-18	J-18	J-16	
1301-1500	H-24	H-18	J-18	J-16		
1501-1800	H-22	J-18	J-16			
1801-2100	J-20	J-18				
2101-2400	J-18	J-18				
2401-2700	J-18					

- 4.3.8 Non-toxic, AC-applications grade P.E. or PVC gasket is to be provided between all mating Rolamate flanged joints. Gasket sizes should conform to flange manufacturer's specification.
- 4.3.9 The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.
- 4.3.10 Dimensional Tolerances : All fabricated dimensions will be within $\pm 1.0\text{mm}$ of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be $\pm 1.0\text{mm}$ per metre.
- 4.3.11 Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

- 4.3.12 Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
- 4.3.13 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- 4.3.14 Plenums shall be shop/factory fabricated panel type and assembled at site.
- 4.3.15 The deflection of transverse joints should be within specified limit for rectangular duct deflection as given in SMACNA.
- 4.3.16 Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts.

Duct sizes 19" (483mm) wide and larger which have more than 10 sq.ft. of unbraced panel shall be beaded or cross broken unless ducts will have insulation covering or acoustical liner. This requirement is applicable to 20 g (1.00mm) or less and 3" W.G. (750Pa) pressure or less. Ducts for 4" W.G. (1000 Pa) or more do not require beads or cross-breaks.

4.4 Support System

- 4.4.1 A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0mm M.S. sheet) nuts, washers and anchor bolts conforming to SMACNA standards should be used.

Table-3 Support for Horizontal Rectangular Duct

Sl. No.	Maximum Duct Size (mm)	Hanger Rod Diameter	Interval (mm)
1	Up to - 700	6mm	2400
2	701 - 1200	8mm	2400
3	1201 - 2000	10mm	2400
4	Above - 2000	12mm	2400

- 4.4.2 As an alternative, slotted galvanized brackets attached to the top two bolts of the Rolamate system may also be used as appropriate for the site condition.

4.4.3 To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

4.5 **Installation**

4.5.1 **Tools and tackles for site work**

The duct installation shall conform to SMACNA norms. For duct assembly and installation suitable tools and tackles should be used to give the required duct quality and speed of installation including (but not restricted to)

- a) Electric Pittsburgh Seamer – used for closing Pittsburgh joints
- b) Electric Slitting shear – to make cut-outs
- c) Drilling machine with drill bits – for drilling holes in sheet metal work
- d) Hammer drill machine with drill bits – for drilling holes in building structures for anchors
- e) Hoisting system – for lifting the duct assembly upto mounting heights

4.5.2 **Installation Practice**

All ducts shall be installed as per tender drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

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 be in accordance to the approval of Engineer in all its parts and details.

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 drawings. Where there is interference/fouling with other beams, structural work, plumbing and conduits, the ducts shall be suitably modified as per actual site conditions.

Ducting over false ceilings shall be supported from the slab above, or from beams. In no case shall any duct be supported from false ceilings hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time without causing delay to other contractor's work in the building.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick appropriate insulation around the duct and totally covered with fire barrier mortar for complete sealing.

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.

4.6 Documentation & Measurement for Duct Work

All ducts fabricated and installed should be accompanied and supported by following documentation:

- 4.6.1 For each drawing, all supply of ductwork must be accompanied by computer-generated detailed, bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by gauge and duct size range as applicable.
- 4.6.2 Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.
- 4.6.3 All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.
- 4.6.4 The entire work shall be measured as per the chapter 'Mode of Measurement' enclosed in the document.

4.7 Testing

After duct installation, a part to duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA - "HVAC Air Duct Leakage Test Manual" (First Edition).

4.8 Dampers

4.8.1 Volume Control Damper

Volume dampers must be provided at the junction of each branch duct with main duct and split of main duct. Dampers shall be two gauge heavier than gauge of the large duct, and shall be rigid in construction to the passage of air. Volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

The dampers shall be of splitter, butterfly type. Damper blade shall not be less than 1.25 mm (18 gauge) reinforced with 25mm angles 3mm thick along any unsupported side longer than 250mm. Angles shall neither interfere with the operation of dampers, nor cause any turbulence. The damper shall be so fabricated as to avoid any leakage of air through the bearing space around damper leave rod.

Automatic and manual opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.8mm steel and blades shall not be over 225mm wide. Dampers for fresh air inlet shall additionally have extruded aluminum rain protection louvers with wire mesh screen fixed on the air inlet side of louver.

Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and fly-nut lock.

After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

4.9 Access Panel

A hinged and gasketed access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

4.10 Miscellaneous

All ducts above 450mm to be cross broken to provide rigidity to the ducts.

All duct work joints to be square or approaching square with all sharp edges removed.

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

Longitudinal and circumferential joints of toilet extract air duct shall be further sealed with flexible permanent mastic to avoid unwanted infiltration of outside air into the duct work and thus affecting the system exhaust adversely.

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

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

Diverting vanes must be provided at the bends exceeding 500mm and at branches connected into the main duct without a neck.

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

The duct should be routed directly with a minimum of directional change.

The ductwork shall be provided with additional supports/ hangers, wherever required or as directed by the Engineer-in- Charge, at no extra cost.

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

All angle iron flanges are to be welded by electric arc welding and holes to be drilled.

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

All the flanged joints to have 4mm thick felt packing stick to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.

The GSS duct should be lapped 8mm across the flanges.

The duct should be supported by approved type supports at a distance not exceeding 2.4m.

Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25mm (18 gauge), sheet thoroughly stiffened with 25mm x 25mm angle iron braces and fitted with access door.

Duct sections in general shall be provided with 18 gauge galvanised weld mesh with about 8mm center for rat protection in the supply air ducts at AHU/fan outlets, return air openings in AHU room and above return air slits in conditioned spaces or as directed by the Engineer-in-Charge at no extra cost.

4.11 Grilles

The supply and return air grilles shall be fabricated from extruded aluminum sections. The supply and return air grilles shall have double adjustable louvers. The supply air grille shall additionally have an opposed blade extruded aluminum damper. The grilles shall be with outer frames.

The opposed blade dampers in black anodised finish shall be suitable for operation from the grille face.

Grilles longer than 450mm shall have intermediate supports for the horizontal louvers. The grilles shall generally be the design of Tuttle and Balley grilles and registers. Grilles shall be powder coated as per the shade approved by Engineer.

Linear grilles shall be fabricated from extruded aluminum section have horizontal fixed sections of minimum 3 mm uniformly thick at angle of 15 Deg.

Return air grilles in MS construction (if included in BOQ) shall be provided with vertical and horizontal adjustable bars and volume control dampers operational from front of grille. The frame shall be of minimum 20G and louvers out of 24g sheet steel. The damper blade shall be of 20G sheet steel.

4.12 Diffusers

The ceiling type rectangular or square diffusers shall be fabricated from extruded aluminum section in removable core construction and provided with anti-smudge ring.

All supply diffusers shall be provided with extruded aluminum, opposed blade dampers, adjustable and lockable from bottom. Dampers shall be in black anodised finish.

Linear diffuser shall be multislot type fabricated from extruded aluminum sections. Each slot shall have air direction controllers with sliding damper for supply air portion only.

4.13 Fresh air intake and Extract Louvers

All the louvers shall be rain protection type and shall be fabricated from extruded aluminum section. The minimum depth of louver assembly shall be 76mm in case of air volumes larger than 8000 CMH. The louvers shall additionally be provided with heavy duty expanded metal (aluminum-alloy) bird screen. In case of smaller air volumes the depth of louver assembly can be 38mm.

4.14 Painting

All grilles, diffusers shall be powder coated in the shade approved by the Engineer.

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

4.15 Testing

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

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the record of balanced air quantity through each outlets shall be submitted to the Engineer for approval.

4.16 Design parameter

a)	Maximum Velocity in main duct	-	450 mpm
b)	Maximum Velocity in supply outlet	-	150 mpm
c)	Maximum friction in duct	-	1.0 cm WG / 100 m run.

5.0 INSULATION

5.1 General

The insulation of water piping, air handling units, ducting, chillers, hot water generator etc. and acoustic treatment of AHU enclosures, plant room, etc. as applicable, shall be carried out as per specifications given under:

5.1.1 Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

Sl. No.	Application	Material	Density (Kg/M ³)	'K' Value (W/MK)	I.S./ B.S. Code (Latest)
1	Duct thermal insulation	Elastomeric Closed Cell Nitrile Rubber Insulation.	50 ± 5	Not to exceed 0.033 at mean temp. of 0°C	DIN EN 8497
2	Acoustic insulation of duct, walls, ceiling etc.	Engineered elastomeric open cell Nitrile Rubber Insulation.	140 - 180	0.047 at 20 deg C	(DIN EN 8497) DIN EN 12667
3	Under Deck Insulation and wall panelling	Polyisocyanurate machine cut shiplap joint slabs pre laminated with 0.05mm aluminium foil.	36 ± 2 / 32 ± 2	Not to exceed 0.021	IS:12436

5.1.2 Mineral Wool

Mineral wool used for insulation and acoustic treatment shall be made from specifically formulated fibres and binder in a suitable ratio to produce fine, fibrous insulation material. The mineral wool shall conform to all properties as mentioned in IS-8183. It shall not settle down due to vibration and jolting. It shall be suited for the maximum design temperature. The material shall be supplied in factory made rolls/slabs of uniform thickness and density and laminated with aluminium foil as specified. Mineral wool shall be non-combustible grade and tested to BS-476 (Part 4, 5, 6, 7).

5.1.3 Polyurethane Foam

Rigid polyurethane foam used for thermal insulation shall be made from Polyol and isocyanate chemicals specially formulated to give CFC free fire retardant properties, good compressive strength and minimum water vapour permeability. The material shall be suitably packed to avoid damage during transit. Rigid polyurethane foam shall be supplied in slabs and pipe sections, suitably laminated with aluminium foil and shall be machine cut from buns and provided with shiplap joint finish conforming to IS-12436.

5.1.4 **Polyisocyanurate Foam**

Rigid polyisocyanate foam made from a specially formulated mixture of polyol and isocyanate chemicals, modified suitably to make it fire safe, CFC free, closed cell, rigid and minimum vapour permeability. The material shall be laminated suitably with aluminium foil or Kraft paper as specified. The material shall be available in slabs and pipe sections provided with shiplap joints finished at the edges. The product shall be machine cut from buns and shall conform to IS-12436.

5.1.5 **Polyethylene Foam**

Polyethylene insulation shall be made by addition Polymerization of Ethene molecules and specifically formulated to give Fire Retardant properties, good compressive strength and minimum water vapour permeability. The material shall be suitably packed to avoid damage during transit.

5.1.6 **Cross linked Closed Cell Polyethylene**

The chemically cross linked closed cell polyethylene insulation material shall be made by polyethylene resin and foaming done through nitrogen gas. It should be chemically cross linked to give strength to air cell and shall be added by the chemicals to give fine retardant properties. It should have tiny, non-inter communicating air cells forming close-cells to provide resistance to flow of heat. It shall have low thermal conductivity, weather resistant, self-extinguishing non dripping, nontoxic, resistive to fungus/bacteria, vermin proof resilient, and shall not deteriorate during handling.

5.1.7 **Acoustic Insulation :**

- i) Material shall be engineered Nitrile Rubber open cell foam.
- ii) The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per the chart below :

Freq (Hz)	125	250	500	1000	2000	4000	NRC
10 mm	0.03	0.04	0.14	0.04	0.88	1.00	0.35
15 mm	0.01	0.09	0.29	0.74	1.08	0.83	0.55
20 mm	0.04	0.13	0.4	0.9	1.04	0.90	0.60
25 mm	0.02	0.25	0.86	1.14	0.88	0.99	0.80
30 mm	0.07	0.32	0.99	1.16	0.93	1.08	0.85
50 mm	0.23	0.73	1.29	0.99	1.09	1.11	1.05

- iii) The material should be fibre free.
- iv) The density of the same shall be within 140-180 Kg/m³
- v) It should have Microban®; antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
- vi) The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
- vii) The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -20°C
- viii) 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.
- ix) 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 10mm for duct work and 30mm for mechanical rooms.

5.2 **Condensate/Refrigerant Pipes**

Condensate piping and refrigerant piping shall be insulated as applicable in the manner specified above. All valves, fittings, strainer etc. in chilled water/refrigerant piping shall be insulated to the same thickness as specified for the main run of piping and applied generally in the manner specified above. Valve bonnets, yokes and spindles shall be insulated in such a manner to allow the dismantling of pumps without damaging the insulation. Tanks wherever required in chilled water piping system i.e. expansion tanks shall be insulated to same thickness as for the pipes to which they are connected.

5.3 **Ducting**

a) **Insulation Material Thickness**

- Case-1 Supply Air Duct. (When return air is being taken through the false-ceiling)
Supply duct 19 mm thick

- Case-2 Supply Air & Return Air Duct (When both are above the false ceiling of the conditioned area).
Supply duct - 19 mm thick
Return duct - 9 mm thick
- Case-3 Supply and return air duct (when both are in the non A.C. area but inside the building).
Supply duct - 25 mm thick.
Return Duct - 19 mm thick.
- Case-4 Supply and return air duct (when both are exposed to atmosphere).
Supply duct - 25 mm thick.
Return Duct - 19 mm thick.

5.4 Installation

- a) **Unexposed Ducts:** (Insulation laminated with metallised polyester foil).
- i) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998/MAS-83) and leave it for drying. Once the adhesive is tacky to touch, place the insulation sheet in position.
 - ii) Press the sheets in position and butt the joints well.
 - iii) Apply 50mm wide self-adhesive tape laminated with metallised polyester foil on both longitudinal and transverse joints.
- b) **Exposed Ducts:** (Insulation laminated with ultra violet).
- i) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998/MAS-83) and leave it for drying. Once the adhesive is tacky to touch, place the insulation sheet laminated with UV barrier film in position.
 - ii) Press the sheets in position and butt the joints well.
 - iii) Apply 75mm wide self-adhesive tape laminated with UV barrier film on both longitudinal and transverse joints.

5.5 Acoustic Lining (Ducts)

The first 5 meters length of duct or upto the first supply grille or as shown on the drawings, starting from each fan outlet, shall be provided with 15 mm thick Open Cell Nitrile Rubber insulation for acoustic purposes.

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.

5.6 Acoustic Treatment of Walls and Ceiling of Equipment Room

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining with open cell Nitrile Rubber insulation sheets. The recommended insulation thickness is 25 mm.

Installation Procedure

The wall surface shall be cleaned and required surface preparation shall be done for applying adhesive. Rubber based contact adhesive recommended by the manufacturer (Pidelite make - SR 998) shall be used. The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the surfaces; wall and acoustic sheet. When it is tack dry, it is should applied / stuck with enough pressure to the walls/ceiling. Minimum 5 fasteners with washer (of G.I Sheet 2.5 inch x 2.5 inch) / square meter, 4 at corners & 1 at centre shall be put immediately after sticking with the help of adhesive. The length of the fastener should be minimum 75 mm.

5.7 Thermal Insulation (Under Deck / Partition Walls)

a) Installation

- i) Clean the surface thoroughly with mild wire brush to make it free from dust and loose particles.
- ii) Apply a coat of cold adhesive MAS-83/CPRX to the R.C.C. ceiling.
- iii) Fix rawl plugs with screws at a distance of 1000 x 500 mm.

- iv) Fix 40 mm thick polyisocyanurate/polyurethane foam slabs pre laminated with aluminium foil of the size 1000 mm x 500 mm with cold adhesive compound MAS-83.
- v) Through the screw take out 26 G GI wire and fix 0.50 mm thick pre coated GI sheet washers of size 50x50 mm at the joints of PIR/PUF slabs.

5.7.1 **Thermal Insulation (Over deck)**

The 40 mm thick CFC free PUF slabs are to be laid on semi hot bitumen (1.0 kg/Sq.M.) or cold adhesive CPRX/MAS-83 and sealing the joints also.

The insulation is to be applied after repairing cracks and filling the gaps, if any, with sand cement plaster, where the roof is mating with the parapet wall/walls.

