

ANNEXURE-E1 TECHNICAL SPECIFICATION

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CIVIL WORKS

MATERIAL & WORKMANSHIP

I. GENERAL

Materials and Workmanship Specifications

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The specifications listed in this Part of the Employer's Requirements may be modified by the Tenderer at the time of submitting the Tender to suit the requirements of the Tenderer's design. Any such modifications shall be submitted with the Tender.

When considering any changes, it shall be noted that the specifications given in this Part shall represent the minimum required standards for material and workmanship to be followed in the construction of the works.

Where there is any discrepancy between this Part 4 of Employer's Requirements and either Part 2 or Part 3 of the Employer's Requirements, the requirements of Part 2 and Part 3 shall take precedence.

Standard of Works

The whole of the materials employed in connection with the permanent work of the Contract shall be new and of the best quality and description of their respective kinds and, except where otherwise called for, shall be of the highest grade described in Indian or other relevant Standards for such materials and shall be tested as prescribed therein; similarly, the workmanship in every case shall be of the best character, and the whole shall be subject to the approval of the Engineer.

Standards & Code

Any Indian, British, American or other International Standard or Code of Practice referred to in the documents relating to the Contract shall be held to be the latest edition published at the time of Tender. Where alternative Standards or Codes of Practice have been published in metric units, these shall take precedence over the publication in imperial units.

Equivalent Standards

- a) Subject to the approval of the Engineer, materials may be supplied conforming with other recognised Standards which correspond closely with the relevant Specified Standards.
- b) In the event that the Contractor proposes use of an alternative Standard he shall provide to the Engineer a copy of the Standard proposed together with an authoritative translation into English where the original is in a language other than English.

Alternative Materials & Equipment

- a) In all cases where the name of a particular type or make of equipment or material is referred to on the Drawings or elsewhere in this Specification, this is intended to indicate only the acceptable standard.
- b) The Contractor may offer alternative materials to equipment to that specified and in all such cases the Contractor's offer shall be at least of equal quality. When alternatives are offered the Contractor shall submit to the Engineer for approval, a statement detailing the alternative(s) and shall include full technical descriptions, drawings, specifications, test certificates etc and shall provide such full information as is required to enable the Contractor to demonstrate to the Engineer that the alternative(s) is (are) equivalent to the item specified. Any further information that the Engineer may require shall be produced by the Contractor when called for.

Approval of Materials & Items of Equipment

- a) As soon as possible after the Contract has been awarded, the Contractor shall submit to the Engineer a list of suppliers from whom he proposes to purchase the materials required for the Works. Each supplier must be willing to admit the Engineer, or his representative, to his premises during ordinary working hours for the purpose of obtaining samples or inspection of the works and processes. In addition, if required by the Engineer, the Contractor shall deliver samples to the offices of the Engineer or to nominated testing laboratories or to the site of the Works. The cost of such samples shall be borne by the Contractor.

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- b) The Contractor shall provide at least the following information when seeking approval of materials and items of equipment.
 - A Description of the material/item
 - Name of proposed supplier
 - Indian Standard, or other approved Standard applicable
 - Test Certificates as applicable
- c) The Contractor shall use locally produced materials in preference to imported providing they comply with the requirements of the Specification.

Supply of Samples

- a) The whole cost of supplying adequate samples of any materials to be used in the Works for testing either at the Manufacturer's Works or at the site or at an independent Laboratory nominated by the Engineer, shall be deemed to be included in the rates or sums entered in the Price Schedule.
- b) Samples shall be taken at regular intervals and tested in accordance with relevant standards.

Material – General

- a) Sources of supply :
- b) The sources of supply of materials shall not be changed from those approved without the written permission of the Engineer.
- c) Quality of supply :
- d) Materials subsequently supplied shall be at least equal to the approved sample in all respects.
- e) Rejected materials :
- f) Rejected materials are to be removed promptly from the Site.
- g) Copies of orders :
- h) The Contractor shall, at the Engineer's request, forward to the Engineer copies of orders for materials to be incorporated into the Works.
- i) Manufacturers instructions :
- j) All materials, goods etc., shall be used or installed in accordance with the instructions of the Manufacturer or Supplier unless otherwise specified or instructed by the Engineer.

Testing of Samples

- a) At the Manufacturer's Works :
- b) The costs of testing at Manufacturer's Works of any materials to be used in the Works and the supply of "proof" or test certificates by the Manufacturer shall be deemed to be included in the rates or sums entered in the Price Schedule.
- c) At an Independent Laboratory :
- d) In addition to those tests required by the Employer's Requirements and relevant Standards, the Engineer may at any time instruct the Contractor to supply samples of materials to be used in the Works for test by an Independent Laboratory. The costs of transport to the Independent Laboratory and laboratory charges, fees of independent inspectors, etc, shall be paid for under the appropriate item in the Price Schedule, except where a sample is found not to be in accordance with the specified requirements, in which case the costs shall be borne by the Contractor.
- e) Sampling and Testing frequency:

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The sampling and test frequencies shall be as per the relevant IS codes. Where the relevant IS code does not lay down any frequency for sampling and testing, the same shall be as given in the table below or as directed by the Engineer

II. TECHNICAL SPECIFICATIONS FOR CIVIL & FINISHING WORKS

1. TECHNICAL SPECIFICATION FOR VACUUM DEWATER FLOORING

This specification covers the method and procedure to be adopted for vacuum dewatering the concrete flooring to improve the quality of concrete floors.

The vacuum dewatering process consists of levelling, compacting and vacuum dewatering the concrete flooring by using vibrating screed, vacuum pumps, suction mats, filter pads, accessories etc. The sequence of operation shall be placing of concrete, vibration, vacuum treatment and floating and the operations shall follow immediately behind each other.

The Contractor shall have persons well experienced in the vacuum dewatering process, and in the operation of all related equipments. All process equipment to be used shall be in good working condition and shall be subject to the approval of the Engineer.

The work should be planned well in advance with a view to determine areas to be concreted daily, the required number of equipment, size of vacuum mats, length of vacuum hoses, arrangement of rails, screeds etc.

The area to be concreted shall be thoroughly cleaned, reinforcement checked and got approved by the Engineer. Then the specified grade of concrete shall be placed in position without any segregation and properly vibrated.

Immediately after placement of concrete, the vibrating screed, fixed at the proper position to achieve the required specified finished level, shall be allowed to run over the concrete on a true surface to level the concrete. For better consolidation proper surcharge of concrete should be maintained in front of the leading edge of the screed and the vibrating screed shall be allowed to move forward rapidly. The concrete surface shall be screeded high by 2% of the slab's thickness to compensate for the compaction caused by the Vacuum dewatering process. (Slabs which have an aggregate hardner shall have compensation made to maintain elevation).

Immediately after levelling, the concrete shall be covered with filter pads and suction mats in strict accordance with the recommendation of the Manufacturer to have the slab fully dewatered. The suction mat shall extend 100 mm beyond the edge of the filter pad on all sides. The pads shall extend to within 100 mm of the edges of concrete slab, and the mats shall cover entire slab. Before connecting the hose on the suction mat to the vacuum pump, the edges of the mat shall be smoothed to enable an airtight seal to be created. A vacuum shall then be applied to the mat. After a minute the gauge on the vacuum pump should indicate a minimum vacuum of 0.70 atmospheres (24.0 in Hg) and if not, the mat must be checked for leakage. For concrete that dewater readily the vacuum should then be maintained at 0.70 - 0.80 atmosphere (24.0 - 25.5 in Hg). For concrete which dewater less efficiently (eg. air-entrained concrete) the vacuum shall then be reduced to 0.50 - 0.60 atmospheres (15.0 - 18.0 in Hg). After approximately 10 minutes the vacuum can then be increased to 0.80 atmospheres.

The vacuum shall be maintained for atleast 3 minutes per 25 mm of concrete thickness at 0.80 atmospheres. (Where aggregate hardners are specified, sufficient moisture shall be maintained to meet Manufacturer's requirements). The suction mats and filter pads shall then be removed and moved to the next section in a leapfrog manner.

Stop the vacuum dewatering when light foot prints only are left in the concrete when stepped upon. A suitable suction time can also be checked with a Proctor-apparatus which should show 1.5 - 2 Kp/Sqcm.

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Upon removal of the suction mats and filter pads the concrete shall be power floated without delay until all imprints from the vacuum process are removed. If crusting occurs, the floating operation must be delayed till the concrete carries the machine.

The higher speed is recommended for the floating operation. The passes with the floating disc should be made in the junction of two mats in order to avoid risk of cracking.

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The trowelling operation cannot take place before the concrete has hardened enough to carry the machine ie. the trowelling blades will not leave any marks on the concrete. Repeated trowelling, with intervals between the passes, which are adapted to the setting of the concrete, greatly improves the surface characteristics. The surface will be more wear resistant and less dusty.

Atleast two passes are recommended for floors which are not to be covered.

Vacuum dewatered concrete should be cured like any quality concrete in order to achieve a good final result. Use curing compounds, plastic sheets or wet burlap.

The contractor has the responsibility for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

The contractor shall be required to maintain control charts showing individual test results for aggregate gradation, slump, air content, cement content and compressive strength.