Apply bitumastic kraft paper over the insulation.

Spread 19mm mesh x 24-gauge chicken wire mesh over the insulation. Ensure that the main insulation is not punctured under any circumstances.

Alternatively CFC free closed cell polyurethane foam insulation 40mm thick having density of 40-45 kg/m³ and k-value of 0.023 w/mk at 10°C mean temperature and conforming to IS:13205 is to be sprayed and finally covered with 1.5mm thick elastomeric waterproofing membrane.

In case of slabs cover the insulated surface with cement plaster in the ratio of 1 part cement, 2 part sand and 1 part pea size gravel. Level the same to smooth finish.

Apply a coat of bituminous primer over the concrete surface when the concrete is dry. Waterproof the same with APP modified bitumen felt.

6.0 **MODE OF MEASUREMENT**

6.1 **General**

This specification covers measurement of various items/materials (as applicable) at site.

6.2 Unit Prices in the Bill of Quantities

The item description in the Bill of Quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the following:

All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.

All the labour required to supply and install the complete installation in accordance with the specifications.

Use of any tools, equipment, machinery, lifting tackle, scaffolding ladders etc. required by the contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipment foundations, from the building structure, wherever necessary and suggested by the Engineer.

Storage and insurance of all equipment apparatus and materials.

The Contractor's unit price shall include all equipment, apparatus material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to complete the system even though not specifically shown, described or otherwise referred to.

6.3 Measurements of Sheet metal ducts, grilles/diffusers, etc.

a) Sheet Metal Ducts

All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars and other fittings. Gaskets, nuts, bolts vibration isolation pads, vanes are included in the basic duct items of the B.O.Q.

The unit of measurements shall be the finished sheet metal surface area in metre squares. No extra shall be allowed for overlaps.

All the guide vanes, deflectors access panels, splitter dampers within the duct work shall be considered as part of the duct and nothing will be paid extra on this account.

The unit duct price shall include all the duct hangers, supports and 'Hilti' metallic fasteners as well as any materials and labour required to complete the duct frame.

b) Box Dampers

Box dampers wherever shown or required in ducts shall be measured as per finished inside cross-sections and paid as per the calculated area in sq.m.

c) Grilles/Diffusers

All measurements of grilles/diffusers shall be the normal outlet size excluding the outer flanges.

The square or rectangular grilles/diffusers shall be measured in plain sq.m.

All round diffusers shall be measured by their diameters in centimeter.

All linear diffusers shall be measured as per actual length in meters.

6.4 Measurements of Piping, Fittings, Valves, Fabricated Items

a) Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and Bill of quantities or as required at site by Engineer-in-Charge.

6.5 Painting

Painting of all pipes, supports, valves and fittings shall be included with the cost of these items. Nothing extra shall be paid for this work.

Painting of grilles/diffusers, tanks and equipment wherever required shall be in the cost of these items.

6.6 Insulation

Measurement of insulation for vessels, piping, equipment and ducts shall be made over the bare uninsulated surface area of the metal.

a) Ducts

The measurements for insulation of ducts shall be made in actual square meters of bare uninsulated duct surface.

In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for damper, flanges, fittings shall be for the surface dimension for the connecting duct. Nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

b) Accessories Insulation

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be of uninsulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves. The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

c) Acoustic Duct Lining

In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metre, shall be final for billing purpose.

The insulation/acoustic treatment shall include cost of battens/sections, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

d) Roof and Wall Insulation and Acoustic Treatment

The unit of measurement for all underdeck roof insulation wall insulation, wall/roof acoustic panel shall be the acoustic uninsulated area of walls, roofs, to be treated, in square metres.

The insulation/acoustic treatment shall include cost of battens supports, adhesives, vapour proofing, finished boards/sheets as well as additional labour and materials required for completing the work.

e) Acoustic Baffle Boxes (wherever required)

The unit of measurement shall be the exposed inside face of the acoustic baffle boxes in square meters.

The unit price shall include all hold fasts, nuts, bolts connecting the size of wall opening and making it good as well. Any additional materials and labour to fabricate and fix the boxes.

7.0 TESTS AT SITE

7.1 General

The Contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the Engineer, in accordance with the provisions of the applicable 'ASHRAE' standards or approved equal and as per site requirements. All tests shall be recorded in the format approved by Engineer-in-Charge.

7.2 Piping System

In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

After tests have been completed, the system shall be drained and cleaned of all dust and foreign material. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

7.3 Duct Work

All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus ten percent (+10%) of fan capacity.

Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

7.4 Electrical Equipment

All electrical equipment shall be cleaned and adjusted on site before application of power.

The following minimum tests shall be carried out by contractor as per relevant IS/IE rules.

Wire and Cable continuity tests.

Insulation resistance tests, phase to phase and phase to earth, and phase to neutral on all circuits and equipment, using a 500 Volt meggar.

The earth resistance between conduit system and earth must not exceed half (0.5) OHM.

The phase rotation tests.

Operating tests on all protective relays to prove their correct operation before energising the main equipment including secondary injection test at site.

Operating tests on all starters, circuit breakers, etc.

7.5 Performance Tests

The installation as a whole shall be balanced and tested upon completion, and all relevant information as per 'Test Proforma' Section - 2 including the following shall be submitted to the Engineer-in-Charge.

- i.) Air volume passing through each unit, duct, grilles, etc.
- ii.) Differential pressure readings across each filter, fan and coil and through each pump chiller and condenser.
- iii.) Electrical current readings, in ampers of full and average load running, and starting, together with name plate current of each electrical motor.

Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil, also suction temperatures and pressures for each refrigerating unit, the current and voltage drawn by each machine.

Any other reading shall be taken which may subsequently be specified by the Engineer.

7.6 Miscellaneous

The above tests are mentioned herein amplification but not by way of limitation to the provisions of conditions of contract and specification. Duration of the test shall be continuous 120 working hours. Contractor shall carry out three seasonal tests each of 48 hours duration during defect liability period of the approved dates.

The date of commencement of all tests listed above shall be subject to the approval of the Engineer and in accordance with the requirements of this specification.

The Contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the Engineer-in-Charge requests such a test for determining specified or guaranteed data, as given in the specifications or on the drawings.

Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer.

In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

The Contractor must inform the Engineer-in-Charge when such tests are to be made, giving sufficient notice, in order that the Engineer-in-Charge or his nominated representative may be present.

Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Engineer-in-Charge.

The Contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the Engineer-in-Charge sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

**SCHEDULE OF EQUIPMENT
(PHASE - I)**

1.0 CENTRIFUGAL FANS

Sl. No.	Description (Fan Tag No.)	Air Qty. (CMH)	Static Pressure (mm WG)	Qty. (Nos.)	Purpose
Hostel Block					
1.	HB - EAU - 01	3000	20	1	Garbage, Dish wash area Exhaust
2.	HB - FAU - 01	23500	30	1	Kitchen Supply Air

2.0 AIR SCRUBBER

Sl. No.	Description (Fan Tag No.)	Air Qty. (CMH)	Static Pressure (mm WG)	Qty. (Nos.)	Purpose
Hostel Block					
1.	HB - SCRB - 01	27500	50	1	Kitchen Exhaust Air

3.0 INLINE FANS

Sl. No.	Description (Fan Tag No.)	Air Qty. (CMH)	Static Pressure (mm WG)	Qty. (Nos.)	Purpose
Ground Floor (Academic Block)					
1.	ILFE - GF - 01 & 02	1800	20	2	Toilet Exhaust
2.	ILFE - GF - 03 & 04	1800	20	2	Toilet Exhaust
First Floor (Academic Block)					
1.	ILFE - 1F - 01 & 02	1800	20	2	Toilet Exhaust
2.	ILFE - 1F - 03 & 04	1800	20	2	Toilet Exhaust
Second Floor (Academic Block)					
1.	ILFE - 2F - 01 & 02	1800	20	2	Toilet Exhaust
2.	ILFE - 2F - 03 & 04	1800	20	2	Toilet Exhaust
Third Floor (Academic Block)					
1.	ILFE - 3F - 01 & 02	1800	20	2	Toilet Exhaust
2.	ILFE - 3F - 03 & 04	1800	20	2	Toilet Exhaust

Sl. No.	Description (Fan Tag No.)	Air Qty. (CMH)	Static Pressure (mm WG)	Qty. (Nos.)	Purpose
Fourth Floor (Academic Block)					
1.	ILFE - 4F - 01 & 02	1800	20	2	Toilet Exhaust
2.	ILFE - 4F - 03 & 04	1800	20	2	Toilet Exhaust
Ground Floor (Hostel Block)					
1.	ILFE - GF - 01, 02 & 03	1000	15	3	Toilet & Hand Wash Exhaust
First Floor (Hostel Block)					
1.	ILFE - 1F - 01 & 02	2000	20	2	Toilet Exhaust
Second Floor (Hostel Block)					
1.	ILFE - 2F - 01 & 02	2000	20	2	Toilet Exhaust
Third Floor (Hostel Block)					
1.	ILFE - 3F - 01 & 02	2000	20	2	Toilet Exhaust
Fourth Floor (Hostel Block)					
1.	ILFE - 4F - 01 & 02	2000	20	2	Toilet Exhaust
Fifth Floor (Hostel Block)					
1.	ILFE - 4F - 01 & 02	2000	20	2	Toilet Exhaust
Sixth Floor (Hostel Block)					
1.	ILFE - 4F - 01 & 02	2000	20	2	Toilet Exhaust

4.0 PROPELLER FANS

Sl. No.	Dia (mm)	Quantity (Nos.)	<u>RPM</u>	Purpose
Academic Block				
1.	225	10	1300	Pantry Exhaust
2.	225	10	1300	Electrical Room Exhaust
3.	300	2	1300	Store Room Exhaust
Hostel Block				
1.	225	1	1300	Toilet Exhaust
2.	300	1	1300	Dish Wash Room Exhaust
3.	450	8	1370	Dining Hall Exhaust

Sl. No.	Dia (mm)	Quantity (Nos.)	<u>RPM</u>	Purpose
MRSS Block				
1.	400	3	1370	MRSS Exhaust
2.	225	2	1300	MRSS Exhaust
Pump Block				
1.	300	2	1300	Pump Room Exhaust

5.0 HI - WALL MOUNTED SPLIT UNITS

S. No.	Tonnage (TR)	Quantity (Nos.)	Purpose
Academic Block			
1.	2.0	4	Server Room
MRSS Block			
2.	2.0	1	Scada Room

TEST PROFORMA

S.No.	Item	Unit	Test Result
1	CONDITIONS		
1.1.	Ambient Conditions		
-	Date		
-	Day		
-	Time	AM/PM	
-	Temp. D.B.	°C	
-	Temp. W.B.	°C	
-	R H	%	
2.0	FANS		
2.1	Fan	Make/Model	
2.2	Air Qty.	CMH	
2.3	Static pressure	WG	
2.4	Fan speed	RPM	
2.5	Motor rating	KW/Amps	
2.6	Fan motor current (actual)	Amps	
2.7	Fan motor voltage (actual)	Amps	
2.8	Controls Report on test and functioning of all controls		
3.0	NOTES:		
	Test Instructions		
3.1	All instruments for testing shall be provided by the Airconditioning Contractor.		

TECHNICAL DATA (To be filled in by Tenderers)

Sl. No.	Description	Unit			
1.0	FANS				
1.1	Manufacturer	Name			
1.2	Type	-			
1.3	Size	mm			
1.4	Air Quantity	CMH			
1.5	Static pressure	mm WG			
1.6	Speed	RPM			
1.7	Motor rating	Watts			
1.8	Speed regulator	Yes/No			
1.9	Gravity Louvers	Yes/No			
1.10	Bird screen	Yes/No			
1.11	Static weight	Kg			
1.12	Dynamic weight	Kg			
1.13	Make/Model of VFD	-			
2.0	INSULATION				
			Duct Work	Acoustic Lining	Pipe Work
2.1	Manufacturer	Name			
2.2	Materials	Name			
2.3	Density	Kg/m ³			
2.4	Mean 'K' value				
3.0	DAMPERS				
			Make	Material Gauge	
3.1	Volume control dampers				
3.2	Motorized fire dampers				
4.0	GRILLES/DIFFUSERS				
			Make	Material Gauge	
4.1	Louvers				
4.2	Grilles				
4.3	Diffusers				

SECTION - E (FIRE-FIGHTING WORKS)

1.0 SCOPE OF WORK

1.1 The scope of work for the Work consists of the following, but is not limited to the same :

1.1.1 Hydrant System consisting of Internal Hydrant Risers cum Down Comer , External Hydrant Ring, Hydrant Stations with all accessories such as Hydrants, Hoses, First Aid Hose Reel, Branch Pipe etc.

1.1.2 Pumping System consisting of Hydrant Pump, engine operated Standby Pump, Jockey Pump, Terrace Pump (one each for Academic and Hostel Block) and equipment's such as Valves, strainers, piping. Instrumentation and Motor Starting System.

1.1.3 Fire Detection and Alarm System for Academic Block. Manual Alarm System for Hostel Block.

1.1.4 PA System.

1.1.5 Supply of Fire Extinguishers.

1.1.6 Exit Signages.

1.1.7 Providing cable seals and fire barriers.

1.1.8 Taking Approval from Local Fire Authority for the works of Fire Fighting and Fire Alarm Systems carried out by the Contractor.

1.2 Hydrant System

1.2.1 The Hydrant System shall be provided for the Academic and Hostel Block.

1.2.2 On each Floor with each Riser cum Down comer there shall be a Hydrant Station having one number Hydrant, 2 nos. Hose and a Branch Pipe. The Hydrant Station shall also be provided with a First Aid Hose Reel consisting of a 36 metre length 20 mm dia hose wound on a drum bracket with aluminium alloy bracket and piping. This set shall be connected to the Hydrant Riser through a 25 mm dia Ball Valve.

1.2.3 The Terrace shall have an Air Vessel with drain and Pressure Gauge to absorb pressure surges and water hammer effect when any of the main pumps start.

1.2.4 All internal piping shall be Mild Steel and shall have welded jointing for pipes above 50 mm dia. External pipe shall be Ductile Iron Pipes.

1.3 Pumping System

1.3.1 To cater for the Hydrant and Systems, the following pumps are being provided :

Sl. No.	Pump Type	Discharge	Head	Drive
	At Underground Tank level			
1.	Hydrant Pump	2850 LPM	88	Electric
2.	Standby Pump	2850 LPM	88	Diesel Engine
3.	Jockey Pump	180 LPM	88	Electric
	At Terrace Level (One for Academic and one for Hostel)			
1.	Terrace Pump	450 LPM	35	Electric

1.3.2 Each Pump shall have a Gate Valve on the Suction Side as well as Gate Valve and Non Return Valve on the Delivery Side. The Delivery of each Pump shall be connected to the Common Delivery Header.

1.3.3 The Pumps shall be single stage type coupled to motor and at 1450 RPM. The Diesel Engine driven pump shall be 1450 RPM. The Engine shall be multi cylinder Heat Exchanger cooled type. All Pumps shall have mechanical seal. Jockey and Terrace Pumps shall be 2900 RPM.

1.3.4 There shall be common Strainers on the Suction manifold with stainless steel mesh to segregate the debris. The Strainers shall have top lift removable flange for cleaning.

1.3.5 An Air Vessel shall be provided in the Pump House. The Air Vessel shall be partly filled with water and shall provide for dampening effect to prevent water hammer when the Pump starts. The Air Vessel shall be provided with pipe spool piece on which pressure switches shall be fitted. The Pressure Switches shall be connected to the Starter on the Pump Starter Panel. Terrace Pump shall also be provided with Air Vessel.

2.0 FIRE PUMPS

2.1 General

2.1.1 The Pumps shall be single stage designed for continuous operation and shall have a continuously rising head characteristic without any zone of instability.

2.1.2 The head vs. capacity, input power vs. capacity characteristics, etc. shall match to ensure load sharing and trouble free operation throughout the range.

2.1.3 In case of accidental reverse flow through the pump the driver shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed.