2. TECHNICAL SPECIFICATION FOR SPECIALISED PAINTING WORK

ANTI CORROSIVE TREATMENT FOR STRUCTURAL STEEL

The surface shall be sand blasted to standard SSPC - SPIO (Sa 2-1/2) with surface profile not exceeding 50 microns.

First Coat :

One coat of epoxy polyimide based Red Oxide Zinc Phosphate Primer of Dry Film Thickness (DFT) 25 microns. Berger paints epilux 610 primer or equivalent should be used.

Mixing Ratio : Base : Catalyst 3:1 by volume

Application : Brush roller airless and conventional spray.

Theoretical spreading rate : 13 Sqm / Ltr.

Drying Time

Touch Dry : 1 hour

Dry to handle : 4 hours

Hard Dry : Overnight

Curing Time : 6 - 7 days

Colour : Red Oxide

Second Coat :

Shall be as per first coat given above.

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Third Coat :

One coat of Epoxy Polymide based finish - Berger paints Epilux 4, Shalimar enamel or equivalent to DFT of 35 microns. Colour should be specified by the Engineer.

Type	:	Two pack, cold cured
Composition	:	Catalyzed epoxy resin suitably pigmented
Mixing Ratio : Base	:	Catalyst 3:1 by volume
Application	:	Brush, roller, airless & conventional spray
Theoretical spreading rate	:	13 Sqm / Ltr.

Drying Time

Touch Dry	:	2 - 3 hours
Dry to handle	:	6 - 8 hours
Hard Dry	:	Overnight
Curing Time	:	6 - 7 days

Overcoating Interval

Minimum	:	Overnight
Maximum	:	5 days
Finish	:	Glossy

Fourth Coat :

Shall be as per third coat given above.

TOTAL DRY FILM THICKNESS (DFT) - 120 MICRONS.

The DFT shall be checked with Elcometer.

3. TECHNICAL SPECIFICATION FOR FRAMED PANEL CUBICLE PARTITION

Scope of works

This section of the Specification, when read in conjunction with the Tender Drawings, provides particular requirements with respect to the following:

- a) WC cubicles.
- b) Shower Cubicles.

Particular Interfaces

- a) Complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture.
- b) Ensure that all interfaces are fully co-ordinated prior to commencement.

SYSTEM DESCRIPTIONS/ TYPES

WC Cubicles

Cubicle System Type -01

ANNEXURE-E1 TECHNICAL SPECIFICATION

WC cubicle installation, in laminate finished board secretly fixed to insitu timber stud wall as shown on the Tender Drawings including front walls and doors, side walls and ironmongery including hinged doors, front pilasters, pedestals, and cubicle divisions.

Shower Cubicles

Cubicle System Type -02

WC cubicle installation, in laminate finished board secretly fixed to in situ timber stud wall as shown on the Tender Drawings including front walls and doors, side walls and ironmongery including hinged doors, front pilasters, pedestals, and cubicle divisions.

Framed Partition Panel Type -03

WC cubicle rear wall panelling installation as above.

SUBMITTALS AND TESTING

The Tender design response shall include:

- i. Samples where specified.
- i. List of Tests included.
- iii. QA/ QC programme.
- iv. List of proposed Working Drawings
- v. Outline technical specifications reflecting proposed materials/ systems, etc.
- vi. A list of proposed suppliers and sub-contractors intended to be used.

Samples, Mock-ups, Prototypes and Quality Benchmarks

Samples

Sufficient samples of the following, including relevant trade literature and technical specifications, shall be provided in accordance with Section

A. Submittals:

- a) 300mm x 300mm laminate sample in specified colour including edging and trims.
- b) Ironmongery.
- c) All visible fixings.
- d) Access panels.
- e) Supporting leg sample.

Testing

Test Requirements

Include for testing by an accredited independent testing specialist or provide independently certified test data to demonstrate compliance with the specification.

PERFORMANCE REQUIREMENTS

Comply with the general performance of Section I. Environmental Conditions and the following specific performance requirements

Structural

Movements

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It shall be ensured that works withstand movement without permanent deformation, or any reduction in their performance, caused by changes in the moisture content of their components from variations in the moisture content of the air inside the building.

Specific Dead Loads

The works shall be capable of accommodating the following dead loads without any reduction in performance.

- a) The works own dead load to be accommodated locally, and without causing deflections or movements which adversely affect any component parts.
- b) The dead loads derived from permanent fixtures or services attached to the surfaces of the works.

Specific Live Loads

The works shall be capable of accommodating the following live loads without any reduction in performance:

- a) All loads resulting from movements of the building structure.
- b) Horizontally applied loads acting on the surface of the works arising from maintenance and cleaning operations. The works shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any part of the framing.
- c) A horizontal line load applied to the works, due to the occupants, in accordance with BS 6180 and BS 6399: Part 1.
- d) Impact loads of transferred impact loads that occur during service life, without deterioration in performance and without sustaining non-repairable damage. e) Loads imposed during replacement.

Fire Performance

- a) Refer to the Fire Strategy documentation.
- b) Materials used in the works shall be classified as materials of limited combustibility.
- c) The works shall achieve a Class 0 rating when tested in accordance with BS 476: Parts 6 and 7.

Durability

- a) All materials used in the works shall have a predicted service life of 25 years minimum without the need for maintenance, other than regular cleaning.
- b) Refer to the Contract documents for warranty requirements.

Environmental

Moisture Resistance

- a) All veneer grades, core materials and preservative requirements for the works shall be selected to satisfy the design life requirements for the environmental conditions as specified in Section I. Environmental Conditions.
- b) All facings, adhesives, fixings and associated elements of the works shall have moisture resistance properties to match core materials.
- c) All timber shall be subjected to controlled drying to ensure that the moisture content, if not otherwise specified, is suitable for the situation of the finished joinery. When fixed it shall remain stable and free from expansion, contraction or other movements detracting from the required performance or appearance..

PRODUCTS AND FABRICATION

ANNEXURE-E1 TECHNICAL SPECIFICATION

MATERIALS

Compact Grade Laminate 100% water proof Phenol Bonded High Pressure Laminate based on thermostatic resin, Homogeneously reinforced with cellulose fibre and Laminate on both sides with Suede finish, scratch and impact resistant to achieve cubicle dimensions joint-less partitions.

- a) Compact grade laminate to BS-476/97 BS EN 438: Part 4.
- b) Machine cut to sizes as shown on the Tender Drawings.
- c) Concealed fixings to be used unless otherwise indicated on the Tender Drawings.
- d) Exposed edges shall be chamfered/ bevelled and polished to avoid sharp edges as indicated on the Tender Drawings.
- e) Concealed panel edges shall be square edged with clean cut edge.
- f) Panels to provide Class 0 spread of flame.
- g) Panel edges shall be sealed where exposed in wet areas.
- h) The thickness shall be 12mm.
- i) Edgings shall be provided as indicated on the Tender Drawings or in accordance with the indicative proprietary panel manufacturer's standard detail.
- j) Edgings shall be applied in a manner that minimizes the visible black line.
- k) The exact type of Materials and Methods of edging to be confirmed and approved by the Engineer.

Plywood/ Laminboard

- a) Plywood generally shall satisfy the requirements of BS EN 313, BS EN 314, BS EN 315, BS EN 322, BS EN 324, BS EN 325, BS EN 326, BS EN 335, BS EN 635, BS EN 636, BS EN 1084, DD ENV 1099, BS EN 12369 and DD ENV 1995 as relevant.
- b) Type: WBP bonding minimum class 2 or class 3 bond quality to BS EN 314, in thickness to suit the design requirements.
- c) Plywood durability shall satisfy minimum hazard class 3 to BS EN 335, (i.e. moisture content frequently above 20%) unless otherwise agreed.
- d) Dimensional tolerances to BS EN 315 and to satisfy any additional requirements of this specification and Tender Drawings.

MDF

All MDF shall be to BS EN 622: Part 5.

Steel Framing

- a) Steel framing members shall be fabricated using only appropriate grades, strengths and thicknesses to provide full structural compliance. The wall thickness of steel sections shall be sufficient to ensure rigidity in the lengths required in the final installation.
- b) Steel as Section Z11.
- c) Corrosion protection, hot-dip galvanizing as Section Z30.
- d) Use only continuous profiles free from marks, defects, flaws, steps, waves or any other damage.

Timber Framing

- a) Regularized treated softwood studs, free from decay and active insect attack, and with no knots wider than half the width of the section.

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- b) Moisture content at time of fixing: Not exceeding 18%.
- c) Spacing: Maximum 600mm or to suit panelling.
- d) Refer also to Section G20 and Section Z10 joinery for general requirements for materials and workmanship.

Aluminium Framing

- a) Aluminium framing members shall be fabricated using only appropriate grades, strengths and thicknesses to provide full structural compliance. The wall thickness of aluminium extrusions shall be sufficient to ensure rigidity in the lengths required in the final installation.
- b) Aluminium as Section Z 26: Metalwork.
- c) Use only continuous profiles free from marks, defects, flaws, steps, waves or any other damage.

Adhesives

- a) Adhesives shall comply with the requirements of BS EN 204, type to match durability class of core material.
- b) Refer also to Section Z20.