2.1.4 The motor shall have a 15% margin of power rating over the rated pump input power.

2.1.5 In case the Pump & Motor are from different manufacturers, the contractor under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.

2.1.6 The pump shall be capable of a minimum of 150 percent of rated capacity at a total head of not less than 65 percent of the total rated head. The total shut-off head shall not exceed 120 percent of total rated head on the pump.

2.1.7 An automatic air release valve shall be provided to vent air from the pump. This valve shall be located at the highest point in the discharge line between the pump and the discharge check valve.

2.1.8 Pumps coupled with motor on a common platform shall perform smoothly without any excessive noise or vibration.

2.2 Pumps Casing

2.2.1 The casing shall be capable of withstanding to the maximum pressure developed by the pump at the pumping temperature.

2.3 Impeller

2.3.1 The impeller shall be of stainless steel and the bush shall also be of stainless steel.

2.4 Pump

2.4.1 The pumps shall be horizontal type split casing.

2.4.2 The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings.

2.4.3 All screwed fasteners shall tighten in the direction of normal rotation.

2.4.4 All Pumps shall be provided with Mechanical Seal.

2.5 Shaft

2.5.1 Shaft size shall be selected on the basis of maximum combined shear stress.

2.5.2 The shaft shall be of stainless steel ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibrations and torques coming in during operation.

2.5.3 Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft and shaft sleeve.

2.5.4 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation. The sleeve shall be of stainless steel.

2.6 Pump Shaft-Motor Shaft Coupling

2.6.1 All shafts shall be connected with adequately sized flexible couplings of suitable approved design. Necessary guards shall be provided for the couplings.

2.7 Base Plate

2.7.1 A common base plate mounting both for the pump and drive shall be provided. The base plate shall be of rigid construction, suitably ribbed and reinforced.

2.7.2 Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.

2.8 Vibration & Balancing

2.8.1 The rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced at workshop. All pumps shall be fitted with rubber expansion joints on suction and discharge sides and anti-vibration mounting on foundation.

2.9 Instruction Manual & Tools/Spares

2.9.1 A comprehensive instruction manual shall be provided by the contractor indicating detailed requirements for operation, dismantling and periodic operation and maintenance procedures.

2.10 Installation Of Pump sets

2.10.1 Foundation :

2.10.1.1 A solid vibration free and levelled foundation of concrete shall be made. The foundation shall depend upon the size and weight of the motor pumpset and the nature of the ground

2.10.2 Erection :

2.10.2.1 Only lifting eyebolt shall be used to lift the motor. Ensure the eyebolt is fully tightened in the threaded hole and shoulder of eyebolt butts with the surface of the hole. Avoid jerks and jolts to the motor to avoid bearing getting damaged.

2.10.2.2 Motor should be mounted on the flat baseplates. The motor should be raised by atleast 15 mm to allow freed passage of air underneath for better cooling.

- 2.10.3 Alignment :
- 2.10.3.1 Flexible coupled motors shall require an accurate alignment as solid coupled machines. Use Feeler Gauge and Dial Gauge during motor-pumpset alignment. The gap between the faces of two half couplings should be maintained by 0.05 mm. Check the Angular and Radial Alignment, the trenches should be within 0.05 mm to 0.1 mm.
- 2.10.4 Earthing :
- 2.10.4.1 The motor body should be effectively and securely earthed by fixing copper or aluminium strip on the foot by the earthing screw provided. The other end of the strip shall be connected to the earthing system. If 3 1/2 or 4 core cables are used for power supply the earthing core of the cable should be connected to the earthing terminal provided inside the terminal box.
- 2.10.5 Cable Termination :
- 2.10.5.1 All terminal nuts and fixing bolts shall be fully tightened. Use correct size of cable corresponding to the current rating of the motor. Larger cable would need bigger cable socket, which may result in lesser clearance between terminals. The minimum safe clearance between phase to phase to earth is 10 mm as per Standard.
- 2.10.5.2 It is to be ensured that the gland is holding the cable tightly and there is no appreciable gap left between the gland packing and the cable.
- 2.10.6 Induction Resistance :
- 2.10.6.1 All new motors or where an existing motor has been stored for any length of time in damp situation, the insulation resistance of the windings both between Phase and to Earth should be taken by means of 500 volts DC Megger. The insulation resistance should not be lower than 1 Mega Ohm when the motor is cold.
- 2.10.7 Installation and Foundation :
- 2.10.7.1 Pump when properly installed and when given reasonable care and maintenance, should operate satisfactorily for a long period.

- 2.10.7.2 The pump should be as near the liquid source as practical so that a short direct suction pipe may be used.
- 2.10.7.3 It should be placed so that it will be accessible for inspection during operation. Provide necessary floor space around for inspection and servicing.
- 2.10.7.4 The foundation should be sufficiently substantial to absorb vibration / normal shock and to form a permanent rigid support to the full area of base plate.
- 2.10.7.5 The foundation template with hanging foundation bolts, sleeves and washers shall be placed in position over the pit and shuttering fixed around it. The bolt, washer and sleeve should be free from oil and may be provided with a mixture of neat cement.
- 2.10.7.6 The purpose of the sleeve is to allow movement of the bolts for final positioning to register with the bolt holes in the base plate).
- 2.10.7.7 The concrete should be 1:2:4 mix. Contact faces of the forms and pit should be wetted before pouring concrete. The pouring of concrete should be continuous and should be completed in one operation.
- 2.10.7.8 The foundation should extend atleast 15 cm beyond each side. The depth and side extensions should be suitably increased for locations having poor soil conditions.
- 2.10.7.9 The foundation should be cured for atleast 7 days before the equipment is put on it. Keep the foundation wet for the entire setting period of 28 days.
- 2.10.8 Levelling and Alignment :
- 2.10.8.1 Remove the template and mount the complete unit with the baseplate on the foundation.
- 2.10.8.2 Secure enough rectangular steel blocks, strips and pack them under baseplate on each side of the foundation bolt so that the baseplate is clear from the foundation surface by 2 cms to 4 cms.
- 2.10.8.3 Adjust the metal supports until the shafts of the pump and driver are level. Have the coupling halves disconnected and check the flange faces as well as the machined suction and discharge connections of the pump for horizontal and vertical positions by means of machinist's level. Correct the position,if necessary, by adjusting the metal supports under the baseplate. Tighten by hand all the bolts by means of nuts and lock washer.

- 2.10.8.4 A flexible coupling should not be used to compensate for misalignment of the pump and driver shafts.
- 2.10.8.5 The coupling halves are to be disconnected during the levelling process and they are to remain disconnected till the final check is made after the pipe connections are made.
- 2.10.8.6 After each change during alignment it is necessary to recheck the alignment both angular and parallel.
- 2.10.9 Grouting :
- 2.10.9.1 With the correct alignment and after the concrete foundation has set, the foundation bolts should be tightened evenly but not too firmly, leaving the steel packing in place. Recheck for level and alignment and correct.
- 2.10.9.2 Mix the grout, using 1 volume of cement to 2 volumes of sharp clean sand, pour the grout through the space between the drain planking and the baseplate.
- 2.10.9.3 When the grout has hardened, usually about 48 hrs after pouring, tighten foundation bolts fully.
- 2.10.10 Check for level and alignment.
- 2.10.10.1 Starting of Motor :
- 2.10.10.2 Disconnect coupling of motor side to coupling of pump side.
- 2.10.10.3 Check supply voltage which should be same as per rated voltage of the motor as marked on the name plate.
- 2.10.10.4 Check all external connections, rating of fuse, setting of protective devices to ensure that they are correct and as per the relevant connection diagram.
- 2.10.10.5 Check ball and roller bearings and bearing housing to ensure that they are correctly charged with grease. For replenishing, if necessary, fresh grease of lithium base should be used. Lithium base grease should conform to Grade 2 of IS:1002.

- 2.10.10.6 For first starting, stop the motor immediately. After starting if there is no fault signs, start the motor for some time and check all electric and mechanical connections.
- 2.10.10.7 Check direction of rotation before coupling to a load. Direction of rotation can be reversed by interchanging any two line lead.
- 2.10.10.8 After the motor has started the following shall be checked :
- 2.10.10.9 Check that there is no abnormal vibration of the motor while it is running on load and noise of the bearing.
- 2.10.10.10 Check the full load current drawn by motor in all three phases. A motor should never be allowed to operate on higher current than stated in the name plate.

3.0 Electric Motors

- 3.1 The motor shall be designed not to draw starting current more than 3 times normal running current. It shall be designed for continuous full load duty. The motor shall be full load duty & shall be capable of handling the required starting torque of the pumps. Speed of motor shall be compatible with the speed of the pump.
- 3.2 The cooling fans shall be directly driven from the motor shaft.
- 3.3 Motors shall be enclosed type and shall have a dust tight construction with suitable means of breathing and of drainage to prevent accumulation of water from condensation.
- 3.4 All components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved.
- 3.5 The rating and design shall conform to relevant IS specification.
- 3.6 The motors shall be Squirrel Cage TEFC Induction type.
- 3.7 The motors shall be wound for Class-F insulation, and the winding shall be vacuum impregnated with heat and moisture resisting varnish, and glass wool insulated to withstand tropical conditions.
- 3.8 Two independent earth points shall be provided on opposite sides of the motor for bolted connections.

3.9 415 Volt power terminals shall be suitable for receiving 1.1 kv grade armoured power cables.

3.10 The cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.

3.11 Motor shall be suitable for +/- 10% variation in voltage and +/- 3 % variation in frequency.

4.0 DIESEL ENGINE

4.1 General

4.1.1 The diesel engine shall be of multicylinder type four stroke cycle with mechanical (airless) injection, cold starting type.

4.1.2 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection. This will also provide interchangeability of parts.

4.1.3 All parts susceptible to temperature changes shall have tolerance for expansion and contraction without resulting in leakage, misalignment of parts or injury to parts.

4.2 Starting

4.2.1 The engine shall be capable of both automatic and manual start. Generally the engine shall start automatically, but in case of the auto-start system failure the engine shall be capable of manual start. Engine shall be able to start without any preliminary heating of combustion chamber; cranking mechanism shall also be provided. All controls / mechanisms which have to be operated in the starting process, shall be within easy reach of the operator. A day oil tank of adequate capacity constructed in M S sheet shall be provided as per manufacturer's guide line.

4.2.2 A high torque D.C. motor charged by battery shall initiate automatic start of diesel engine. The battery shall hold adequate retainable charge to provide the starting of the diesel engine. Starting power will be supplied from one set of storage batteries. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression.

4.2.3 The battery shall be used for no other purpose other than starting of the engine and shall be fully charged at all times with provision for trickle & boost chargers. After start of the engine the charger shall be disconnected, the battery being fed from the engine dynamo.

4.3 Governing System

4.3.1 The engine shall have a speed control device which will control the speed under all conditions of load. The governor shall be suitable for operation without external power supply.

4.3.2 The Governor shall offer following features :

4.3.2.1 An adjustable governor to regulate engine speed within a range of 10% between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

4.3.2.2 An over speed shutdown device to shutdown the engine at a speed approximately 20% above rated engine speed with manual reset, so that the automatic engine controller will indicate an over speed signal until the device is manually reset to normal operating position.

4.4 Fuel System

4.4.1 The diesel engine is to run on High Speed Diesel, the tank provided being enough to hold the volume required for 6 hours (minimum) continuous operation. The Day Oil Tank shall be supplied by the Engine Manufacturer. The Tank shall be of M S sheet of thickness approved by the Engine Manufacturer with an internal lead sheet lining to prevent contact between tank and oil.

4.4.2 Tank shall have indications for Low Fuel Level, Float Switch, Fuel Level Indicator with Shut Off Nozzle and shall be duly calibrated.

4.5 Engine cooling System

4.5.1 The Diesel Engine shall be cooled by Heat Exchanger and the Contractor shall make arrangements for continuous supply of such water from Underground Tank and provided with pressure reducing arrangement.

4.6 Accessories

- 4.6.1 The engine shall be mounted on a base plate of fabricated steel construction. Adequate access shall be provided to the big end and main bearings, camshaft and governor drives, water jackets etc.
- 4.6.2 The engine shall have a base plate made from M S sections. There shall be reasonable space at the big end, camshaft, water jackets, governor drives and main bearings.
- 4.6.3 The engine shall be provided with intake and discharge duct work, inlet filter and silencer, outlet muffler, expansion joints, dampers etc. as necessary for efficient operation. Intake air should be taken from inside the building in which the engine is located, but the exhaust should be discharged into the air at a location as desired by the Owner.
- 4.6.4 The engine shall have two number batteries of 180 Ah each and consisting of 25 plates each.

4.7 Instrumentation

- 4.7.1 The diesel engine shall be provided with adequate instrumentation. The gauges etc. as required are provided for in the Engine Panel.

5.0 CONTROL PANEL

5.1 General

- 5.1.1 The Panel shall be fabricated with 16 SWG for Doors and Covers and 14 SWG for frame and of CRCA M.S. Sheet Construction with Red Oxide Primer and finally with approved colour paint to be stove enamelled. The busbar shall be of aluminium with PVC sleeving of appropriate colour code, have a minimum current carrying capacity of 400 Amps. Colour shade shall be RAL 7032 as per DIN and shall be powder coated.
- 5.1.2 The Panel should be cubical compartmentalised type with separate cable chamber & Busbar Chamber. The Control terminals & Power terminals should be separated and necessary ferrule markings, Colour code shall be followed. A space for 300 mm shall be provided at the Bottom of the panel and necessary M.S. channel for the foundation shall be provided. The ammeter & voltmeter shall be 96 mm sq. size and all the HRC fuses rupturing capacity should not be less than 80 K.A.

- 5.1.3 The Busbar calculation shall be made for 1 Amp / mm² for Aluminium. The necessary interlocks shall be provided as per system description. The fuse switch/switch fuse unit shall be IS:4064-1978 and HRC fuse links shall be IS:2208-1962 or IS:9224-1979.
- 5.1.4 The Contractor shall submit the drawings, interconnections diagram for approval of the Client/Consultant. Drawings shall indicate cable inlets, outlets, chamber dimensions and front and side elevations. Further, the Contractor shall also submit complete schematic of the electrical circuits for all pumps from the point of cable entry upto supply to the pumps. This drawing shall take into account all fuses, contactors, switches, meters etc.
- 5.1.5 The apparatus and circuits in the panels shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.
- 5.1.6 Provision shall be made in the panel for terminating the incoming cables as required in the single line diagram. Only Top entries shall be permitted and all cables shall be provided with cable terminations.
- 5.1.7 Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.
- 5.1.8 Equipment shall conform to the latest applicable Standards as mentioned . In case of conflict between the Standards and this specification, this specification shall govern.

IS:13947 (Part 2&5), 1993	-	Low voltage switchgear & control gears
IS:2147, 1966	-	Degree of protection
IS:13947 (Part 4, Sec.I),1993 BS:60947-4-1, 1992:IEC:158	-	Contactors for voltage not exceeding 1000V AC.
IS:375, 1993	-	Marking and arrangement of bus bars
IS:694, 1990 & IS:8130, 1984	-	PVC Insulated cables and aluminium conductor
IS:1248,1991	-	Direct acting electrical indicating instruments

IS:13703, 1991	-	Low voltage fuses
IS:13118 (All parts), 1991	-	Alternating current circuit breakers
IS:2705 (Part 1 to 4), 1992	-	Current transformers
IS:3156 (Part 1 to 3), 1992	-	Voltage transformers

5.1.9 **Constructional Features**

5.1.9.1 Switchgear panel shall be :

- a) of the metal enclosed, indoor, floor mounted modular type
- b) made up of the requisite vertical sections
- c) of dust and vermin proof construction
- d) provided with a degree of protection of IP-52
- e) easily extendable on both sides by the addition of vertical sections after removing the ends covers.
- f) provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.
- g) provided with labels on the front indicating the switchgear designation.
- h) provided with cable entry facilities at top with 3mm thick removable gland plates and necessary cable glands. For 1 core cables these plates shall be non-magnetic.
- i) of uniform height of not more than 2450mm
- j) of single front execution
- k) provided with neoprene gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.

- l) provided with aluminium busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.
- 5.1.9.2 Operating devices shall be incorporated only in the front of the Switchgear.
- 5.1.9.3 The switchgear shall be provided into distinct vertical sections each comprising:
- a) A completely metal enclosed busbar compartment running horizontally.
 - b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
 - c) Enclosed vertical busbars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical busbars.
 - d) A vertical cable alley covering the entire height. The cable alley shall be minimum 200mm wide for motor control modules and 500 mm wide for circuit breaker controlled modules.
 - e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.
- 5.1.9.4 Each vertical section shall be equipped with space heaters which may be located in the cable alley.
- 5.1.9.5 One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.
- 5.1.9.6 All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

- 5.1.9.7 For draw out type, modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing.
- 5.1.9.8 Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.
- 5.1.9.9 In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.
- 5.1.9.10 After isolation of power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the busbars and adjacent circuits live.
- 5.1.9.11 The withdrawl chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.
- 5.1.9.12 Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance of cable connections to any one circuit with the busbars and adjacent live circuits . Adequate number of slotted cable support arms shall be provided for dressing the cables.
- 5.1.9.13 All doors shall be provided with concealed type hinges and captive screws with padlocking arrangement.
- 5.1.9.14 The withdrawable chassis housing circuit breakers shall be of the fully drawout type.
- 5.1.9.15 The withdrawable chassis housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully-drawout, or fixed type.

5.2 Diesel Pump Panel

5.2.1 The Panel should consist of the following :

5.2.1.1 It should be lead acid of minimum 180 Ah capacity.

5.2.2 **Engine Instruments and Control Panel :**

- 5.2.2.1 It shall be complete with required connections to set and comprising :
- 5.2.2.2 Water temperature gauge (dial type)
- 5.2.2.3 Lubrication oil pressure gauge.
- 5.2.2.4 Lubrication oil Temperature gauge.
- 5.2.2.5 RPM indicator.
- 5.2.2.6 Automatic Start Stop Device.
- 5.2.2.7 Manual : The Engine can be manually operated by means of Push Buttons.
- 5.2.2.8 Start Stop and Failure Control Device.
- 5.2.2.9 Start key for manual starting.
- 5.2.2.10 Stop Push Button for manual stopping of engine.
- 5.2.2.11 Starting failure indication by lamp and Horn Unit.
- 5.2.2.12 Engine temperature very high indication by audio alarm.
- 5.2.2.13 Lubrication oil Pressure low indication by audio alarm and automatic stopping of engine.
- 5.2.2.14 Engine over speed indication by red lamp with engine over speeding audio alarm.
- 5.2.2.15 Engine set in operation indication by green lamp.
- 5.2.2.16 Mains supply available indicated by yellow lamp.
- 5.2.2.17 Push Button for Audio Alarm reset.
- 5.2.2.18 Push Button Failure Indication by lamps.

5.3 **Power Cable**

The Power Cables shall be PVC insulated PVC sheathed aluminium conductor armoured cable conforming to IS:1554-1988 (Part - I) with upto date amendments or revision. The cable shall be laid directly in ground, pipes, masonry ducts, cable tray surface of wall etc.as shown on drawings.

- 5.3.1 The cable shall satisfy the following tests as per relevant IS codes :
- 5.3.1.1 Insulation Resistance Test (Sectional) and overall).
- 5.3.1.2 Continuity Resistance Test.
- 5.3.1.3 Earth Continuity Test.
- 5.3.2 All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Indian Electricity Rules. The contractor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all expenses of conducting such tests.

5.4 Cable Tray

- 5.4.1 The cable tray shall be fabricated out of slotted/perforated MS Sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. The Cable Tray shall be fabricated from cold rolled MS sheets of 2 mm thickness.
- 5.4.2 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200 mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scrapped and removed before the installation.
- 5.4.3 Factory fabricated bends, reducers, tee/cross junctions etc. shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.
- 5.4.4 The entire tray and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust and finished with two coats of spray paint of approved make synthetic enamel paint.
- 5.4.5 The cable tray shall be bonded to the earth terminal of the switch bonds at both ends.
- 5.4.6 Cable tray shall be supported by 10 mm dia MS Rods at interval of 100 cm by using dash fasteners.

5.5 Earthing

5.5.1 All equipments installed shall be earthed by making proper connection by means of copper cables / wires to the main earthing system.

6.0 CODES AND STANDARDS FOR PUMPS AND MOTORS

6.1 Pumps

6.1.1 The pumps shall perform to the standards and codes as given below :

6.1.2 IS:1520 Horizontal centrifugal pumps for clear, cold and fresh water.

6.1.3 BS:599 Methods of testing pumps.

6.1.4 PTC:8 ASME Power Test Codes - Centrifugal Pumps.

6.2 Motor

6.2.1 The following codes shall be applicable for the motor.

6.2.2 IS:325 Induction motors, three-phase

6.2.3 IS:900 Induction motors, installation and maintenance, code of practice for

6.2.4 IS:7816 Guide for testing insulation resistance of rotating machines.

6.2.5 IS:4029 Guide for testing three phase induction motors.

6.2.6 IS:3043 Code of practice for earthing.

6.2.7 Further to those stated above, the design, manufacture, installation and performance of motors shall conform to the latest Indian Electricity Act and Indian Electricity Rules. The motor shall also be acceptable to the Tariff Advisory Committee.

7.0 FIRE FIGHTING ACCESSORIES

7.1 Piping

7.1.1 Pipes of the following types (depending upon the description of item) shall be used :

7.1.2 MS pipes conforming to IS:1239, ISI marked (heavy / medium grade, as required) for pipes of sizes 150mm NB and below) suitably treated on the outside to prevent soil corrosion as per IS:10221.

7.1.3 **Piping (for Pipes upto 150 mm dia)**

The pipes shall be manufactured by Electric Resistant Welded (ERW) / High Frequency Induction Welding or Hot Finished Welded process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps / strips conforming to IS :10748.

The following manufacturing tolerances shall be permitted on the tubes and sockets :

7.1.4 The pipes shall be manufactured by Electric Resistant Welded (ERW) Electric Fusion Welding or Induction Welding process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps / strips conforming to IS :10748 by butt welding longitudinally or spirally. The weld shall be continuous. The pipes shall conform to the Tensile Test, Hydraulic Pressure Test and Mechanical Tests as per IS:3589. The pipes shall also conform to the requirements of the Outside pipe dias as laid down in IS : 3589. The tolerances on the pipe body shall not vary more than 0.75 percent of that prescribed in the above mentioned Code. All pipes shall be of minimum 6 mm wall thickness. Pipes shall be supplied with bevel edging.

7.1.5 MS / GI pipe upto 150 mm dia shall have all fittings as per IS:1239,part II (heavy grade) while pipes above 150 mm dia shall be as per IS:3589 inclusive of IS marking.

7.1.6 For MS / GI pipes upto 50 mm dia screwed jointing shall be adopted, while for pipes above 50 mm dia welded or flanged connections shall be used. Only electro galvanised nuts / bolts shall be used.

7.1.7 The different type of pipes / fittings shall conform to the following :

Type of Pipe / (Dia)	Size	Grade	Ends/ Fitting	Code
M S Pipes	Upto 50 mm dia	Heavy	Screwed	IS:1239 (Part I)

Fittings	- do -	Heavy	- do -	
MS I Pipes	Above 50 mm dia and upto 150 mm dia	Heavy	Bevel, Butt Welded, 3 layers	IS:1239 (Part I)
MS Fittings	- do -	Heavy, machine formed from IS marked Heavy Grade Pipes	- do -	

7.1.8 Hangers and supports shall be capable of carrying the sum total of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipelines movements as necessary. All guides, anchors, braces, dampeners, expansion joints and structural steel to be attached to the building / structure, trenches etc shall be provided by the Contractor. Hangers and components for all piping shall be approved by the Engineer in Charge. Hangers / supports to be used shall be as per the drawing enclosed. Anchoring fasteners shall be rated to take minimum 0.4 ton load and shall be as per approved make. Hangers shall be at 3.0 M intervals. Additional supports shall be provided at bends etc. Angles for pipe supports should not be less than 40 x 40 x 6 mm size. Cutting shall be by gas cutter. All cut edges and weld surfaces shall be grounded to a smooth finish.

7.1.9 The piping system and components shall be capable of withstanding 150 per cent of the working pressure including water hammer effects and test pressure upto 12.0 kg/cm².

7.1.10 Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of strategic points to facilitate erection and subsequent maintenance work.

7.1.11 All welding shall be carried out by a certified welder only. The Contractor must produce the Welder's Certificate.

7.1.12 All pipe to pipe weld edges shall be bevel finished to a clean edge by a electric grinder. A requisite gap determined by the thickness of the weld electrode shall be given between the joints before start of welding.

- 7.1.13 Weld Electrodes shall be of approved make, of grade and type as suitable for the job. This shall be satisfied by the Consultant before start of work.
- 7.1.14 Joints shall be given a first weld in full width without burrs on the full dia of the pipe. Welding shall be carried out vertically from the surface to be welded. Weld fluxes shall not be so plastic such as to fall or drip down.
- 7.1.15 After application of first coat the weld shall be ground and then another layer of welding shall take place. The weld shall also be cleaned by grinding. Similarly, a third weld shall also be applied.
- 7.1.16 All pipe cutting shall be by oxy acetylene gas welding only. The cut surface shall be cleaned and ground by a electric grinder before further welding.

7.2 Ductile Iron pipes and fittings

- 7.2.1 The spun iron fire pipes where specified shall be Centrifugally cast (Spun) Ductile iron, Pressure pipe as per IS: 8329 and classified as K-12. The specials for ductile iron pipes shall be as per IS:9523 and classified K-12.
- 7.2.2 The jointing shall be done with flanged ends, either welded on or cast in one piece.
- 7.2.3 Ductile iron pipes shall be jointed by means of flanges cast on where required e.g. near sluice valves, connection of G.I. risers with CI pipes, etc.. The jointing material used between flanges of pipes shall be compressed fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per m² shall be not less than 112 gm/mm thickness.
- 7.2.4 Pedestals of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20mm nominal size) shall be provided for each pipe length, one at each end of flange and one in centre of pipe. Pedestals shall be 300 x 300 x 300. A strap shall be mounted over the pipe to anchor the pedestal to the pipe.
- 7.2.5 After a new pipes has been laid, jointed and back filled (or any valved section thereof), it shall be subjected to pressure test at a pressure of at least double the maximum working pressure.
- 7.2.6 The pressure test shall not be made unit at least five days have elapsed after the concrete its cast, if rapid hardening cement has been used in these blocks or anchorages, test shall not be made until at least two days have elapsed. Prior to testing, enough back fill shall be placed over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been

sufficiently cured and no temporary bracing shall be used. The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line, as many be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate. Flanges shall be provided at all joints to valves, other fittings and to MS piping.

7.3 Valves

7.3.1 Sluice valves / Butterfly valves / Ball Valves will be used for isolation of flow in pipe lines For sizes upto 50 mm, gate valves shall be outside screw rising spindle type and shall be as per IS: 778 Class-I and Class-II, as applicable. For sizes 80 mm to 300 mm, gate valve shall be as per IS: 780, PN=1.0 and shall be of outside screw and non-rising type and cast iron double flanged. The valves shall, however, be tested to PN:1.6.

7.3.2 Gate valves shall be provided with a hand wheel arrangement. Gate valves shall have back setting bush to facilitate gland renewal during full open condition.

7.3.3 Non-return valves shall be cast iron spring action swing check type. An arrow mark in the direction of flow shall be marked on the body of the valve. These valves shall conform to IS:5312. The flap shall be of cast iron and flap seat ring of leaded gun metal.

7.3.4 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections. Drain lines will have valves for draining.

7.4 Hydrant

7.4.1 Hydrant valve shall be as per IS : 5290 of stainless steel. The valve shall be oblique type complete with hand wheel, quick coupling connection, spring and blank cap as per I.S.:5290. The hydrant shall be fixed on Hydrant Riser through a 80 mm dia spool piece, at approx. 1.2 mtr from floor level. The Hydrant shall be IS marked. Orifice plate in 6 mm thick stainless steel with orifice of 32 / 40 / 50 mm dia shall be provided with each Hydrant.

7.4.2 The Hydrant shall be constructed from stainless steel as per IS, and finished to a smooth polish on screwed ends. The Hydrant shall have screwed inlet of 75 mm dia, flanged type with 4 nos holes. The outlet shall be 63 mm female instantaneous oblique type. The spindle shall be of stainless steel with cast iron wheel. The Hydrant shall have a PVC plug with chain fixed to the main body of the Hydrant. The Hydrant shall conform to IS:5290. The Hydrant shall be tested to 25 kg / cm² test pressure. All threaded joints shall be sealed with Holdtite. The lug shall be wing type.

7.5 First Aid Hose Reel

7.5.1 The Hose Reel shall be drum type with hub wheel ties. The supply pipe shall be of aluminium alloy and be a part of the suspension assembly. The drum shall rotate freely on the assembly. The drum shall be fabricated from GI sheet of minimum 18 guage thickness.

7.5.2 The hose reel shall be directly tapped from the riser through a 25 mm dia pipe, the drum and the reel being firmly held against the wall by use of dash fasteners. The Hose Reel shall be swinging type (180 degrees) and the entire Drum, Reel etc shall be as per and IS:884 including marking. The rubber tubing shall be of IS:444 marked and rayon double braided. The nozzle shall be 6 mm dia ABS plastic rotating head shut off type. A Ball Valve shall be used to shut off the water supply to the Hose Reel.

7.6 External Hose Cabinets

7.6.1 Each hydrant / Fire Brigade inlet shall be housed in a Hose Cabinet of 0.9 M x 0.6 M x 0.45 M. The Hydrant Cabinet shall hold single headed hydrant, 2 nos. Hoses and 1 no. Branch pipes or Fire Brigade Inlets.

7.6.2 The cabinet shall be of 3 mm thick aluminium sheets with 25 x 25 aluminium framing members. The sheet shall be rivetted to the frame. The Box shall have a single shutter with glass of 8 mm thickness.

7.6.3 The aluminium work shall be powder coated with red paint. The words "Yard Hydrant", "Hydrant" etc. shall be painted in white (or red on the glass) in 75 mm high letters. The hose box shall be lockable with socket spanner. All horizontal surfaces shall be sloped adequately with water discharge holes. Vents shall also be located on sides of the Hose Box.

7.6.4 A brick pedestal with brick wall complete with plaster shall also be constructed for supporting the hose box. All surfaces shall be plastered with 1 : 4 ratio (1 cement : 4 fine sand) mortar.

7.7 Fire Brigade Inlet

7.7.1 Fire Brigade Inlet Connection shall be taken directly to the Riser. It shall comprise of four instantaneous male inlet coupling with plug and steel chain. The Inlet shall have a dual plate wafer type non return valve and a Butterfly Valve on the line upto the Riser. The Fire Brigade Inlet shall be complete with necessary components like special fittings of medium quality MS bends, flanged tees etc. The plug shall be of moulded P V C.

7.7.2 Fire Brigade Inlet for Tank Filling by Fire Brigade shall be four way with gun metal instantaneous male inlet coupling connection for connection with Fire Brigade vehicles.

7.7.3 The inlets shall be provided with ABS Quality by Plastic Blank caps with chain and arrangement for attaching the blank cap & chain to the FB inlet.

7.8 System Drainage

7.8.1 The system shall be provided with suitable drainage arrangements with GI piping of 40 mm dia, complete with all accessories, and provided with 40 mm dia ball valve.

7.9 Valve Pits

7.9.1 A masonry pit of internal dimension 1.0 x 1.0 x 1.0M depth shall be built to accommodate each of the valves placed externally. Walls shall be of 75 class designation brick work in cement mortar 1:5 (1 cement:5 fine sand) with 116 kg CI manhole cover with frame (500 cm internal dia). The Top Slab RCC shall be of 1:2:4 mix (1 cement : 2 coarse sand : 4 graded same aggregate 20 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick. The man hole chamber shall be internally finished with commercial grade white glazed tiles.