Fixings

- a) Refer to Section Z20. b) Corrosion resistant anchors, inserts, fasteners and other such devices shall comply with BS 4183, BS EN ISO 1580, BS EN ISO 7045 and BS EN ISO 3506: Parts 1 and 2.
- c) Fixings shall be concealed unless specified otherwise.

Ironmongery

- a) Aluminium/ Satin finish SS ironmongery shall be fixed to each cubicle as follows:
 - i. Coat hook. ii. Door lock.
- b) All cubicle doors shall have 1½ pairs of self-closing stainless steel butt hinges.
- c) All cubicle doors and panelling shall have local reinforcement and thicknesses to facilitate ironmongery fittings.

FABRICATION

Tolerances

- a) Exact Site dimensions shall be taken as necessary before starting fabrication.
- b) Permissible deviations for panel manufacture:
 - i. Length: 1mm
 - ii. Width: 1mm
 - iii. Squareness: 5mm. (Taking the longer of 2 sides at any corner as a baseline, the deviation of the shorter side from perpendicular)
 - iv. Flatness: 1.5mm under a 1000mm straightedge.
- c) Holes/ cut-outs in rigid sheet boards shall:
 - i. Form 90° internal corners.
 - ii. Form holes for fastenings oversize

SITE INSTALLATION

WORKMANSHIP

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General

- a) Manufacture as much as possible in shop with machinery to eliminate as much hand tooling on project Site as possible. Shop manufacture to allow for adjustments at site for proper levelling, anchoring and joining.
- b) Accurately cut and form materials to the required shape, accurate in size and profile with all exposed surfaces free from irregularities and defects.
- c) Noggings, bearers, etc. shall provide fixing points for linings running parallel with but offset from main structural supports, or to support fixtures, fittings and services which are accurately positioned and securely fixed. After fixing the panels and linings, the positions of noggings and bearers shall be marked, for following trades.
- d) Do not cut, plane, drill, or sand pre-finished panels.
- e) Adhesive joints shall be adequately protected during the curing process to avoid contamination by dust and other debris.
- f) Allowance for future moisture and temperature movement of panels shall be made.
- g) Linings and panels shall be stored on Site for at least 48 hours before fixing, in conditions similar to those that will prevail after the building has been occupied. Free circulation of air to all surfaces shall be maintained at all times.
- h) All work shall be carried out in accordance with the manufacturer's recommendations.
- i) Dimensions and levels of the structure shall be verified by the Contractor prior to manufacture of components.
- j) All elements of framework and associated beads and strips shall be stored on Site such that they shall not be damaged, distorted or weathered unevenly.
- k) Factory finished boards shall be consistent in colour and texture, including accessories, throughout individual areas of work. Boards shall be laid out to ensure that any texture is all one direction and lined up if there is any visible repeat.
- l) Preparation: Wood shall be sanded to remove offset and non-level conditions, roughness, machine marks, glue residue and arrises. Remove all sanding residue and clean off grease and resinous deposits with proprietary thinners.
- m) Do not cut, plane, drill or sand pre-finished panels unless otherwise indicated on the Tender Drawings.

INSTALLATION

Inspection

- a) Areas scheduled shall be checked before receiving the works for correct dimensions,
- b) Plumb ness of walls and soundness of surfaces that would affect installation of mounting brackets.
- c) Spacing of sanitary appliances/ fittings shall be verified to assure compatibility with installation of compartments.
- d) Compartments shall not be installed until conditions are satisfactory.

Installation

- a) The panelling shall not be installed before the surrounding areas are made watertight, wet trades have finished their work, wall and floor tiling is complete and the surrounding area has dried out.
- b) The works shall be installed rigid, straight, plumb and level and in accordance with the manufacturer's installation instructions.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- c) Installation methods shall conform to the manufacturer's written recommendations for backing and proper support.
- d) No evidence of concealed drilling, cutting and fitting to room finish shall be visible.
- e) Uniform clearance shall be maintained at vertical edges of doors.
- f) Top edges of doors and panels shall be installed flush.
- g) Panels shall be installed with a floor clearance and ceiling line as indicated on the Tender Drawings.
- h) Doors shall be installed with a floor clearance and ceiling clearance as indicated on the Tender Drawings.
- i) Fixings shall be concealed unless otherwise stated.
- j) Works shall be set out accurately, true to line and level, free from undulations, with lines and joints aligned, straight and parallel unless specified otherwise.
- k) Works shall be fixed securely using adequate concealed fixing components, to prevent pulling away, bowing or other movement during use and without causing stress or distortion to panels and doors.
- l) Adequate allowance shall be made for future moisture and temperature movement of boards.
- m) Methods of fixing and fastenings shall be as recommended in writing by the manufacturer.
- n) Trims shall be in unjointed lengths between angles or ends of runs. Where running joints are unavoidable, acceptance of location and method of jointing mitre angle joints shall be obtained from the ENGINEER, unless specified otherwise.
- o) The works shall be earth bonded to ensure continuity in accordance with BS 7430 and BS 6651.

Adjustment and Cleaning

- a) Ironmongery shall be adjusted for proper operation after installation.
- b) Exposed surfaces

4. TECHNICAL SPECIFICATION FOR WATERPROOFING TREATMENT

SCOPE

This specification covers the general requirements for water proofing to the underground structure, machinery foundation, pits, trenches, lift pits, roof slab, toilet sunken slab etc.

GENERAL REQUIREMENTS

Waterproofing treatment shall be done with waterproofing materials of approved reputed manufacturers and applied by specialist firms with long experience in the particular trade and proven track record.

The Contractor shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men, materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.

The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code and the provisions of the Safety Rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

Any approval, instructions, permission, checking, review etc. whatsoever by the Engineer shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, workmanship etc.

ANNEXURE-E1 TECHNICAL SPECIFICATION

The treatment shall include both external and internal type at different stages of execution involving various operations of preparation, application and induction of chemicals as water proof barrier in order of sequence.

The treatment shall be done as per the specifications and instructions of manufacturers including cost of all materials all leads and lifts, cleaning, scaffolding, curing, conducting, leakage test etc.

All spaces underneath the tiered seating completely watertight and designed as habitable spaces

CODES AND STANDARDS

The applicable Indian Standard and Code is given below :

IS : 2645	:	Integral cement water proofing compounds.
IS : 9103	:	Admixtures for Concrete

MATERIALS

Cement	:	Ordinary Portland cement of 43 Grade conforming to IS : 8112 shall be used.
Coarse Aggregate	:	Coarse aggregate shall conform to IS:383
Sand	:	Sand shall conform to IS : 383, IS :1542 and IS :2116
Water	:	Water shall conform to IS : 456.
Water Proofing Compound	:	Waterproofing compound shall conform to IS:2645

SURFACE PREPARATION

The surface to receive the waterproofing shall be cleaned of all dust, dirt, loose material, debris, mortar droppings, laitance, oil, grease or any other form of foreign matter which might affect adhesion and left in a saturated, surface dried condition and approval of Engineer taken before starting the work. The surface to be treated in underground structures shall be kept dry by continuous pumping of water.

The surface preparation shall be done as per specification and instructions of the manufacturer.

DIFFERENT STAGES OF TREATMENT TO UNDERGROUND STRUCTURES

Treatment on PCC levelling course :

Treatment on the top surface of PCC levelling course before casting of base slab :

After laying of PCC to proper level and line, the surface shall be cured for the required period.

The PCC surface shall be prepared as described above and kept dry by continuous pumping of water.

12 mm thick plaster with cement sand mortar (1:3) admixed with approved normal setting integral cement water proofing compound like **CICO No.1 – (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645 @ 2%** by weight of cement, or approved equivalent at the rate specified by the manufacturer shall be laid on top of the PCC surface as per specifications and instructions of the manufacturer. The plaster shall be finished smooth with a steel trowel and cured for 1day.

The plastered surface shall then be coated with two (2) coats of **TAPECRETE – Acrylic Polymer modified cementitious coating**, or approved equivalent as per manufacturer's specification and instructions. The coating shall be cured with water for 1 day.

The surface shall then be covered with another 12 mm thick plaster as described under clause (c) above. The treated surface shall be cured for 5 days.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Base slab concrete admixed with **CICO No.1 (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645** or **CICO SUPAPLAST Super Plasticiser-cum-High Range Water Reducing Admixture-Cum-Waterproofer conforming to IS : 9103 as Plasticiser and IS : 2645 as Integral Waterproofer** as per recommended dosage or approved equivalent shall be laid over this treated surface.

Note :

Applicable to PCC levelling course below base slab of under ground sump, under ground structure, lift pit, machinery foundations, trenches etc.

Chemical injection treatment to base slab :

Chemical injection treatment in the form of pressure grouting to the concrete mass of base slab :

The treatment shall be as per manufacturers specification adopting following general operation details :

After casting of base slab and side wall, the surface shall be cured as per the standard practice.

18 mm dia. holes shall be drilled on top of base slab to required depth using pneumatic hammer drill in grid pattern at a spacing not exceeding 1 M centre to centre. Particular care should be taken to drill holes and fix nozzles along the construction joint line wherever it occurs and on other vulnerable areas.