7.10 Pressure Gauge

7.10.1 The Pressure Gauge shall be constructed of die cast aluminium. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type Pressure Gauge with a scale range from 0 to 16 Kg / CM square and shall be constructed as per IS: 3624.

7.11 Painting

7.11.1 All Hydrant pipes shall be painted with post office red colour paint. All pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO. 1" etc. All necessary protection to adjacent objects shall be taken by the Contractor. Flanges, Nuts, bolts, Gate and Non Return Valves shall not be painted.

7.12 Butterfly Valve

- 7.12.1 The Butterfly Valve shall be suitable for waterworks and tested to minimum of 20 kg / sq cm pressure. The Valves shall fulfil the requirements of AWWA (American Water Works Association) C 504, API 609 and MSS-SP-67.
- 7.12.2 The body shall be of cast iron to IS:210 in circular shape and of high strength to take the minimum water pressure of 20 kg / cm². The disc shall be heavy duty ductile iron with anti-corrosive epoxy or nickel coating.
- 7.12.3 The valve seat shall be of high grade nitrile rubber and shall be teflon coated or silicon coated. The Valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be of EN 8 grade carbon steel.
- 7.12.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages. The flap shall be of ductile iron and nylon coated.
- 7.12.5 The Valves shall be supplied with manual gear operated opening / closing system by lever as required by the specifications.

7.13 Couplings

- 7.13.1 Couplings shall be of stainless steel, machined and polished to requirements. Both Male and female couplings shall be fitted into each other smoothly and without any unnecessary force. Couplings shall IS:903 marked with the name of the manufacturer. The coupling shall be tested to 25 kg / cm² test pressure. The Male couplings shall be provided with lugs for inserting female coupling. The lugs of the coupling shall be wing type.

7.14 Branch Pipe / Neulite

- 7.14.1 The Multipurpose Branch Pipe shall be constructed from Gunmetal / aluminium alloy and finished to a smooth polish. The Branch shall have hook for control and grip type handle for holding. The Branch pipe shall be able to give straight stream, high pressure fog, jet and shut off, all provided by the operation of the handle - lever. The Fog Nozzle shall be as per IS:903. The Branch Pipe shall be tested to 20 kg / cm² pressure.

7.15 Air Vessel

7.15.1 The Air Vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter acting pressure surges whenever the pumping set comes into operation. It shall be normally partly full of water, the remaining being filled with air which will be under compression when the system is in normal operation. Air vessel shall be fabricated from 8 mm thick MS plate with dished ends and suitable supporting legs. It shall be provided with a 100 mm dia flanged connections from pump, one 50 mm drain with valve, one water level guage and 25 mm sockets for pressure switches. The air vessel shall be hydraulically tested to 20.0 kg / cm² pressure for 30 minutes. All Valves shall be Ball Valves in gunmetal.

7.15.2 The Vessel shall be at least 1.5 M long (excluding dished ends) and shall be of 150 mm dia.

8.0 CODES & STANDARDS

8.1 The following codes and standards and their subsequent modifications shall apply for the design, manufacture, shop testing, erection, fabrication at site, testing and trial operation of piping, valves and specialities requirements :

8.1.1 IS:554 : Dimensions for pipe threads where pressure tight joints are required on the threads.

8.1.2 IS:638 : Sheet rubber jointing and rubber insertion jointing.

8.1.3 IS:778 : Copper alloy gate, globe and check valves for water work purposes.

8.1.4 IS:780 : Sluice valves for water-works purposes (50 mm to 300 mm).

8.1.5 IS:901 : Couplings, double male and double female, instantaneous pattern for fire fighting.

8.1.6 IS:1239 : Mild steel tubes, tubulars and other wrought (Part I & II) steel fittings.

8.1.7 IS:884 : Swinging type wall mounted hose reel with drum,

8.1.8 IS:388 : hose tubing.

8.1.9 IS:4038 : Foot valves for water-works purposes.

- 8.1.10 IS:5290 : Landing valves.
- 8.1.11 IS:10221 : Anti-corrosion treatment for underground MS pipes.
- 8.1.12 IS:5312 : Swing check type reflux (non-return) valves.
- 8.1.13 Rules for Automatic sprinkler installation & Tariff Advisory Committee.

9.0 FIRE ALARM SYSTEM

9.1 Scope of Work

The scope of work includes the following :

- 9.1.1 Intelligent Addressable Fire Detection System for the Academic Building.
Manual Alarm System for the Hostel Building.
- 9.1.2 Emergency Public Address System.
- 9.1.3 The Contractor shall get the Fire Alarm System approved from the Local Fire Authority without any cost to the Owner.

9.2 System Description

- 9.2.1 The Academic Building shall be provided with an Intelligent Addressable Fire Alarm Panel located on the Main Level. Intelligent Addressable Fire alarm System with Photo Electric Multi Criteria Detectors in all air conditioned areas. Areas not directly air conditioned such as store rooms shall also be provided with smoke detectors. Areas above the false ceiling shall be provided with Heat Detectors.

9.3 Provision of Multi Criteria Smoke cum Heat Detectors in areas :

All air conditioned areas including rooms, corridors, store rooms.

9.4 Provision of Heat Detectors :

Areas open to the atmosphere and not air conditioned such as entry areas or staircases.

AHU Rooms.

Above false ceiling.

9.5 Provision of Manual Call Box :

At all staircases entry points on all levels.

Internal areas in corridors etc.

Other areas where Call Point is required as per code.

9.6 Provision of Hooter cum Strobe :

At staircases.

All corridors and public areas shall be provided hooters.

Large Rooms

At locations desired by Client / Codes.

9.7 Provision of Repeater Panels :

One no per Floor near staircases.

9.8 Provision of Fault Isolators :

Inbuilt with Detectors.

9.9 Provision of Input Modules :

For NO / NC signal from Flow Switches.

9.10 Provision of Output Module :

For tripping AHUs.

For initiating Hooter cum Strobe. Not more than 2 Hooter cum Strobe per Module. Output Modules shall be programmable to allow operation only in area of fire.

9.11 Provision of Response Indicators :

For Detectors above false ceiling.

9.12 Provision of Duct Detector :

For air sampling for return air of AHUs.

9.13 Provision of Speakers :

Provided in the common areas.

10.0 INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

10.1 Scope of Work

10.1.1 The Design consists of a multi loop Intelligent Addressable Fire Alarm System with the Panels located on the Ground Floor along with accessories such as Sensors, Call Points, and Alarm signals located as per drawing.

10.1.2 The Building shall have an Intelligent Addressable Fire Alarm System for all areas from Ground Floor onwards. The System shall have Class A Wiring. Field Devices shall include Sensor Devices, Manual Call Box, Input Card (from Flow Switch and Magnetic Contact), Output Modules to switch off AHUs etc. Strobes and shall be provided with Output Module on common areas. Fault Isolators shall be provided as required.

10.1.3 The scope of work under this head shall include designing, supplying and installing of Intelligent Addressable Fire Detection cum Alarm System for the Building and shall cover areas marked by the line diagram plus any other area which may be decided subsequently, to be protected by the Fire Alarm system. The work under this system shall consist of furnishing all materials, equipment's and appliances and labour necessary to install the said System, complete with Detectors, Panel, Speakers, Manual Push Button Stations, Input Modules, Output Modules, Relays etc. for disconnecting other systems such as A H Us and electric supply etc.

10.1.4 It shall include laying of cabling ducts, conduits and power supply etc, necessary for installation of the System with supply of detectors of appropriate type as indicated in the specification and Schedule of Quantities. Any openings / chasing in the wall / ceiling required to be made for the installation shall be made good in appropriate manner.

10.2 Design Description

10.2.1 The System shall have a multi loop panel and distributed as per drawing. All Devices shall be connected directly to the Loop. The P A System shall be independent from the Fire Alarm System.

10.2.2 Loop cabling shall be A class.

10.2.3 The Panel shall have necessary Logic Software and Hardware built into it for time delay starting of strobe and for hooters. Further, AHUs of each Floor shall be shut off only when any detector on that floor operates an alarm.

10.3 Specification

10.3.1 The design, supply and installation and testing of the entire fire alarm system shall conform to EN 54 or NFPA 72. The detectors shall conform to relevant codes for Fire Alarm Systems.

10.3.2 A general line diagram showing the circuit, and spacing of detectors is enclosed. However, this line diagram is mainly for guidance of the Bidders and wherever it may be at variance with the EN 54 or NFPA 72, the latter shall be followed.

10.4 Intelligent Addressable type Rate of Rise type Heat Detector

10.4.1 The Heat Detector shall be Intelligent Addressable detector with its own manually-set digital code and be able to give a single digitised output to the Fire Alarm Panel regarding its condition. The Detector shall employ the thermistor principle for heat sensing and the fixed temperature setting shall be at 57° Centigrade. It shall be able to communicate with the Fire Alarm Panel by the electrical pulses emitted from the Panel. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.

10.4.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.

10.4.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).

10.4.4 The detector shall have a microprocessor that shall have an environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The microprocessor shall have differential sensing algorithms

which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector every day.

10.4.5 The Base of the Detector shall be interchangeable with other Smoke Detectors and the construction shall be of poly carbonate or any approved proprietary flame retardant material. LEDs shall be provided to indicate locally alarm condition. The enclosure shall meet IP 22 protection grade.

10.4.6 The Detector shall meet the requirements of NFPA / EN 54 and shall be specifically approved by UL / LPCB / VDS. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder. The approved coverage per Detector for unhampered areas shall not be less than 50 M².

10.4.7 The detector shall be protected from reverse polarity or faulty zone wiring. It shall also be possible to test the detector in the field through use of magnet or test devices. The circuitry shall be solid state devices and sealed to prevent damage from dust, dirt or humidity. The circuitry shall be protected against usual electrical transients and electromagnetic interference.

10.4.8 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit / loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.

10.4.9 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.

10.4.10 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

10.5 Intelligent Addressable Photo Electric type Smoke Detector

10.5.1 The Photo Electric Smoke Detector has an optical sensing chamber that operates on the light scattering principle and responds to those particles that form optically dense smoke. When smoke enters the sensing chamber it scatters

light which is received by a photo cell. The signal is amplified and digitised for reception by the Panel. The Detector shall activate on receiving smoke particles in the 0.5 to 10 micro metre range. The detector shall be completely solid state with L E D indication at the base. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.

- 10.5.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.
- 10.5.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).
- 10.5.4 The detector shall have a microprocessor that shall have in environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The microprocessor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector every day.
- 10.5.5 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion. The light source intensity shall automatically adjust to compensate for possible effects of dirt and dust accumulation in the sensor/lens. The Smoke density in the chamber shall be measured by a optical system built within the detector. The detection principle shall employ a multiple light pulse coincidence circuit in order to prevent the false alarms. The detector shall be provided with response indicator (LED) and the sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure of voltage variation.

- 10.5.6 Neither its performance shall be affected by air current upto 10 mtr per second. The detector shall be suitably protected against dust accumulation / ingress. All detectors shall be identical in construction design and characteristic to facilitate easy replacement. The detector housing shall be damage resistant made of polycarbonate or proprietary self-extinguishing material. The detector shall have a screen to prevent entry of insects into the sensor.
- 10.5.7 The coverage per smoke detector shall be upto a minimum of 80 M². This coverage area will reduce depending upon structural configurations or partitions etc. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Buttons in the same circuit. The sensitivity of detector shall be set adjusted by the supplier to suit the site requirement.
- 10.5.8 It shall have in-built safety device to monitor the removal and pilferage of the detector. The detector also must have facility for remote indication.
- 10.5.9 The Base of the Detector shall be interchangeable with other Smoke or Heat Detectors. The enclosure shall meet IP 40 protection grade.
- 10.5.10 The Detector shall meet the requirements of NFPA / LPCB and be approved by UL / LPCB VdS. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.
- 10.5.11 It shall be possible to mount the detectors in Duct Casting Units for sampling of Supply Air from the A H Us.
- 10.5.12 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit / loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.
- 10.5.13 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.
- 10.5.14 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

10.6 Fire Alarm System

- 10.6.1 The Fire Alarm System shall conform to NFPA 72 / EN 54 in respect of design and installation, and it shall give Audio / Visual Alarm signals when the temperature in case of Heat Detector or smoke density in case of Ionisation or Photo Electric Detector exceeds the pre-set limit. The system shall give pin point location of fire with warning system and voice communication for commands and instruction if required. All Panels shall have 16 bit processors.
- 10.6.2 The System shall be Computer aided microprocessor based with central control and monitoring facility. The basic function of the System shall be to be able to achieve pin point location of alarm indication. Secondary functions such as pre warning of possible alarm situation, self-diagnosis, checking upon faulty detectors and switching on / off of unrelated activities such as A H Us or Power Supply shall also be possible in this System. In case of more than one panel, all panels shall have peer to peer communication. Both panels shall be independant in operation for the area it serves. Master - slave configuration shall not be acceptable.
- 10.6.3 Each Loop shall have a minimum capacity of 120 detectors in a circuit. The Fire Alarm Panel itself shall have the mother boards / transponders / interface of each zone built-in.
- 10.6.4 Annunciation (Hooter Alarm) facility shall also be inbuilt into the Panel, the Panel being able to initiate alarm signal for any particular set - in this case a floor - hooter as required. The signal shall be transferred to the relevant channel in the P A System.
- 10.6.5 The system shall be fully supervised for all fault conditions with distinctive alarms operated for fault and fire conditions. Test push buttons / features shall be provided to test the electronic circuits and detector conditions.
- 10.6.6 The Panel shall be so programmed that when a particular detector or group of detectors give a fire signal the Panel should be able to trip an individual A H U automatically. The respective Loop Card shall be so programmed that in case of Fire conditions in a area air conditioned by an AHU the Panel shall be able to trigger a Relay through the Output Card that shall shut off the AHU through an additional Contactor provided in the AHU Panel by the AC Contractor.
- 10.6.7 The Basic System Functional Operation shall be as follows :
- 10.6.8 The Panel LED shall flash and Panel piezo-electric signal in the control panel shall actuate.

- 10.6.9 The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- 10.6.10 The Panel shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- 10.6.11 All system output programs assigned via control-by-event/ logic equations to be activated by the particular point in alarm shall be initiated.

10.7 Addressable Manual Call Box

- 10.7.1 Manual Push Button shall be of Break Glass or Pull down type units, completely encased in a plastic housing with provision for cable or conduit coupling. The Manual Push Button shall have the word prescribed in clear bold letters on facia window "In Case of Fire Break Glass / Pull Down".
- 10.7.2 The Manual Call Box Station shall be fully addressable with its own set code and operated by digitised signals sent from the Panel. The Voltage range shall be from 15 V to 28 V. It shall have protection as per IP 33. For exposed areas in Upper Concourse IP55 Manual Call Boxes shall be provided.

10.8 Addressable Fire Alarm Control Panel

- 10.8.1 The Fire Alarm Control Panel shall be microprocessor based fully Intelligent Addressable Analogue Control Unit which shall control all Intelligent Addressable detectors, Manual Call Stations and Switching Systems (for disconnecting A H U and power supply) connected to it and outther Input Devices such as Magnetic Contacts and Flow Switches.
- 10.8.2 All addressable units shall be connected to the Panel through the Loop Cards and shall be addressed through individualised numbers. The Panel shall be able to obtain analogue value / percentage obscuration value for all detectors in the circuit through a pulsed digitalised current data. The Panel shall be able to analyse all analogue inputs from all addressable units, and through its own software and ambient level screening the Panel shall be able to identify Fire, possible Fire or Fault conditions. The Unit supervision shall be dynamic and continuous.
- 10.8.3 The Fire Alarm Panel shall itself have all Loop Cards in it. No isolated mother board or transponder is being considered. Each Loop shall have a capacity of 120 detectors.

- 10.8.4 The Panel shall also give adequate warning signal whenever there is dust accumulation in detectors, and upto the point of its replacement it should be possible to change the level of ambient alarm calibration condition either by the use of software programme operable by the Owner or by resetting the detector.
- 10.8.5 Short circuiting, loose wiring or missing units shall also be reported at the Panel with pin point or segment-wise location. In such cases, the System through the use of Fault Isolators shall be able to isolate that segment between the two fault Isolators.
- 10.8.6 The Panel shall have a minimum 2 x 40 character Liquid Crystal Display Alpha - Numeric type on it to indicate immediately all conditions. In case of testing of the System from the Panel, the Display shall be able to give status of analogue value of all detectors being tested. The Panel shall also be able to carry out continuous self-monitoring when in normal condition.
- 10.8.7 The Panel shall have either an in-built or external printer coupled to the Panel which shall log all events with time. The printout shall clearly indicate the event - Fire / Pre Alarm / Fault etc., the Unit address and time.
- 10.8.8 The Panel shall also be able to discriminate between false alarms and fire conditions, as well as priority selection of alarm address in case alarm activates in two or more remotely located Units simultaneously. In such cases, the Manual Call Box shall be reported first, group of sequentially laid detectors (in one room for example) second and a detector with the greatest obscuration over a period of time third.
- 10.8.9 The Panel shall also be able to actuate Switches automatically in case of Fire condition, that of A H Us and Power Supply. The Bidder will be required to design and install the System in operation in coordination with the relevant Contractors. The Bidder will not be allowed to charge extra on this account, and such charges shall be included in his package.
- 10.8.10 In this respect the Bidder is required to take note of Clause relating to cutting off of AHUs given above. The Bidder shall indicate in his Bid what facilities shall need to be provided by the Client for completion of this mechanism.
- 10.8.11 The System shall be fail safe and adequate safe guards should be under taken that in the event of a failure of a part of the System it shall not handicap the complete System. The Mother Board shall be of Modular Construction.

- 10.8.12 The Bidder shall undertake the responsibility of the complete installation, commissioning, user trials, training and maintenance of the System as required. The Bidder shall take all responsibility for preparation and installation of System Soft Ware into the Panel. The Soft Ware shall be such so as to be easily operated by the Owner's Personnel, is secured against Software errors, ability to be upgradable so as to incorporate more Detector Units or replacement / changing of Detector Units, can incorporate more features at a later date such as Illumination Control, Security etc.
- 10.8.13 The Panel shall have its own Battery Backup. The Battery shall be of sealed maintenance free type of capacity minimum 25 Ah capacity.
- 10.8.14 The Panel shall be totally enclosed dust and vermin proof type made of minimum 18 guage dust inhibited sheet with even baked finish. The panel shall be of completely solid state design.
- 10.8.15 The logic circuitry shall be based on high noise immunity solid state hardware employing modular construction. Logic cards shall be of epoxy fibre glass construction.
- 10.8.16 The System shall meet the EN 54 / NFPA 72 standards and all equipment's excluding cabling and wiring shall be listed with UL / LPCB / VdS.
- 10.8.17 The Panel shall have software to cater to the changeover of any of the operating Loop Cards to an extra Loop Card. Other software necessary to actually change the terminals of a Loop from an existing Loop Card to the extra Loop Card shall be carried out at site as and when required. Charges for such software, loading, test run etc. shall be indicated when required.
- 10.8.18 Peer to peer communication between panels shall be provided with event of each panel being provided on the other panel.
- 10.8.19 The Panel shall also have programmable Automatic Day / Night Sensitivity Adjustment, Drift Compensation by which the detector's sensitivity threshold level due to dust shall be automatically adjusted over time. The panel shall also upload / download System Database to PC Computer. The System shall also allow Walk Test.
- 10.8.20 The Fire Alarm Control Panel shall be capable of supporting interactive Colour Graphics Package complete with history logging. All the zone shall be displayed with colour coded graphics that indicate the status of each zone and its location.

10.8.21 The Main Processor Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the central processing unit. The CPU shall contain and execute all control-by-event/ logic programs for specific action to be taken if an alarm condition is detected by the system.

10.9 Power Supply

10.9.1 The control panel shall derive 230 Volts power from main supply. A standby power supply shall be immediately available in the event of failure of normal supply and shall automatically be connected so as to maintain the equipment in condition such that fire alarm originating from the operation of detector can be given.

10.9.2 Suitable arrangements shall be incorporated to prevent secondary batteries from discharging through the charging equipment in the event of its breakdown or a failure in the supply.

10.9.3 Necessary automatic changeover from normal to standby DC supply in case of main supply failure shall be provided by the Contractor.

10.9.4 In addition to the batteries, a battery charger suitable for operation on the auxiliary power shall be supplied. The capacity of the charger shall be such that the same can boost charge the battery (within 8 hrs) while supplying the rated load of the fire detection and annunciation system. Facilities shall be provided to limit the voltage supplied to fire detection and alarm system to their rated values during the time of boost charging. The charger shall normally supply the battery trickle charging current and the DC load of the fire detection and alarm system. In case the AC supply on the input side of the charger fails the necessary power for the complete fire detection and alarm system including P A shall be supplied by the battery.

10.9.5 Switches, fuses, overloaded devices, voltmeter, ammeter and earth fault indicating device shall be furnished for the power supply system.

10.9.6 Visible and audible annunciation for troubles or failure in the power supply system like "Charger Failure", "Battery Low Voltage", etc. shall be provided.

10.9.7 Battery earth / fault indication / annunciation shall be included in the panel.

10.9.8 The electronic cards to be used in the battery chargers shall be of PCB type with male /female type plug-in contacts.

- 10.9.9 Automatic boost / trickle charging facility shall be included in chargers.
- 10.10 Intelligent Addressable Multi Criteria Photo Electric cum Heat Detector**
- 10.10.1 The Detector shall be provided with both Smoke and Heat Sensor. The Photo Electric part shall have an optical sensing chamber that operates on the light scattering principle and responds to those particles that form optically dense smoke. When smoke enters the sensing chamber it scatters light which is received by a photo cell. The signal is amplified and digitised for reception by the Panel. The Detector shall activate on receiving smoke particles in the 0.5 to 10 micro metre range. The detector shall be completely solid state with L E D indication at the base. The microprocessor within the detector shall independently employ programmable algorithms to dynamically examine smoke values and initiate an alarm based on that data.
- 10.10.2 The detector shall be capable of carrying out independent fire detection algorithms. The fire programmable detection algorithm shall measure sensor signal dimensions, time patterns and shall be able to combine different fire parameters to increase reliability and distinguish real fire conditions from nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by inbuilt software filters.
- 10.10.3 The detector shall have a separate means of displaying communication and alarm status. Each detector shall be individually programmed to operate at different sensitivity settings (those operating in offices and those in corridors).
- 10.10.4 The detector shall have a microprocessor that shall have an environmental compensation algorithm, which shall identify and set ambient thresholds based on environmental conditions. The detector shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. This shall employ digital compensation to adapt the detector to 24 hour long period environmental changes. The detector shall monitor the environmental compensation value and alert the system operator when the detector approaches the threshold of the threshold considered for the environment. The microprocessor shall have differential sensing algorithms which shall provide a constant differential between selected detector sensitivity and the approved sensitivity level. The approved sensitivity information shall be updated and permanently stored at the detector every day.
- 10.10.5 The Heat Sensor shall consist of a thermistor for heat sensing and the fixed temperature setting shall be at 57° Centigrade.

- 10.10.6 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion and shall actuate on rate of heat rise increasing over the factory set threshold. The light source intensity shall automatically adjust to compensate for possible effects of dirt and dust accumulation in the sensor/lens. The Smoke density in the chamber shall be measured by a optical system built within the detector. The detection principle shall employ a multiple light pulse coincidence circuit in order to prevent the false alarms.
- 10.10.7 The detector shall be provided with response indicator (LED) and the sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure of voltage variation.
- 10.10.8 Neither its performance shall be affected by air current upto 10 mtr per second. The detector shall be suitably protected against dust accumulation / ingress and it shall be free from maintenance and functional test at intervals. All detectors shall be identical in construction design and characteristic to facilitate easy replacement. The detector housing shall be damage resistant made of polycarbonate or proprietary self-extinguishing material. The detector shall have a screen to prevent entry of insects into the sensor.
- 10.10.9 The coverage per smoke detector shall be upto a minimum of 80 M². This coverage area will reduce depending upon structural configurations or partitions etc. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Buttons in the same circuit. The sensitivity of detector shall be set adjusted by the supplier to suit the site requirement.
- 10.10.10 It shall have in-built safety device to monitor the removal and pilferage of the detector. The detector also must have facility for remote indication. The Base of the Detector shall be interchangeable with other Smoke or Heat Detectors. The enclosure shall meet IP 40 protection grade.
- 10.10.11 The Detector shall meet the requirements of NFPA / EN 54 and be approved by UL / LPCB / VdS. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.
- 10.10.12 Each Detector shall be provided with a Fault Isolator which shall be able to detect wire short circuit / loose wiring and similar conditions and shall be able to isolate that segment from the circuit, so that the rest of the circuit continues to operate.
- 10.10.13 The Fault Isolators shall operate in pairs in any loop and whenever any short circuit occurs between any two of them, both immediately shall switch to an

open circuit state and isolate the length of wiring between them. The Isolators should automatically return to the closed circuit as soon as the short circuit is corrected.

- 10.10.14 The Fault Isolator shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop. When a wire-to-wire short occurs, the Fault isolator shall automatically disconnect that part of the circuit. When the short circuit condition is corrected, the Unit shall automatically reconnect the isolated section.

10.11 Conduits

- 10.11.1 These shall be 16 G. Mild Steel Welded and having perfectly circular tubing and capable of being cleaned and tight fitting joints. Conduits shall be laid either surface or in recessed as required and it shall be protected from rust by one coat of iron oxide, and one coat of Red Enamel Paint.

- 10.11.2 Above false ceiling cables shall be drawn off from the conduits laid on the slab. The cables shall be drawn through flexible P V C conduits including all necessary supports, clamps etc. as required.

- 10.11.3 Where conduits have to be installed under R C C slabs, the Bidder shall use drill guns and P V C dash fasteners for screwing of saddles for exposed conduits.

10.12 Addressable Switch (Output Module)

- 10.12.1 The Switches shall be addressable and commandable Units controlled from the Fire Alarm Panel that shall automatically energise circuits to disable electrical circuits for A H Us or Power Supply etc.

- 10.12.2 The Bidder shall take note of relevant Clauses given above. He shall be required to specifically inform the Owner about what facilities he shall require from the Owner or the Air Conditioning Agency working at site for tripping off the A H Us.

- 10.12.3 The Switch shall also be used to operate a group of strobes or a group of electronic hooters through the use of a Power Supply Unit, or shall operate a magnetically operated Door Closing Device by de magnetising the unit.

10.13 Addressable Duct Casting Unit

- 10.13.1 The Duct Casting Units are to be directly installed in the air conditioning ducts for detecting any hazardous quantity of products of combustion being carried through the ducts.

- 10.13.2 The complete unit shall consist of aluminium or poly carbonate housing to accommodate a Ionisation or Optical Detector with plug - in facility and sampling tubes, one for air inlet and the other as the air outlet.
- 10.13.3 The Inlet tube shall extend into and across the duct width (from 0.5 metre to 3.0 metre), the outlet tube shall be of fixed length of 7.5 cm length.
- 10.13.4 When the A H U blower fans shall operate a continuous cross sectional sampling of air from the duct shall flow through the housing containing the detector. The outlet tube shall return the sampled air into the duct.
- 10.13.5 The functional requirements of the Duct Casting Unit shall be :
- 10.13.5.1 Uniform Sensitivity - irrespective of air velocity - upto 1200 metres per minute.
- 10.13.5.2 It shall function on the Venturi principle, with aluminium venturi tubes.
- 10.13.5.3 The Duct Casting Unit shall be compact, easy to install and with the facility to dismantle the cover or detector for maintenance purposes.
- 10.13.6 The housing shall be mounted outside the duct, the probe tubes shall be inserted through the duct by cutting precision sized holes into it and sealed with rubber gaskets.
- 10.13.7 The Duct Casting Unit shall be UL / LPCB approved.

10.14 Cables and Wires

- 10.14.1 Cables shall be Zero Halogen FRLS stranded and insulated for armoured and unarmoured. The conductor shall be stranded shielded as required copper conductor.
- 10.14.2 The entire installation shall be tested to Electricity Rules and as per IS:732 (1973) with amendments. The cables shall be laid as per IS:1255 (1967).
- 10.14.3 Loop cabling shall be 2 core 1.5 sq mm stranded copper conductor cable.
- 10.14.4 All terminals shall be done with thimbles and ferrules.

10.15 Sounder Base

- 10.15.1 Specific Detectors as per the requirements given in the drawings and schedule of Quantities shall have Sounder Bases. On activation of the specific Detector on which the Sounder is mounted, the Sounder shall initiate beeping. The

Sounder shall be activated only after the detector crosses the Alarm threshold, and not the Pre Alarm level. The Sounder circuit shall be solid state and its Power Driver shall be derived from the available power in the Intelligent Addressable circuit or through an independent power supply circuit. The Sounder shall work on 24 Volts. The Sounder Output shall be 50 dB minimum.

10.15.2 In case of the Sounder, the Detector's performance shall not be disabled on account of the Sounder being disabled. The Detector shall still be able to communicate directly with the Panel.

10.15.3 In case the Bidder is unable to provide a single unit of Addressable, Intelligent Detector with Sounder Base, then he shall quote for the above as given below :

Detector with Sounder Base : Intelligent Addressable Detector with Output Card or Device, Electronic Sounder and necessary hard wiring to make a complete unit.

10.16 Response Indicator

10.16.1 Response Indicator shall be fabricated from 16 gauge M.S fabricated box or in aluminium casing. The Response Indicator shall glow clearly in case the detector to which it is connected gives an alarm signal. The word "FIRE" shall be clearly written on the visible face of the box. There shall be two numbers of red LEDs to compensate for fusing of either LED.

10.17 Repeater Panel

10.17.1 The Repeater Panel shall be provided with an LCD Display Unit of 2 lines of 40 characters that shall provide alpha numeric information on the fire / fault signal with zone number.

10.17.2 For accessing the LCD display a keypad operation shall be provided. The keypad shall have Help Menu and other functions controlled from either Function Keys or by a combination of keypad numbers. By using the Keypad one can scroll through the event list for at least a month.

10.17.3 The Processor shall be rugged with non-volatile memory. Due to voltage fluctuations and change from normal to standby current there shall be no variation in the software or programmed logic sequence. The Repeater Panel shall be provided with a Buzzer / Sounder to indicate Alarm, which shall generate automatically in case of an alarm in the area to which the Repeater Panel is connected / programmed.

10.18 Addressable Input / Interface Module

10.18.1 The Input Module shall be used to receive signals from the NO / NC contacts such as Flow Switches. They shall also be able to be connected directly to a batch of Conventional Detectors and shall power the conventional detectors through it. Power Supply Unit, if necessary, shall be included in the cost of the Input Module itself. Power Supply Unit shall include Rectifier and Step Down Transformer, as applicable.

10.19 Personal Computer

10.19.1 The P C shall be a personal computer (PC) based central, with full 32 bit processor (Intel Pentium Core 4 Duo or higher), 2.4 GHz minimum clock speed, minimum of 8 GB of RAM, 40 GB ESDI hard disk drive, 19" TFT Monitor, high performance video graphics array (VGA) driver, high speed DVD-R/RW and all other miscellaneous components to meet the highest specifications. Notwithstanding the foregoing guidelines, the Work Station shall be to the latest state-of-the-art performance for similar systems and shall be operated by the use of an optical mouse connected to the station without the need of keyboard entry.

10.19.2 The PC shall be configured such that external media of any kind may not be loadable at Operator level which could pose the threat of external virus infection or compromise the operating system.

10.19.3 A Keyboard having 101-keys which includes f such listing is in e ull upper/lower case ASCII keyset, a numeric keypad, dedicated cursor control keypad, and a minimum of 30 programmable function keys.