The depth of nozzles shall be adequate to push the grout at all depth. GI nozzles shall be fixed in the holes drilled using single component rapid setting mortar like CICO No.3, or approved equivalent.

Cement slurry mixed with grout admixture like **CICO Non-Shrink Polymer Waterproof Grouting Compound** at 2% by weight of cement or approved equivalent as per specification and instruction of the manufacturer shall be prepared to the required consistency.

The prepared slurry shall be injected through the prefixed nozzles under pressure using grout pump to fill all possible pores and gaps left within the concrete mass. When the flow of the grout stops the grout mains shall be disconnected.

The GI nozzles shall be sealed off with single component rapid setting mortar like **CICO NO. 3**, or approved equivalent after the injection operation is over.

The grout holes shall then be finished after cutting the projected nozzles.

Note :

Applicable to base slab of underground sump, underground structure, pile and pipe cap, lift pit, trenches etc.

Treatment to side wall

Treatment to side wall from exterior surface

Casting of RCC walls shall be done with specified grade of concrete admixed with **CICO No.1 (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645** or **CICO SUPAPLAST Super Plasticiser-cum-High Range Water Reducing Admixture-Cum-Waterproofer conforming to IS : 9103 as Plasticiser and IS : 2645 as Integral Waterproofer** as per recommended dosage or approved equivalent, shall be laid over this treated surface.

After casting of side wall to the required height, the surface shall be cured as per the standard practice.

Chemical injection treatment in the form of pressure grouting shall be done as given below :

18 mm dia. holes shall be drilled on exterior surface of wall to required depth using pneumatic hammer drill in grid pattern at a spacing not exceeding 1 M centre to centre. Particular care should be taken to drill holes and fix nozzles along the construction joint line wherever it occurs and on other vulnerable areas.

The depth of nozzles shall be adequate to push the grout at all depth. GI nozzles shall be fixed in the holes drilled using single component rapid setting mortar like CICO No.3, or approved equivalent.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Cement slurry mixed with grout admixture like **CICO Non-Shrink Polymer Waterproof Grouting Compound** at 2% by weight of cement or approved equivalent as per specification and instruction of the manufacturer shall be prepared to the required consistency.

The prepared slurry shall be injected through the prefixed nozzles under pressure using grout pump to fill all possible pores and gaps left within the concrete mass. When the flow of the grout stops the grout mains shall be disconnected.

The GI nozzles shall be sealed off with single component rapid setting mortar like **CICO NO. 3**, or approved equivalent after the injection operation is over.

The grout holes shall then be finished after cutting the projected nozzles.

The outside surface of wall shall be prepared as described under head "Surface Preparation" after the chemical injection treatment is over.

The prepared exterior surface shall be coated (2 coats) with **TAPECRETE – Acrylic Polymer modified cementitious coating**, or approved equivalent as per Manufacturer's Specification and instructions. The surface shall be cured with water for 1 day.

On top of the coating a 12 mm thick plaster with cement sand mortar (1:3) admixed with **CICO NO. 1 – Normal Setting Integral Waterproofing Compound conforming to IS : 2645**, or approved equivalent at the rate specified by the manufacturer shall be applied as per specifications and instructions of the manufacturer. The plaster shall be finished smooth with a steel trowel and cured for 5 days.

In case of nil accessibility owing to constructional hazards, etc. the interior surface of wall may be treated as mentioned above to produce same effect.

Note :

Applicable to side walls of underground sump, underground structure, trenches and retaining wall. In the case of underground sump interior surface of walls shall be treated.

GUARANTEE

Guarantee for watertight performance of the structure for a minimum period of 10 years from the date of completion shall be given in the prescribed form given below. This guarantee shall be in legal paper in an acceptable form. The guarantee shall be enforceable by the Owner. If, during the guarantee period, water leaks are noticed in the structure from the portions treated by the Contractor, the same shall be rectified when called upon immediately, all at no extra cost to the entire satisfaction of the Owner.

5. TECHNICAL SPECIFICATION FOR EPOXY FLOOR AND WALL COATING

The specification covers the general requirements for Epoxy painting to floors and walls.

Epoxy painting to floors and walls shall be done with epoxy painting materials of approved reputed manufacturers and applied by specialist firms with long experience in the particular trade and proven track record.

Surface Preparation :

The concrete surface should be free from loose and friable particles, cement laitance, dust, dirt and other contaminant. It should be dry, dense and grippy. The surface preparation shall be done as per specifications and instructions of the manufacturer.

Primer Coat :

Over the prepared floor surface one coat of 2 - component, solvent free, non-toxic moisture insensitive epoxy primer like NITOPRIME (FOSROC) or approved equivalent shall be applied to a thickness of 50 microns.

ANNEXURE-E1 TECHNICAL SPECIFICATION

The primer coat shall be done as per the specification and instructions of the manufacturer.

Finishing Coats :

Over the primer coat two coats of 2 component high build, smooth, glossy, coloured epoxy resin based floor coating with high mechanical and good chemical resistance like NITOFLOOR FE 145 (FOSROC) or approved equivalent shall be applied to a thickness of 200 - 240 microns (in two coats).

The finishing coat shall be done as per the specification and instructions of the manufacturer.

The two components shall be mixed thoroughly in the ratio specified by the manufacturer with electric drill fitted with a stirrer of 500 - 600 RPM for about 3 minutes until a smooth and even consistency is achieved.

The surface to be coated should be prepared well before mixing of the two components. The mixed material should be applied by appropriate brush, roller and should be consumed within 2 hours after mixing at 30 Deg. C, the second finishing coat shall be given after 24 hours of the 1st coat. The coated surface shall be allowed for its full air curing for a period of seven (7) days at 30 Deg.C and after its full curing the surface can be put into use.

The colour and make shall be decided by the Engineer.

Wall Coating :

Surface Preparation :

The plastered surface should be absolutely smooth, free from loose and friable particles, cement laitance, dust dirt and other contaminant. The surface preparation shall be done as per specifications and instructions of the manufacturer.

Primer Coat :

Over the prepared wall surface one coat of solvent - free, water based, two component epoxy resin primer like NITOFLOOR FC 145 (FOSROC) or approved equivalent shall be applied to a thickness of 60 - 80 microns.

The primer coat shall be done as per the specification and instructions of the manufacturer.

Finishing Coats :

After 24 hours of application of primer coat, two coats of two component high build, solvent free, chemical resistant epoxy coating with high mechanical strength and good abrasion resistance like NITOFLOOR FC 145 (FOSROC) or approved equivalent which will be easy to clean also shall be applied to a thickness of 200 - 300 microns (in two coats). The finishing coat shall be done as per the specifications and instructions of the manufacturer.

The two components shall be mixed thoroughly in the ratio specified by the manufacturer with electric drill fitted with a stirrer of 400 - 500 rpm for about 3 to 5 mins until a smooth and even consistency is achieved without entrapping much air.

The surface to be coated should be prepared well before mixing of the two components. The mixed materials should be applied by appropriate reputed brand brush/roller and should be consumed within 40 minutes after mixing at 30 Deg. C.

The second finishing coat shall be given after 5 hours of the first coat.

The coated surface shall be allowed for its full air curing for a period of seven (7) days at 30 Deg. C and after its full curing the surface can be put into use.

The colour and make shall be decided by the Engineer.

6. TECHNICAL SPECIFICATION FOR PLASTER BOARD/ CEMENT BOARD/ DRY LININGS/PARTITIONS/CEILINGS

Indian Standards

ANNEXURE-E1 TECHNICAL SPECIFICATION

Work shall be carried out to Indian Standards and Code of Practices. In absence International Standards shall be followed. These shall be latest issue. List given hereunder is not to be considered as conclusive and is for reference and guidance only. Any discrepancies/ conflict noticed shall be directed to the Engineer for his direction/ approval. However, as a general rule more stringent specification shall take precedence.

- a) IS 2547 Specification for Gypsum building plaster
- b) IS 2818 Specification for Indian Hessian
- c) IS 412 Specification for Expanded metal steel sheets for general purpose.
- d) IS 2095 Specification for Gypsum plaster boards Part 1 Plain Gypsum Plaster Boards; Part 2 Coated/ Laminated Gypsum Plaster Boards; Part 3 Reinforced Gypsum Plaster Boards (second revision).
- e) IS 2098 Specification for Asbestos cement building boards.

Scope of Work

This section of the Specifications, when read in conjunction with the Tender Drawings, provides particular requirements with respect to the following:

- a) Stud partitions. Impact resistant plasterboard shall be used for all areas heavily trafficked.
- b) Gypsum board ceiling

System Descriptions/Types

Internal Wall System Type 1 - Dry lining with high impact plasterboard on cement fibre board on both faces including insulation in Boxes.

Internal Wall System Type-2 - Cement Fibre Board Partition to riser core/ plant areas - shaftwall system

Internal Wall System Type-3 - Moisture resistant waterproofing wall system of Cement Fibre Boards lined with Tiles in toilets on both faces with additional Metal frame supporting toilet fixtures.