10.20 Telephone Exchange

10.20.1 An EPABX shall be used to communicate between the different floors and the Fire Control Room. The works shall comprise the supply, delivery, installation and commissioning of a PABX System including the Exchange, telephone set, all interconnecting cables, and back-up batteries, charger and associated works.

10.20.2 The system shall be fully digital and employ stored program control, distributed processing, universal port. The equipment shall be modular in design with all components mounted on printed circuit boards (PCBs) which can be easily inserted into and removed from their respective positions in the equipment.

10.21 Amplifier

- 10.21.1 The Amplifier shall be of 2 x 240 Watts capacity. All terminals shall be soldered firmly on to solder tags or terminated on good quality connector strips. The Amplifiers shall be Multi Channel Mixing type and capable of running on 240 V AC or 12 / 24 V DC. The Amplifier shall have Dual Tone Control, Level Indicators and cater to complete frequency range.

- 10.21.2 The Amplifier shall be Rack Mounted within the housing of the Fire Alarm Panel. It shall have Microphone Channel Volume Control, Microphone / Auxiliary Selector, Volume, Bass and Treble Control with LED type level Bargraph. It shall be provided with 2 Channels.

- 10.21.3 The Audio Signal Quality shall have a Frequency Response from 80 Hz to 20,000 Hz. Distortion shall be less than 5 %.

LIST OF APPROVED MAKES

SECTION - A (CIVIL WORKS)

NOTE : THE CONTRACTOR SHALL QUOTE HIS RATES ON THE BASIS OF THE PRICE OF BEST QUALITY PRODUCT OF THE BRAND / MAKE. IN CASE ANY PARTICULAR BRAND OF ITEM IS NOT ACCEPTABLE TO THE CLIENT, THE CONTRACTOR SHALL SUPPLY ITEMS OF OTHER APPROVED BRANDS AT NO EXTRA COST.

SL. NO.	MATERIAL		MAKES/MANUFACTURER
1.	CONCRETE ADDITIVE	:	SIKA / STP /CICO TECHNOLOGIES LTD. / PIDILITE / FOSROC / FAIRMATE / MC BOUCHEMIE / CHOKESY / BASF
2.	ADHESIVE FOR DOOR WORK	:	FEVICOL / VAMICOL / DUNLOP
3.	DASH FASTENERS	:	HILTI / FISCHER / BOSCH
4.	DOOR LOCKS	:	GODREJ / HARRISON / LINK
5.	FIXTURES / FITTINGS FOR ALUMINUM DOORS AND WINDOWS	:	EVERLITE / ARGENT / CLASSIC / CROWN / EARL BIHARI
6.	BITUMASTIC FIBRE BOARD	:	SHALIMAR TAR PRODUCT / FOSROC / BASF
7.	EXPANSION JOINT SYSTEM	:	HERCULES / J. SONS / KANTAFLEX
8.	FIRE DOORS	:	NAVAIR/ SHAKTI - MET DOR/ GODREJ
9.	FLUSH DOOR SHUTTERS	:	DURO / GREENPLY / CENTURY
10.	STAINLESS STEEL HARDWARE	:	ARKAY/ GODREJ/ D-LINE/ CARL-F
11.	LAMINATES	:	DURO / CENTURY / GREENLAM / FORMICA / DECOLAM/ EURO

SL. NO.	MATERIAL	MAKES/MANUFACTURER
12.	PLYWOOD / BLOCKBOARD / PLY BOARD	: DURO / GREENPLY / CENTURY / KITPLY / GREENLAM / NOVAPAN / MARRINO / GREENPLY / EURO
13.	PRE-LAMINATED PARTICLE BOARD	: ANCHOR / NOVAPAN / CENTURY / GREEN PLY / ARCHIDPLY
14.	PVC CONTINUOUS FILLET FOR PERIPHERY PACKING OF GLAZINGS / STRUCTURAL / GLAZINGS	: ROOP / ANAND / FOREX PLASTIC / NAGALIA
15.	STAINLESS STEEL BOLTS / WASHERS / NUTS & SCREWS	: KUNDAN/ PUJA/ ATULI
16.	STAINLESS STEEL FRICTION / SPRING HINGES	: EARL BIHARI / SECURISTYLE / EBCO / ARKAY
17.	M.S. PIPE	: JINDAL / PRAKASH-SURYA / KALINGA / TATA / TT SWASTIK
18.	CERAMIC TILES	: JOHNSON / SOMANY / KAJARIA / SPARTEK / NITCO / ORIENT / BELL CERAMICS
19.	ADHESIVE FOR TILES	: CICO TECHNOLOGIES LTD. / BELL / PIDILITE / BALENDURA / BASF / SIKA / FAIRMATE
20.	COMPRESSED CHEQUERED TILES	: JOHNSON / SOMANY / KAJARIA / SPARTEK / NITCO / ORIENT / BELL /SCORPIO /ULTRA
21.	VITRIFIED TILES	: NITCO / NAVEEN / BELL / H.R. JOHNSON / KAJARIA / SOMANY / EURO
22.	ROCKWOOL / MINERAL WOOL / PUF	: M/S LLOYD INSULATIONS INDIA LTD. / MALARPUR ENTECH / ARMACELL

SL. NO.	MATERIAL	MAKES/MANUFACTURER
23.	WATER PROOFING MATERIAL	: SHALIMAR TAR PRODUCTS / IWL (INDIA) LTD. / LLOYD INSULATIONS INDIA LTD. / CHEMISOL ADHESIVE PVT. LTD. MUMBAI / INDIAN WATER PROOFING / OVERSEAS WATER PROOFING / (CHEMISTIK) TEXAS LTD. / FOSROC / SIKA / CICO TECHNOLOGIES LTD. / MC BOUCHEME / BASF
24.	METAL SHEET ROOFING	: M/S LLOYD INSULATIONS INDIA LTD. / M/S KIRBY / M/S TATA BLUE SCOPE / M/S INTER ARCH / KARTHIK ROOFINGS
25.	DRY DISTEMPER	:
26.	OIL BOUND DISTEMPER/ACRYLIC WASHABLE DISTEMPER	:
27.	OTHER PAINTS / PRIMER	: ICI / BERGER / ASIAN / SHALIMAR / NEROLAC / JOHNSON & NICHOLSON
28.	PLASTIC EMULSION PAINT	:
29.	SYNTHETIC ENAMEL PAINTS	:
30.	RESIN BASED PAINTS	:
31.	EXTERNAL EMULSION PAINT	:
32.	TEXTURE PAINT	: BERGER / J & N / SPECTRUM / ASIAN / SHALIMAR / ICI
33.	CLEAR GLASS / CLEAR FLOAT GLASS / TOUGHENED GLASS	: MODI / SAINT GOBAIN (SG) / ASAHI INDIA / GSC / ATUL

SL. NO.	MATERIAL		MAKES/MANUFACTURER
34.	GYPSUM FALSE CEILING	:	INDIA GYPSUM / LAFFARGE / ST. GOBAIN
35.	POLYSULPHIDE SEALANT	:	PIDILITE / FOSROC / CHOKSEY / CICO TECHNOLOGIES LTD / SIKA / MC BOUCHEMIE / BASF /FAIR MATE
36.	ALUMINIUM EXTRUSIONS	:	INDAL / HINDALCO / JINDAL.
37.	ALUMINIUM FABRICATORS	:	M/S INTERNATIONAL GLASS HOUSE / M/S AGV ALFA LAB LTD. / M/S CONSOLIDATED ENGG. COMPANY/ M/S AJIT (INDIA) PVT. LTD. / KALCO / ALKARMA / M/S G-FAB PVT. LTD.
38.	DOOR CLOSER / FLOOR SPRING	:	DOORKING /EVERITE / HARDWYN / MASTER / SPECIFY LOCCALC
39.	CEMENT	:	ACC (ASSOCIATED CEMENT CO.) / L&T / AMBUJA CEMENT / BIRLA CORP. LTD. JK CEMENT / GRASIM CEMENT / SHREE CEMENT / CENTURY / PRISM / INDIA CEMENT / BINANI /RAMCO
40.	READY MIX CONCRETE	:	POABSONS /PTC
41.	STEEL REINFORCEMENT RODS	:	SAIL / RASHTRIYA ISPAT NIGAM LTD. / TISCO / IISCO /JINDAL
42.	CALCIUM SILICATE BOARDS	:	HILUX / AEROLITE
43.	CALCIUM SILICATE TILES	:	AEROLITE / HILUX.
44.	E.P.D.M. GASKETS	:	ANAND REDDIPLEX / ENVIRO SEALS

SL. NO.	MATERIAL		MAKES/MANUFACTURER
45.	SILICON SEALANTS (I) WEATHER SEALANT (II) STRUCTURAL GLAZING SEALANT	:	GE-SILICON / PIDILITE /CHOKSEY / WACKER / FORSOC / DOW CORNING / SIKA
46.	WHITE CEMENT	:	BIRLA WHITE/ J.K. / GRASIM
47.	MICRO PERFORATED GFR (GLASS FIBER REINFORCED)	:	SAINT GOBAIN / ANUTONE

SECTION - B (PLUMBING WORKS)

NOTE : THE ENGINEER RESERVES THE RIGHT TO SELECT ANY OF THE BRANDS INDICATED IN THE LIST OF APPROVED MAKES. THE TENDERER SHALL QUOTE HIS RATES ON THE BASIS OF THE PRICE OF BEST QUALITY PRODUCT OF THE BRAND/MAKE STIPULATED IN THE ITEM OF WORKS AS DESCRIBED IN BOQ & SPECIFICATION AS WELL AS IN THE LIST OF APPROVED MAKE. THE CONTRACTOR CANNOT CLAIM ANYTHING EXTRA IF THE OWNER CHANGES THE MAKE BUT WITHIN THE LIST OF APPROVED MAKE.

SL. NO.	ITEMS	MAKES/MANUFACTURER
1.	VITREOUS CHINA SANITARYWARE	HINDWARE / PARRYWARE / CERA
2.	W.C. SEATS & COVER	HINDWARE / PARRYWARE / COMMANDER / CERA
3.	HANDICAPPED TOILET	HINDWARE / PARRYWARE / COMMANDER / CERA
4.	STAINLESS STEEL SINKS	JAYNA / KINGSTON / NEELKANTH / NIRALI
5.	C. P. FITTINGS & ACCESSORIES & FLUSH VALVES	JAQUAR / PARKO / KINGSTON / HINDWARE / ESS-ESS
6.	LIQUID SOAP DISPENSER	CHILLY / EURONICS / CAMRY / UTEC / KOPAL
7.	SENSOR OPERATED AUTO FLUSHING SYSTEM FOR URINALS	JAQUAR / AOS SYSTEMS / ANGASH / EURONICS / UTEC
8.	HAND DRIER	KOPAL / EURONICS / UTEC

SL. NO.	ITEMS		MAKES/MANUFACTURER
9.	SOIL, WASTE, RAIN WATER PIPES & FITTINGS :		
10.	SWR UPVC PIPES & FITTINGS	:	SUPREME / KISAN / AJAY / ASTRAL / FINOLEX
11.	DUCTILE IRON PIPES (IS:8329)	:	ELECTROSTEEL / KESORAM / JINDAL
12.	DUCTILE IRON FITTINGS (IS:9523)	:	ELECTROSTEEL / KESORAM / JINDAL / KARTAR
13.	RCC PIPES	:	INDIAN HUME PIPE / PRAGATI CONCRETE UDYOG / ISI MARKED PIPES
14.	G.I. PIPES UPTO 150 MM	:	TATA / JINDAL / HISSAR / PRAKASH SURYA
15.	G.I. FITTINGS MALLEABLE CAST IRON	:	R/KS / UNIK / ZOLOTO
16.	CPVC PIPES & FITTINGS FOR INTERNAL & EXTERNAL SUPPLY	:	ASTRAL / ASHIRWAD / SUPREME
17.	UPVC PIPES CONFORMING TO IS:4985 - 2000	:	SUPREME / FINOLEX / KISAN / ASTRAL
18.	GUN METAL VALVES (FULLWAY, CHECK AND GLOBE VALVES)	:	ZOLOTO / LEADER / SANT / KARTAR / ATAM / ELEM
19.	C.I. VALVES (FULLWAY, CHECK AND GLOBE VALVES)	:	ZOLOTO / KIRLOSKAR / SANT / CASTLE / KARTAR / ATAM
20.	BALL COCKS, CHECK & FOOT VALVE, PRV, AIR VALVE	:	GPA / SANT / L & K / TBS / ZOLOTO / ATAM

SL. NO.	ITEMS		MAKES/MANUFACTURER
21.	STONEWARE PIPES & GULLY TRAPS	:	PERFECT / BURN / HIND / RK
22.	C.I. MANHOLES COVERS AND FRAME	:	NECO / R.I.F. / B.C. / NEER / HEPCO / SKF
23.	STAINLESS STEEL / C P GRATING	:	CHILLY / CAMRY / JAYNA
24.	COCKROACH TRAPS	:	CHILLY / CAMRY / JAYNA
25.	RCC / SFRC MANHOLE COVERS / PRECAST RCC GRATING	:	KK / S K PRECAST CONCRETE / ADVENT CONCRETOVISION
26.	PVC - U PIPES FOR SEWERAGE AND DRAINAGE CONFORMING TO IS : 15328 : 2003 AND ISI MARKED	:	SUPREME / FINOLEX / KISAN / ASTRAL
27.	MIRROR	:	ATUL / MODI GUARD / GOLDEN FISH / SAINT GOBAIN
28.	WATER COOLERS	:	BLUE STAR / VOLTAS / USHA
29.	WATER HEATER	:	RACOLD / VENUS / BAJAJ / SPHEREHOT / AO SMITH (JAQUAR)
30.	WATER FILTER / PURIFIER	:	AQUAGUARD
31.	HIGH DENSITY POLYETHYLENE (HDPE) WATER STORAGE TANK	:	SINTEX / ROTEX / FUSION / PLASTO / POLYCON
32.	WATER METERS	:	CAPSTAN / KRANTI / ANAND

SL. NO.	ITEMS		MAKES/MANUFACTURER
33.	PUMPS & MOTORS	:	
a)	ELECTRIC MOTORS	:	KIRLOSKAR / BHARAT BIJLEE / CROMPTON / SIEMENS
b)	CENTRIFUGAL PUMPS	:	KIRLOSKAR / LUBI / KSB / MATHER & PLATT
c)	SUBMERSIBLE DRAINAGE PUMPS	:	GRUNDFOS / LUBI / KSB
d)	METERING PUMPS	:	MILTON ROY / PENTAIR / PROMINENT
34.	ELECTRICAL	:	
a)	CONTROL PANEL	:	ANY CPRI APPROVED VENDER
b)	AUXILIARY RELAYS / CONTRACTORS	:	L & T / SIEMENS / CUTLER HAMMER / ENGLISH ELECTRICAL
c)	PUSH BUTTONS	:	L & T / SIEMENS / CUTLER HAMMER
d)	OVERLOAD RELAY	:	L & T / SIEMENS / GE / SCHNEIDER
e)	INDICATING LAMPS	:	L & T / SIEMENS / VAISHNAV
f)	SELECTOR SWITCHES	:	L & T / JAY / KEYCEE
g)	LINE TYPE FUSE	:	L & T / ENGLISH ELECTRICAL / SIEMENS
h)	TIMER	:	L & T / SIEMENS / GE / SCHNEIDER
i)	ANALOG METERS	:	L & T / RISHAB / AE / MECO
j)	DIGITAL METERS	:	L & T / RISHAV / AE/MECO / GE
k)	LEVEL CONTROLLER	:	MINILEC / PUNE TECTROL

SL. NO.	ITEMS		MAKES/MANUFACTURER
l)	POWER CABLES	:	FORT GLOSTER / ICL / NATIONAL / HAVELLS / HVPL
m)	CONTROL CABLES	:	HAVELLS / KEI / GLOSTER / UNIVERSAL / NATIONAL / CCI
n)	CABLE TRAY	:	SLOTCO / PILCO / EQ.
35.	M.S. PIPES UPTO 200 MM	:	JINDAL / PRAKASH SURYA / TATA
36.	VALVES & ACCESSORIES	:	
a)	C.I. BUTTERFLY VALVES	:	AUDCO / KSB / CRANE
b)	C.I. Y STRAINERS	:	SANT / ZOLOTO / ADVANCE
c)	PIPE STRAINERS	:	ENVIROTECH UTILITY / STRAINWELL / BHATIA
d)	WATER METER	:	ZENNER / AQUAMET / CAPSTON / ANAND
e)	PRESURE GAUGE	:	H-GURU / FIEBIG / WAREE
f)	FLEXIBLE PIPE CONNECTOR	:	KANWAL / EASYFLEX
g)	FLOW METER	:	FLOWSTAR / FLOWTECH / SCIENTIFIC DEVICE
37.	AIR BLOWER	:	EVERST / KAY / SWAM
38.	MULTI GRADE SAND FILTER	:	ENVIROTECH UTILITY / ION EXCHANGE / SEPRATECH
39.	ACTIVATED CARBON FILTER	:	ENVIROTECH UTILITY / ION EXCHANGE / SEPRATECH
40.	U V SYSTEM	:	SUKRUT / ALFAA

SECTION - C (ELECTRICAL WORKS)

NOTE : THE OWNER RESERVES THE RIGHT TO SELECT ANY OF THE BRANDS INDICATED IN THE 'LIST OF APPROVED MAKES'. THE TENDERER SHALL QUOTE HIS RATES ON THE BASIS OF THE PRICE OF THE BRAND/MAKE STIPULATED IN THE ITEM OF WORKS AS DESCRIBED IN BOQ & SPECIFICATION AS WELL AS IN THE LIST OF APPROVED MAKE. THE CONTRACTOR CANNOT CLAIM ANYTHING EXTRA IF THE OWNER CHANGES THE MAKE BUT WITHIN THE LIST OF APPROVED MAKE, BEFORE PLACING THE ORDER. ORDER OF THE MAKES IS NOT PREFERENTIAL. FINAL CHOICE OF MAKES LIES WITH THE EMPLOYER. ALL MATERIALS SHALL BE WITH ISI MARK. CONTRACTOR SHALL GET MAKES APPROVED BEFORE PROCUREMENT.

SL. NO.	MATERIAL	MAKES/MANUFACTURER
1.	VOLTMETER AND AMMETER	: AE / MECO / UNIVERSAL / RISHAB / ENERSOL
2.	SELECTOR SWITCH, PUSH BUTTONS, EMERGENCY SWITCHES	: KAYCEE / L & T / GE / BCH
3.	CURRENT TRANSFORMER	: AE / KAPPA / PRECISE / ADVANCE / GILBERT MAXWELL / INDCOIL
4.	HRC FUSES	: L & T / GE / SIEMENS / ABB
5.	MCB	: L & T (HAGER) / SCHNEIDER - (MULTI9) / SIEMENS - (BETAGARD) / ABB (S - 270 RANGE) / LEGRAND (LEXIC)
6.	MAIN / SUB DISTRIBUTION BOARD	: L & T (HAGER) / SCHNEIDER / SIEMENS / ABB / LEGRAND
7.	RCBO	: L & T (HAGER) / SCHNEIDER / SIEMENS / ABB / LEGRAND (LEXIC)

SL. NO.	MATERIAL	MAKES/MANUFACTURER
8.	FRLS PVC INSULATED COPPER CONDUCTOR SINGLE / MULTI CORE STRANDED WIRES OF 650 / 1100 VOLT GRADE	: L & T / FINOLEX / PARAGON (ELEKTRON) / SKYTONE / BATRA HENLEY / POLYCAB
9.	TELEPHONE WIRES	: SKYTONE / FINOLEX / BELDEN / HAVELLS / BATRA HENLEY
10.	TELEPHONE TAG BLOCK	: TVS R & M / KRONE
11.	MS CONDUIT / PVC CONDUIT	: BEC / AKG / ATUL PIPE
12.	SWITCHES, TV & TELEPHONE SOCKET OUTLETS, BOXES (MODULAR TYPE) (RJ - 11, RJ - 45)	: LEGRAND (MOSAIC) / SIEMENS (DELTA VEGA) / MK (WRAPAROUND)
13.	CEILING FAN / WALL BRACKET FANS	: HAVELLS / ALMONARD / BAJAJ
14.	EXHAUST FAN	: HAVELLS / ALMONARD / BAJAJ
15.	TERMINAL BLOCKS / CAGE CLAMP / CONNECTORS	: WAGO & CONTROLS / PHOENIX CONTACTS
16.	LIGHTNING PROTECTION	: DUVAL MESSIEN / SOUTH ASIAN ENTERPRISE LTD. / DEHN INDIA PVT. LTD.
17.	TRANSIENT VOLTAGE SURGE SUPPRESSOR	: PHOENIX / SIEMENS / DEHN

SL. NO.	MATERIAL	MAKES/MANUFACTURER
18.	FLOOR TRUNKING / WALL CHANNELS	: MK / LEGRAND / NEXO
19.	MULTI - FUNCTION METER	: ABB / SIEMENS / L & T / ENERSOL
20.	LIGHT FIXTURES	: PHILIPS / BAJAJ / TRILUX / SCHREDER
21.	LAMPS & TUBES	: OSRAM / PHILIPS / CROMPTON GREAVES
22.	ENERGY METER	: CONZERV (EM 6400 WITH MD) / HAVELLS / HPL SOCOMEC / SIEMENS (PAC) / SCHNEIDER (PM810)
23.	CONTACTORS	: L & T / SCHNEIDER - TESYS / SIEMENS / ABB (A RANGE)
24.	STARTER	: L&T / SIEMENS/ABB/ SCHNEIDER / LEGRAND
25.	MOULDED CASE CIRCUIT BREAKER	: L&T(D SHINE) / SIEMENS (SENTRON) / SCHNEIDER COMPACT - NS / ABB (TMAX) / LEGRAND (DPX)
26.	PUSH BUTTONS	: ABB / SIEMENS / L&T / TELEMECHANIQUE / SCHNEIDER
27.	PROTECTION RELAYS	: ABB / AREVA / L&T / SCHNEIDER / SIEMENS
28.	TIMERS	: ABB / SIEMENS / L&T / TELEMECHANIQUE / GE
29.	INDICATING LIGHTS	: ABB / SIEMENS / L&T / AE / VAISHNAV / SCHNEIDER
30.	INDICATING INSTRUMENTS	: RISHABH / CONSERVE / L&T / YOKINS INSTRUMENTS / ENERCON

31.	KWH METERS	:	HPL INDIA (SOCOMAC) / L&T / CONSERVE / SECURE / YOKINS INSTRUMENTS
32.	LT CABLE	:	CABLE CORPORATION OF INDIA / UNIVERSAL / GLOSTER / FINOLEX / GEMSCAB
33.	CABLE GLANDS	:	DOWELS / CROMPTION / BICO / SIEMENS / COMET / RAYCHEM
34.	SELECTOR SWITCH	:	KAYCEE / L&T / SIEMENS / BCH / GE
35.	BATTERY	:	EXIDE / STANDARD / AMCO / HBL - NIFE / PANASONIC / CUMINS PULSELITE
36.	BATTERY CHARGER	:	VOLSTAT / AMARARAJA / CHHABBI / CALDYNE / LABOTECK / JAKSON
37.	REACTORS	:	EPCOS / ABB / L&T / DUCTI
38.	THYRISTORS	:	EPCOS / ABB / L&T / DUCTI
39.	TRIVECTOR METRE	:	L&T / DUCATI / CONSERVE / SECURE / SCHNEIDER
40.	POWER FACTOR CORRECTION RELAY	:	EPCOS / L&T / NEPTUNE - DUCATI / GE / SCHNEIDER
41.	RUBBER MAT	:	PREMIER POLYFILM LTD. / POLY ELECTROSAFE / CHALLENGER
42.	LT PANEL	:	ADVANCE PANELS & SWITCHGEAR PVT. LTD. / SIEMENS / ABB
43.	CTS & PTS	:	KAPPA / L&T / AREVA / MATRIX / ADVANCE PANELS & SWITCHGEAR PVT. LTD. / ANANT POWER

44.	TERMINATION KIT	:	CABSEAL / 3M / RAYCHEM / DENSON
45.	CABLE TRAYS	:	LEGRAND CABLOFIL / OBO BETTERMANN / GEWISS / INDIANA / SLOTCO / MEM / VENUS / CTM ENGINEERING
46.	CABLE LUGS	:	DOWEL / CROMPTION / BICO / SIEMENS / COMET / CABSEAL
47.	OCTAGONAL / ORNAMENTAL POLE (G.I.)	:	BAJAJ / SURYA / TRANSRAIL LIGHTING LTD. (TLL) / SCHREDER
48.	HDPE PIPE	:	DURA LINE / CARLON / EMTELLE
49.	LIFT	:	KONE/OTIS/ JOHNSON
50.	ALL OTHER ITEMS NOT COVERED ABOVE	:	AS PER SAMPLE APPROVED

SECTION - D (HVAC WORKS)

NOTE : *The tenderer shall quote his rates on the basis of the price of the brand/make stipulated in the item of works as described in BOQ and specification as well as in the approved makes. The owner reserves the right to select any of the brands indicated in the "List of Approved Makes/Agency" in case of delay in delivery of ordered "make of item". The contractor cannot claim anything extra for the same.*

Sl. No.	Items	Approved Makes
1.	Ventilation Fans	
1.1	Centrifugal Fans	Kruger, Nicotra, System Air
1.2	Inline Fans	Kruger, System Air
1.3	Propeller fans	Crompton Greaves, Kruger, Systemair
1.4	Air Scrubber	Airflow, Edgetech, Roots Cooling, Systemair
2.	Hi-Wall Split Unit	Bluestar, Carrier, Daikin
3.	GI Sheets	HSL, Jindal (HISSAR), SAIL, TATA
3.1	Factory Fabricated Duct	Ecoduct, Rola Star, Seven Star, Zeco
3.2	Flexible Duct	Atco, Ecoduct, Ruskin Titus
4.	Copper pipe	Mandev, Mexflow, Rajco, Total-line
5.	Grilles/ Diffusers/ Louvers/ Dampers	Air master, Ravistar, Ruskin Titus
6.	Fire Dampers	Air master, Dynacraft, Ravistar, Ruskin Titus
7.	Open & Closed Cell Nitrile Rubber Insulation	Armacell, K-flex
8.	Poly isocynurate Insulation	Lloyd Insulations, Malanpur Entech
9.	Air Filters	AAF, Puromatic, Spectrum, Thermadyne

Sl. No.	Items	Approved Makes
10.	'V' belts / Pulley	Dunlop, Fenner
11.	Electric Motors	ABB, Areva, BBL, Crompton, Kirlosker, NGEF, Siemens
12.	Starters/Switches/ Contactors	ABB, Cutler-hammer, GE, L&T, Siemens
13.	Switch Board	Advance, EAP, KEPL, Tricolite
14.	ACB/MCCB/MCB	ABB, GE, L&T, Schneider, Siemens
15.	Cables	
15.1	Power Cables	CCI, Finolex, Gloster, Grandlay, Universal
15.2	Control Cables	Asian, Finolex, Grandlay, Gloster, Universal
16.	Single Phase Preventer	ABB, GE, L&T, Minilac, Siemens
17.	Thermal Relay	GE, L&T, Siemens
18.	Lamps	BCH, GE, L&T, Siemens, Technic
19.	Lugs	Dowell, Jainsons, Lotus
20.	Relays/ Push buttons	BCH, L&T, Siemens, Technic
21.	Current Transformer/ Ammeter/ Voltmeter	Automatic Electric, Kappa, Kaycee Rishab, Indcoil, Precise, L&T
22.	Cable Trays	Indiana, MEM, Profeb, Steelite
23.	PVC Conduits	Fusion Polymer, Geoflex
24.	Time delay relay/ Limit Switch	BCH, GE, L&T, Siemen's
25.	Thermostat	Anergy, Honeywell, Johnson Control, Siemens
26.	Vibration Isolators	Dunlop, Emerald, Resistoflex

SECTION - E (FIRE-FIGHTING WORKS)

NOTE : *Before supply of materials the Contractor shall have the make approved by the Owner.*

Sl. No.	Items	Approved Makes
1.	Pipes (M S / G I)	Tata / Jindal Hissar.
2.	Ductile Pipes	Electrosteel / Lanco.
3.	Hydrant valves, four way Fire Brigade inlet & shut off nozzle	Newage / Minimax / Eversafe
4.	Rubber pipe for hose reel	Gates / Jyoti.
5.	Sluice & non return valves.	Kirloskar / Kalpana /Kartar.
6.	Pressure switch.	Indfoss / Switzer.
7.	Pressure Gauges.	BRC / HD.
8.	Pump.	Mather & Platt / Kirloskar / Grundfos
9.	Motor.	ABB / Siemens / Crompton Greaves / Kirloskar.
10.	Enamel Painting of pipes etc.	Asian / Goodlas Nerolac / ICI / Berger.
11.	Paint Primer.	Asian / Jenson Nicholson / Berger.
12.	Fasteners.	Hilti / Fischer.
13.	Weld Rods.	Advani / Esab.
14.	Ball Valves.	RB (Italy) / Bugatti / Zoloto/ Cim.

Sl. No.	Items	Approved Makes
15.	Butterfly Valve.	Audco (PN 1.6)
16.	Fire Extinguishers. (Water type / 50 Kg DCP / Ceiling mounted DCP / AFFF)	Minimax / Ceasefie
17.	Fire Extinguishers (ABC / CO ₂)	Minimax / Ceasefire.
18.	Hose.	Newage / CRC./ eversafe
19.	Rubber Gaskets	C I C / Varuna.
20.	Engine.	Cummins / Caterpillar / KOEL.
21.	Hose Drum.	Newage/ Eversafe
22.	Mechanical Seal.	Durametallic/ Sealol.
23.	Strainer.	Emerald / Grandprix.
24.	Wafer type Non Return Valves	C & R / Advance.
25.	Passive Fire Protection Materials	Promat / Hilti / Ace.
26.	Neulite Branch Pipe	Newage / Minimax.
27.	Nuts & Bolts	Lakshmi / Unbrako.
28.	Signages	Prolite.
29.	Air Vessel	Locally fabricated

ELECTRICAL

Sl. No.	Items	Approved Makes
1.	Power Cables.	Skytone / Finolex / Polycab..
2.	Conduit ERW (ISI marked).	BEC / AKG.
3.	Contactors & Overload Relays.	L&T / Siemens / GE Power.
4.	Fuse link.	Siemens / L&T / GE Power / C & S.
5.	Voltmeter/Ammeter.	L&T / AE / IMP.
6.	CT/PT Transformer.	AE / Kappa / C & S.
7.	S.F. Unit.	L&T / Siemens / GE / Controls & Switchgear.
8.	Cable Trays.	Slotco / Pilco.
9.	Indicating Lamps	L & T / Siemens / GE Power.
10.	Electrical Pump Panels	Advance / Diamond / Risha

FIRE ALARM

Sl. No.	Items	Approved Makes
1.	Addressable Networkable Panel	Honeywell / Siemens / Esser / Cooper / Morley / Tyco / Notifier
2.	Intelligent Addressable Smoke Detectors Optical Type + Multi criteria	Honeywell / Siemens / Esser / Cooper / Morley / Tyco / Notifier
3.	Intelligent Addressable Rate of Rise Heat Detector	Honeywell / Siemens / Esser / Cooper / Morley / Notifier
4.	Control Cable	Polycab / KEI / Skytone / Lapp
5.	Addressable Duct Detector Unit	As per (1) above.
6.	Input / Output Modules	By Parent Company Manufacturing Detectors / Panel
7.	Manual Call Box	By Parent Company Manufacturing Detectors / Panel.
8.	Strobe.	UL Listed.
9.	PC / Monitor / keyboard	HP / Dell.
10.	PA System	Bosch / Ahuja / Aural.
11.	Response Indicator	Agni / GAC.