Ceilings - Gypsum board ceiling

Samples, Mock-ups, Prototypes and Quality Benchmarks

Samples & Submittals:

- a) 500mm x 500mm sample of all plasterboard types.
- b) 500mm lengths of all metal framing components.
- c) Access panels, grilles, etc.
- d) All fixing types.
- e) All insulation material.
- f) Contractor shall submit samples of 300x300 specified gypboard ceiling system along with allied materials from the manufacturer along with test reports.
- g) Edging, expansion, etc special strips which are to be used.
- h) Cavity barrier material.

Mock-ups

The contractor shall prepare and install mockup samples as per approved shop drawings. Mockup samples shall be to full size and shall be true representation of actual works to be carried out at site. Mockups may be part of completed work if undistributed.

Benchmark Requirements

First structural bay of each type of partition, dry lining system, in locations to be agreed.

Delivery, Storage and Handling

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) Material received at site shall be with original packing and labeled. It shall be intact till issued for use of site.
- b) Store all material on elevated platform under cover at dry location and safe from damage.

Test Requirements

Carry out test or provide published and certified data to demonstrate all fire, structural and acoustic performance requirements.

Shop Drawings

The contractor shall prepare shop drawings for layouts based on architectural concept drawings. Drawings shall include –

- a) Detail plan with material & sizes of each element.
- b) Details shall show expansion, contraction, control and isolation joints in Structure and finished surfaces.
- c) Method of fixing.

PERFORMANCE REQUIREMENTS

Comply with the general performance of Section I. Environmental Conditions, and the following specific performance requirements.

Structural

General

Specific Movements

- a) Any necessary joints shall accommodate the maximum movements likely to occur at that point.
- b) The works shall withstand all static and dynamic design loads imposed, without causing permanent deformation of components or the failure of components, and shall transmit such loads safely to the points of support.
- c) The works shall not deflect under loading in any way that is detrimental to any element of the works, adjacent structures or building elements.
- d) All components, couplings and fixings shall be installed in such a manner as to be capable of accommodating deflection and tolerances without distortion, deformation or failure.
- e) The works shall withstand all vibrations caused by wind effects or any other such shocks, strains, stresses and movements, including the vibrations of smoke extractors and other mechanical ventilation devices that may occur. These shall not cause fracture or deterioration of any element, particularly to any movable or openable element. Suitable devices for absorbing or damping any such vibration shall be included.

Specific Dead Loads

- a) The works shall accommodate the following dead loads without any reduction in performance –
 - i. The works own dead load to be accommodated locally, and without causing deflections or movements which adversely affect any component parts.
 - ii. The dead loads derived from permanent fixtures or services attached to the surfaces of the works. Where indicated in the Specifications and shown on the Tender Drawings, the works shall sufficiently accommodate dead loads such as mirrors, glass, etc. fixed directly to its surface.
 - iii. Loads associated with wall finishes such as surfaced fixed panelling, ceramic tiling and other finishes as specified.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) Noggings, bearers and reinforcement to be provided as necessary within the partition thickness to accommodate all relevant dead loads. Co-ordinate with the M&E Specification and drawings and all other relevant information as necessary.
- c) When calculating loads the worst combination shall be considered, taking account of the fact that the pressure coefficients at various locations may determine more than one design criterion

Specific Live Loads

- a) Vertical partitions and dry lining shall be capable of accommodating the following live loads without any reduction in performance or distortion
 - i. Horizontally applied loads acting on the surface of any component. The works shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any part of the framing.
 - ii. A horizontal line load applied to the works, due to the occupants, in accordance with BS 6180 and BS 6399: Part 1.
 - iii. Comply with the heavy duty category for all partition and lining types to comply with the requirements of BS 5234: Part 2.
 - iv. Accommodate loads associated with door opening and closing to meet the heavy duty category
- b) Horizontal dry lining shall be capable of accommodating without any reduction in performance or distortion, loads resulting from vibration caused by mechanical and electrical installations in ceiling and floor voids or loads induced by access walkways, etc

Deflection

- a) Head deflection detail to be provided to accommodate the structural movements indicated in the Structural Engineer's Specification and Drawings.
- b) Allowable deflection of stud members shall not exceed 1/ 240 of their length.

Environmental Performance

General

The partitions including lining materials, framing and all components shall accommodate the relevant thermal and moisture related conditions as applicable to location without permanent deformation, delamination of paper linings, deterioration of plasterboard, linings, framing or any reduction in the specified performance both during construction and after for the design life specified.

Fire

Particular Fire Ratings

- a) The works shall be classified as 'materials of limited combustibility' as defined in the Building Regulations. Linings shall achieve a Class 0 rating when tested in accordance with BS 476: Parts 6 and 7.
- b) Fire resistant partitions shall be designed by the Contractor to meet the Fire Strategy Drawings.

Acoustic Performance

Sound Insulation

- a) The works shall provide the sound insulation levels specified, for the Hospitality boxes also to be used as meeting rooms with acceptable acoustical performance which shall be achieved on Site for each type, inclusive of all services penetrations and interfaces with other elements.
- b) The Weighted Sound Reduction Index (R_w) and the Weighted Apparent Sound Reduction Index (R'_w) shall be defined according to BS EN ISO 717.

ANNEXURE-E1 TECHNICAL SPECIFICATION

The partitions shall comply with the requirements of the Building Bulletin 93 in relation to sound insulation and shall conform to IS 11050(Part 1): Rating of sound insulation in buildings and of building elements: Part 1 Airborne sound insulation in buildings and of interior building elements and IS 11050(Part 2): Rating of sound insulation in buildings and of building elements: Part 2 Impact sound insulation.

- c) Provide certificates from laboratory acceptable to the Engineer confirming that the wall constructions meet the laboratory performance requirements.
- d) The suspended ceilings shall provide sound attenuation from room to room and contribute to sound insulation of floors and roofs

PRODUCTS AND FABRICATION

MATERIALS

Partition Studwork

- a) The support system shall be as recommended by the manufacturer.
- b) Additional supports shall be provided at service outlet, access hatches, etc. positions.
- c) Metal studwork shall be fabricated from hot-dip zinc coated and iron zinc alloy coated sheet steel to BS EN 10143, being not less than 0.55mm thick fixed by zinc or cadmium plated self-drilling and self-tapping countersunk headed screws from Everest Rondo Stud system or equivalent. The centre to centre distance of the stud system shall ensure the additional load of the Tiles, fixed on the outer face of the cement fibre boards, is incorporated and is approved by the Engineer.

Impact Resistant Plasterboard

- a) Gypsum plasterboard with heavy duty paper facings and a higher density core from Gypsum India or acceptable equivalent. Conforming to IS 2095 Specification for Gypsum plaster boards Part 1 Plain Gypsum Plaster Boards; Part 2 Coated/ Laminated Gypsum Plaster Boards; Part 3 Reinforced Gypsum Plaster Boards (second revision).

High Performance Cement Fibre Board conforming to IS 14862

- a) Specially formulated Cement Fibre board suitable for high humidity areas to receive ceramic tiling or similar bonded surface finish.
- b) Minimum 1500kg/ m³ density.

Gypboard

- a) Gypboard Plain, Gypboard Fireline (mixed with Glass fiber providing superior fire protection performance) and Gypboard MR Ultra (high performance moisture resistant board) as manufactured by India Gypsum Ltd. or equivalent approved. Board shall confirm to CBRI certification.
- b) Gypboard are formed by enclosing and bonding together a core of set Gypsum plaster by two sheets of heavy paper.
- c) Board shall be fire resistant, light weight, strong, durable, dimensionally stable, smooth surface finished such that ready to receive directly painting, wall papering.
- d) The thickness of the board shall be 12.5/15 mm as specified in the BOQ item.
- e) Where specified one hour fire rating boards shall be used.
- f) Suspension system shall be as specified and approved.
- g) G.I. suspension system manufactured from pressed steel metal sheets such as angles, channels "Tee" etc. shall be used. GI wire and rawl plug fasteners shall be as per manufacturers' recommendation and also of approved size as per false ceiling drawing for desired location.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- h) The suspended ceiling system shall inter alia comprise GI perimeter channel, intermediate channel, ceiling sections, connecting clips, painted MS suspenders, GI soffit cleats, expansion fasteners, nuts, bolts, countersunk screws, gypsum boards, paper tapes, jointing compound, GI perimeter channels for framing around light fixtures, air grilles, etc.

- i) Jointing compound and jointing tapes etc. shall be as per the recommendation of the Manufacture

Fire Protection

The Contractor shall furnish details of the construction of a suspended ceiling which has been tested for fire resistance, using the same materials as being used in the works, in accordance with BS: 476 Part-8. The same details shall also be incorporated in the shop drawings

Fixing

- a) Fixings shall be as recommended by the manufacturer being suitable and adequate to comply with the Tender Drawings and Specifications.
- b) All fixings shall conform to all statutory requirements in respect of strength and type.
- c) Fixings within the framing components shall not be visible.
- d) Fixings shall be zinc or cadmium plated, self-drilling and self-tapping countersunk headed screws.

Insulation

Void Filling Material

- a) Use only material that is inert, durable, rot/ vermin-proof and non-degradable by temperature, moisture and water vapour.
- b) Material shall be fixed so as not to bulge, sag, delaminate or detach.
- c) Mineral fibre mat to comply with BS 3958: Part 5.

Accessories

Beads, Joints and Angles

- a) Beads/ angles: Galvanised mild steel edge beads to suit the plasterboard thickness to form a positive perimeter edge.
- b) Metal corner reinforcement angles to all exposed arrises, to the board manufacturer's written recommendations.
- c) Galvanized mild steel dry lining movement control joints.
- d) Primary movement joints: 5mm gasket seals on aluminium extrusions.
- e) Sealant to joints in compliance with BS 8212.
- f) Style trims: Extruded aluminium or galvanized steel.
- g) Edge reveals: Extruded aluminium or galvanized steel edge reveals.
- h) Jointing tape: Minimum 53mm wide.
- i) Jointing compounds: Comply with BS 8212 with respect to shrinkage and consistency.
- j) Acoustic sealant to be applied at all junctions with walls, floors, ceilings and around openings applied as a continuous bead leaving no gaps.
- k) Air pressure sealant to be applied to perimeter junctions with walls, floors and ceilings, air gaps around openings and other potential leakage points including framing members and around fire stops, applied as continuous bead.

Partition Access Panels

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) Concealed frame vertical and horizontal access panel with plasterboard infill or moisture resisting board or pre-primed ready for site painting, to match the partition or ceiling type as follows:
 - i. Manufacturer India Gypsum or acceptable equivalent.
 - ii. Reference: 'Gyproc Profilex Standard Panels'.
 - iii. Hatch Size: Various as indicated on the Tender Drawings.
 - iv. Frame: Galvanised mild steel.
- b) Ironmongery: Budget lock with fully concealed side hung stainless steel hinges.
- c) For doors over 450mm x 450mm two budget locks shall be provided.
- d) Fire Rating: To match partition fire rating to BS 476: Part 22.
- e) Doors to include metal earthing tags.
- f) Finish to be treated to accept paint finish to match surrounding partition walls and ceilings.
- g) Access panels shall be insulated to achieve continuity of acoustic properties and fire rating for the dry lined partitions and ceilings.
- h) Access panels shall be installed strictly in accordance with the manufacturer's written instructions.

Ceiling Access (Hatch) Panels

- a) Where required, concealed frame access hatch within suspended plasterboard ceilings with plasterboard infill to match surrounding ceiling shall be provided as indicated on the Tender Drawings as follows:
 - i. Proprietary access hatch for moisture resistant plasterboard systems to provide a flush finish with the ceiling.
 - ii. Access hatch to provide a minimal and uniform gap to all edges.
 - iii. Access hatch to be hinged and capable of accepting 1 or 2 layer(s) of 12.5mm moisture resistant plasterboard to form access hatch flush with surrounding ceiling including all framing, support hangers fixed to structural soffit and all runners and bearers as required.
 - iv. Frames to be concealed using on-site tape joints to the manufacturer's recommendations.
 - v. Frames to be minimum 1.6mm electrogalvanised mild steel.
 - vi. Hatch size: Various as indicated on the Tender Drawings.
 - vii. Access hatch to incorporate key operated or budget type lock as agreed with the ENGINEER. For hatch doors over 450mm x 450mm two budget locks shall be provided.
 - viii. Doors to include metal earthing tags.
 - ix. Installation to be in accordance with the manufacturer's recommendations including all necessary fixings and finishing requirements.
- b) Access panels to be insulated to achieve continuity of acoustic properties for the surrounding plasterboard ceiling.

Finishes

Joints to all plasterboard lining boards shall be taped and filled and surfaces of boards shall receive a primed and skimmed finish as specified herein. The final surface on the faces shall appear sufficiently smooth and flat in order to receive a decorative finish as specified.

Smooth Finish

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) The tapered edge of the boards shall be filled with Universal Board finish plaster and joint paper tape is embedded to complete the first application and finished with 2mm thick board finish plaster on the entire surface of the Gypboard to achieve a smooth and seamless finish or alternatively jointing compound and joint paper tape and two coats of dry wall top coat as per manufacturer's recommendation.
- b) Painting to be in accordance with Section M60 of the Specifications.

Skirtings

Skirtings to comprise chamfered MDF board to BS EN 622: Part 5, with 18% moisture content, prepared to receive painted finish. All angle joints to be mitred.

Barriers

Cavity Barriers (Fire Compartmentation)

Provide continuous vertical fire-rated barriers within the ceiling void to comply with the requirements of Building Regulations using plasterboard faced metal studwork fixed up to the structural substrate with non combustible (mineral wool) insulation or acceptable equivalent material. Ensure that all gaps are closed and the barrier is continuous and meets the required fire rating. Where barriers are required within partitions ensure that these are provided to achieve the required fire performance.

Sound Barriers

Where required within ceilings or partitions provide continuous acoustic barriers using mineral fibre/ wool or acceptable equivalent material of the required density. Ensure that all gaps are closed and the barrier is continuous and meets the required acoustic rating.

Sealants

Air Pressure Sealant

- a) Sealant: A type recommended by the board manufacturer.
- b) Location: To perimeter junctions with walls, floors and ceilings, air gaps around openings, and other potential air leakage points, including frame members prior to fitting core boards and around fire stops to horizontal joints.
- c) Apply as a continuous bead leaving no gaps

Acoustic Sealant

- a) Sealant: A type recommended by the board manufacturer.
- b) Location: To perimeter junctions with walls, floors, ceilings and around openings.
- c) Before fixing boarding, apply as a continuous bead to clean, dry, dust-free surfaces, leaving no gaps. d) After application of sealant, fill gaps greater than about 6mm with jointing compound recommended by the plasterboard manufacturer.

SITE INSTALLATION

INSTALLATION

Storage and Accuracy

- a) The works shall be installed using continuous profiles, being free from marks, defects, flaws, steps, waves, or damage of any nature.
- b) All elements of framework and associated beads and strips shall be stored on Site such that they shall not be damaged, distorted or weathered unevenly.
- c) All finished components shall be carefully packed in stillages or crates such that they are suitably separated and protected to prevent scratching, scuffing, or other surface damage

ANNEXURE-E1 TECHNICAL SPECIFICATION

- d) All materials shall be stored on Site in accordance with the manufacturer's written recommendations.
- e) Dimensions and levels of the structure shall be verified before installation commences.
- f) Acceptance shall be obtained from the ENGINEER before drilling or cutting parts of the structure, other than where shown on the Tender Drawings.
- g) The works shall be installed square, regular to line, level and plane at all junctions fitting to the stated tolerance

Preparation of Backgrounds

- a) All loose material shall be removed by thoroughly brushing the structure to be lined.
- b) Noggings, bearers, etc. required to provide fixing points for heads of partitions running parallel with, but offset from main structural supports, or to support fixtures, fittings and services, shall be accurately positioned and securely fixed. After fixing boards, the positions of noggings and bearers shall be marked for following trades.
- c) All works shall be carried out in accordance with the board manufacturer's materials and workmanship recommendations.

Fixing Requirements

- a) The fixing, jointing and finishing of the works, where not specified otherwise, shall be as recommended by the board manufacturer.
- b) Boards shall be fixed only in areas that have been made weathertight.
- c) Boards shall be cut neatly and accurately without damage to core or tearing of paper facing. Cut edges shall be kept to a minimum and positioned at internal angles wherever possible, with masked bound edges of adjacent boards at external corners.
- d) Boards shall be fixed securely and firmly to suitably prepared and levelled backgrounds, with heads of fastenings set in a depression, without breaking the paper or the gypsum core. Finishes shall appear flush, smooth and flat with surfaces free from bowing and abrupt changes of level. Damaged boards shall not be used.

Fixing Using Dabs

Plaster dabs shall be applied strictly in accordance with the board manufacturer's written recommendations using an appropriate adhesive recommended by the manufacturer.

Installing Metal Stud Partitions

- a) Comply with the requirements of BS 5234.
- b) Metal stud partitions shall be fixed in accordance with the manufacturer's recommendations.
- c) Studs shall be positioned at equal centres, maintaining sequence across openings.
- d) Additional studs shall be provided as necessary to ensure support to all vertical edges of boards.
- e) Vertical joints shall be provided on opposite sides of partitions and be staggered.
- f) Where more than one layer of plasterboard is applied, joints between layers shall be staggered.
- g) Boards shall be fixed to each stud and along all edges with proprietary screws at appropriate centres, not less than 10mm from the edge of the board. Heads shall be set in a depression, without breaking the paper or the gypsum core.
- h) Where indicated on the Tender Drawings, as required for fire or acoustic purposes, or where required for integrity of the installation, partitions shall be extended up between recesses and services to the underside of the structure over.

ANNEXURE-E1 TECHNICAL SPECIFICATION

i) Where indicated on the Tender Drawings to provide support for handrails and/ or equipment, fixtures and fittings, provide additional support framing and fixings points within the partition.

Movement Joints

- a) Movement joints shall be provided as necessary and/ or as shown on the Tender Drawings.
- b) Movement joints shall be installed in accordance with the manufacturer's written recommendations.
- c) Taping and finishing: All joints shall be taped and veneer skimmed in accordance with the manufacturer's written recommendations.

Joints in Plasterboard

- a) Joints between tapered edges of boards shall be lightly butted, leaving a 3mm gap where cut unbound edges occur.
- b) Horizontal joints shall not occur in surfaces exposed to view except where the height of the wall exceeds the maximum available length of the board. Precise joint positions not shown on the Tender Drawings shall be agreed with the ENGINEER. Horizontal joints in two layer boarding shall be offset by a minimum of 600mm and noggings shall be positioned to support the outer layer horizontal joints as recommended by the manufacturer.
- c) Where plasterboard edges abut dissimilar materials and at points of stress, appropriate edge beads shall be installed as recommended by the manufacturer.
- d) Control joints shall be provided in long runs of partitions and linings as recommended by the manufacturer in order to relieve stress.

Taping and Finishing

- i) Cut edges of boards shall be lightly sanded to remove paper burrs with a PVAC sealer applied to exposed cut edges and any other plaster surface to which tape is applied.
- ii) Joints and gaps shall be filled and covered with continuous lengths of tape, and fully bedded. Where joints are to be covered with finish they shall be feathered out to provide a smooth seamless surface.
- iii) All external angles shall be protected by the use of drywall angle beads with plasterboard edge beads at all visible jointed abutments. Joint finish shall be applied to all external angles. When jointing is complete and dry, apply drywall primer to the complete surface ready to receive decoration.
- iv) All beads shall be flush with the board.
- v) Nail and screw depressions shall be filled with joint filler to provide a flush and smooth surface.
- vi) All minor indents shall be filled.
- vii) On completion of joint, angle and spotting treatments a surface finish shall be applied to provide a continuous consistent finish to the surface of boards.

Fire Sealing of Building Services

- a) Install suitable fire barrier as recommended by the manufacturer. Barrier to provide fire protection to maintain the fire rating of works. All materials/ products shall be manufactured to BS EN ISO 9002 and tested to BS EN 1366 and installed to the manufacturer's instructions.
- b) All openings through the dry wall shall be framed out on all sides with metal studding and cross-braced to the metal stud uprights on two opposite sides where possible.
- c) Duct/ Dampers shall be restrained on all sides with metal angles or channels anchored to the soffit. Movement of the duct/ dampers shall be through penetrations to accommodate the movement range indicated by the deflection head.

Fire Sealing to Top of Non-load bearing Walls

ANNEXURE-E1 TECHNICAL SPECIFICATION

Install suitable fire strip, to maintain the fire rating of the works. All materials/ products shall be manufactured to BS EN ISO 9002 and tested to BS EN 1364: Part 1 and installed to the manufacturer's instructions, unless indicated otherwise on the Tender Drawings.

Fire Sealing Joints around Door Frames

Install suitable fire seal, water based acrylic mastic to maintain the fire rating of the works. All materials/ products shall be manufactured to BS EN ISO 9002 and tested to BS EN 1366 and installed to the manufacturer's instructions.

Sound Barriers

a) Align accurately with partition heads and fix tightly at all perimeters and joints in accordance with the manufacturer's recommendations and include steel support sections to ensure permanent stability and continuity with no gaps.

b) Seal any gaps at junctions of sound barriers with partition head, suspended ceiling, structural soffit, walls, ducts, pipes, etc. using mineral wool or suitable sealants.

Ceiling Suspension system

a) Pressed GI metal sections in combination of GI wire/ section hangers fixed with anchor fasteners to ceiling providing basic hanging and suspension frame work. These are readily available or may be specially fabricated to suit site requirement. Hangers are provided @ 1200 mm c/c on both ways. Grid shall be adjusted to suit other requirements to approval of the Engineer.

b) Use special corner metal studs and special metal trim corner beads at acute and obtuse corners of inter-sectioning walls and partitions. Aluminium angles / Tees and channels suspended in combination of GI/ Aluminium hangers are also provided for creating hanging and suspension framework.

c) The GI perimeter channels shall be suspended so as to provide a gap of 10 mm from the face of the Concrete Block wall or RCC members. A gasket made of hollow circular rubber pipe of 15 mm outer diameter with wall thickness of about 2 mm shall be inserted in the 10 mm gap between the channel and the Concrete Block wall or RCC member to provide for seismic isolation.

d) Intermediate channels shall be provided in the shorter direction at 1200/ 900mm centre to centre as approved by ENGINEER.

e) The perimeter and the intermediate channels shall be suspended at every 900 mm centre to centre from the ceiling using GI cleats fixed to the ceiling with 6 mm diameter expansion fasteners (bolt size) having 75mm depth of embedment, fixed using epoxy/ polyester resin.

f) Ceiling section shall be fixed to the intermediate channels with the help of GI connecting clips in a direction perpendicular to the intermediate channel at about 450 mm centre to centre.

g) Thereafter, the 12.5 mm/ 15 mm thick gypsum board with tapered edge shall be screwed to the ceiling section with 25 mm long screws at 230 mm centre to centre. Screw fixing shall be done with drilling machines with suitable attachments.

h) The tapered edge of the boards shall be filled with Universal Board finish plaster and joint paper tape is embedded to complete the first application and finished with 2mm thick board finish plaster on the entire surface of the Gypboard to achieve a smooth and seamless finish or alternatively jointing compound and joint paper tape and two coats of dry wall top coat as per manufacture's recommendation.

i) The system for the suspended ceiling shall be generally as recommended by India Gypsum Limited, or approved equivalent manufacturer or modified as directed by the Engineer for seismic isolation and anchoring.

j) Points to be checked are -

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) It shall be responsibility of the false ceiling contractor to prepare coordinated reflected ceiling layout and get them approved prior to start. He shall be responsible to provide and arrange required service doors, cut outs, fixing arrangements to receive light fitting, AC diffusers, Grills, etc.
- ii) Prior to start of false ceiling services work above false ceiling is completed.
- iii) Edge angles are fixed to correct line and level.
- iv) Hangers are located allowing movement of services within false ceiling.
- v) Main and secondary runners are spaced with due care and perfect rigid frame work is achieved to correct line and level.
- vi) False ceiling panels shall be fixed with suspension by GI screws/ pins etc. Joints shall be well treated and neatly finished as detailed.

TOLERANCES

Installation Tolerances

- a) The works shall maintain the planning grid and distribute tolerances equally to achieve the following:
 - i) Vertical walls maintaining the offset (ceiling to floor) within $\pm 2\text{mm}$ of its notional setting-out position.
 - ii) Straight lines and flat planes in all directions.
 - iii) A final finished surface position within 5mm of its notional position when measured in accordance with BS 8212. b) All dimensions shall be checked on Site prior to commencement of installation.
- c) The installation shall accommodate all required tolerances including differences between actual Site dimensions and dimensions shown on the Tender Drawings.
- d) Account shall be taken of the installation tolerance requirements such that repetitive units are accurately located, relative to gridlines.
- e) The works shall be erected in alignment and in relation to established lines and grades as shown on the Tender Drawings.
- f) The maximum variation in height of any part of the works from given datum shall be $\pm 2\text{mm}$.
- g) The maximum offset in plane, level or section between any two adjacent sections shall be $\pm 1\text{mm}$.
- h) The maximum variation in plan over a distance of 1800mm shall not exceed $\pm 2\text{mm}$.
- i) Cut-outs for interfacing works shall comply with the dimensions shown on the Tender Drawings $\pm 1\text{mm}$.
- j) A detailed list of tolerances to which the works are to be installed shall be submitted for review by the ENGINEER prior to commencement of installation. As a minimum this shall include the following:
 - i) Position on Plan. ii) Level. iii) Alignment. iv) Plumbness. k) Analysis of the erection sequence and overall method statement shall be produced to satisfy the ENGINEER that the installation tolerances Stated shall be met

7. TECHNICAL SPECIFICATIONS FOR PLASTICS/CORK/LINO/CARPET TILING / SHEETING

Indian Standards

Work shall be carried out to Indian Standards and Code of Practices. In absence International Standards shall be followed. These shall be latest issue. List given hereunder is not to be considered as conclusive and is for reference and guidance only. Any discrepancies/conflict noticed shall be directed to the Engineer for his direction/approval. However as a general rule more stringent specification shall take precedence.

- a) IS 5756 Code for packaging of carpets

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) IS 5884 Textile floor covering – Tufted carpets Specification
- c) IS 10466 Guide for care and maintenance of carpets
- d) IS 11471 Method for determination of dimensional changes due to the effects of varied water and heat conditions for machine made carpets
- e) IS 12503 Coir mattings, mourzouks and carpets - General

Scope of Work

Providing and laying of carpet floor finish as per specification and colour pattern design as per Architect including

- a) Preparing shop drawings if any
- b) Preparing surfaces and gradients if any
- c) Laying of carpet floor in pattern if any
- d) Cleaning joints
- e) Sealing of joints
- f) Protecting the flooring till handing over

System Descriptions/Types

Carpet Broadlooms.

Samples, Mock-ups, Prototypes and Quality Benchmarks

Technical data with the informations from the listed manufacturer’s product

- a) 600mm x 600mm carpet broadloom samples
- b) All edge trims, covers and grippers
- c) Movement joint material minimum 300mm

Testing

Testing Requirements

- a) Durability
- b) Appearance Retention
- c) Colour Fastness
- d) Static Control
- e) Flammability

Quality Assurance

- a) Carpet broadloom manufacturer shall confirm that material is as per specification and within acceptable tolerances.
- b) Broadloom shall be homogeneous, of consistent quality, appearance and physical properties.
- c) The flooring shall incorporate a specially formulated primary and secondary backing, to assure quality.

PRODUCTS AND FABRICATION

Pile Reversal

Provide information to the Engineer detailing the resistance to the effects of pile reversal of each carpet type. Include in the warranty the provision for guarding against pile reversal occurring. If pile reversal

ANNEXURE-E1 TECHNICAL SPECIFICATION

occurs before, during or following the installation of the carpet, all areas of carpet affected shall be replaced at no cost to the Employer

MATERIALS

Carpet flooring : Exact type / manufacturer to be confirmed

Broadloom carpet, pile fibre made out of wool mixed with 15% nylon

- a) Manufacturer: Birla TransAsia Carpet Ltd, Milliken, or acceptable equivalent.
- b) Range/ Reference: Dynasty Velvet Deluxe tufted cut pile carpet or acceptable equivalent.
- c) Background: Raised wooden floor/ concrete.
- d) Colour: From standard range.
- e) Underlay: Fire retardant backing of 10mm thk PU foam
- f) Adhesive: As manufacturer's recommendations.
- g) Accessories: Grippers etc

Carpet broadloom, pile fibre made out of 100% nylon (Polyamide PA 6)

- a) Manufacturer: Carpet Splendor, Milliken, or acceptable equivalent.
- b) Range/ Reference: Exact type to be confirmed
- c) Background: Raised wooden floor/ concrete.
- d) Colour: From standard range.
- e) Underlay: Fire retardant backing of 10mm thk PU foam
- f) Adhesive: As manufacturer's recommendations.
- g) Accessories: Grippers etc

Delivery and Storage

- a) Approved material conforming shall be procured by the contractor as per schedule.
- b) Each batch of material shall be received with manufacturers' certificate confirming chemical and mechanical properties.
- c) All material shall be stored on elevated platforms under cover at dry location and safe from damage.
- d) Storage areas shall be maintained clean so as to avoid any contamination due to dust, mud, oil, grease etc.

SITE INSTALLATION

WORKMANSHIP

General

- a) All bases shall be rigid, dry, sound, smooth and free from grease, dirt and other contaminants before coverings are applied.
- b) Finished coverings shall be accurately fitted, fixed at edge with grippers, tightly jointed, securely bonded, smooth and free from air bubbles, rippling, adhesive marks and stains.
- c) The setting out of the pattern shall be agreed with the ENGINEER before ordering the floor finish materials.

ANNEXURE-E1 TECHNICAL SPECIFICATION

d) The materials shall be delivered to Site in original packaging, clearly marked with the batch number. Where possible, the use of different batches adjacent to each other shall be avoided to ensure consistency of appearance.

e) No materials shall be laid until the building is weather tight, wet trades have finished their work, the building has dried out, all paintwork is finished and dry, and floor service outlets, duct covers and other fixtures around which the materials are to be cut have been fixed. The Engineer shall be informed not less than 48 hours before commencing laying.

f) Before laying commences the materials shall be thoroughly conditioned by unpacking and spreading out in the spaces where they are to be laid. Minimum time and temperature shall be as recommended in writing by the manufacturer.

g) Before, during and after laying, the temperature and humidity shall be maintained at the approximate levels that will prevail after the building is occupied.

h) Joints shall be made on the centre line of the door leaf unless specified otherwise.

Installation of Carpet broadlooms

Install in accordance with the Code of Practice as per BS codes

Bases

The laying of coverings shall not occur until bases are suitable

Dampness

Where coverings are to be laid on new wet-laid bases it shall be ensured that:

a) Drying aids have been turned off for not less than four days.

b) Tests for moisture content, using an accurately calibrated hygrometer in accordance with BS 5325 or BS 8203 are taken.

c) Readings are taken in all corners, along edges and at various points over the area being tested.

d) Coverings are not laid until all readings show 75% relative humidity or less.

Adhesive

a) Adhesive and method of fixing shall be supplied and laid as per manufacturer's recommendations.

b) Primer shall be used where recommended by the adhesive manufacturer and allowed to dry thoroughly before applying adhesive.

c) All surplus adhesive shall be removed from exposed faces of coverings as the work proceeds.

d) Ridges and high spots caused by particles on the substrate shall be removed

Seams

a) Patterns shall be accurately matched at seams.

b) Seams shall be cut in to ensure a tight joint, without gaps, and be bonded to the manufacturer's instructions.

d) A neat, smooth, strongly bonded seam joint shall be formed flush with finished surface.

8. TECHNICAL SPECIFICATION FOR GLAZED CURTAIN WALLING

Scope of Work

This section of the Specification, when read in conjunction with the Tender Drawings, provides particular requirements with respect to the following:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) Structural silicone glazed curtain walling/ cladding system.
- b) Integrated glazed doors including all associated ironmongery, actuators etc as specified.
- c) All associated bracketry, insulation, waterproofing, vapour barriers, breather membranes, flashings, trims, closure pieces, fixings and other associated works as specified.

Interfaces

- a) Complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture.
- b) Ensure that all interfaces are fully co-ordinated prior to commencement.

SYSTEM DESCRIPTIONS/ TYPES

External Glazed Walling System – Type A

External Glazed Walling Systems Capless vertical glazing including but not limited to Subconcourse VIP entrance, Concourse Viewing Areas and Bars, Hospitality Boxes, Committee Room, and Venue Management Area. Location, layout, profiles, configuration, etc..

- a) External glazed walling system with double glazing structural silicone bonded (SSG) to aluminium framing.
- b) All visible aluminium to be polyester powder coated.
- c) Panels to be fixed lights.
- d) Double glazing units to have black spacer bars.
- e) Double glazed units to have flush glass-to-glass external appearance with sealant joints.
- f) Where indicated, acid etched finish to agreed sample to glazed panels. Where indicated, factory applied paint/enamel finish to rear/interior of glazed panel to provide opacity to panel. Paint/enamel finish to be to agreed sample. Opacified glazing to match non-opacified glazing.
- g) Blinds to be manually operated venetian type as specified.

External Glazed Walling System – Type B

Vertical frameless double glazing (type GL-102) without mullions, including but not limited to Concourse Viewing Area at interface with Services Risers. Location, layout, profiles, configuration, etc.

- a) External glazed walling system with frameless double glazing structural silicone bonding (SSG).
- b) Patch plates, if required, to be in brushed stainless steel (grade 316).
- c) Panels to be fixed lights.
- d) Double glazing units to have black spacer bars.
- e) Double glazed units to have flush glass-to-glass external appearance with sealant joints.
- f) Where indicated, acid etched finish to agreed sample to glazed panels. Where indicated, factory applied paint or enamelled finish to rear/interior of glazed panel to provide opacity to panel. Paint finish to be to agreed sample.

External Glazed Walling System – Type C

Vertical sliding folding double glazing system including but not limited to Subconcourse Kiosk/Merchandising areas. Location, layout, profiles, configuration, etc.

- a) External glazed walling system with double glazing structural silicone bonded (SSG) to sliding and/or folding aluminium framing.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) All visible aluminium to be polyester powder coated.
- c) Double glazing units to have black spacer bars.
- d) Where indicated, acid etched finish to agreed sample to glazed panels. Where indicated, factory applied paint finish to rear/interior of glazed panel to provide opacity to panel. Paint finish to be to agreed sample.
- e) Blinds to be manually operated venetian type within glazing unit as specified.

Glass

Frameless double glazed units with low E coating as required to meet Mechanical Services specification. Where exposed to cricket balls or other projectiles, glazing to be toughened and laminated. Toughened only on non-cricket ball elevations. Acid etched where required to approved sample. Location, layout, profiles, configuration, etc

Doors

Door Type A - Single leaf, external, full height double glazed door without overpanel.

Door Type B - Single leaf, external, full height double glazed door with overpanel.

Door Type C - Double leaf, external, full height double glazed door without overpanel

Door Type D - Double leaf, external, full height double glazed door with overpanel

Samples, Mock-ups, Prototypes and Quality Benchmarks

Provide post contract samples :

- a) 500mm length of each type of framing incorporating glazing with metal finishes proposed.
- b) 1200mm square sample of each and every type of glass panel and metal spandrel panel.
- c) Various extrusions at least 300mm in length.
- d) Samples of metal finishes on 300mm lengths of extruded aluminium and 300mm square panels of pressed aluminium.
- e) Various ironmongery including hinges, budget locks and window and door handles.
- f) Samples of fixings, bolts, fastening devices and anchors, etc.
- g) Sliding switches, controls, operating mechanisms, track and wheels.

Testing

Previous/ Comparative Testing Certification

- a) The Contractor may provide certification to demonstrate that the cladding works have been previously tested to meet the criteria specified.
- b) When previous testing data is not representative of the project specific requirements or is not deemed to be satisfactory by the ENGINEER, laboratory tests shall be carried out to satisfy the requirements of the Specification.
- c) Test certificates do not relieve the Contractor of his responsibilities regarding the performance and service life requirements of the cladding works.

Testing of Prototypes

- a) Supporting Frames: The prototypes shall be mounted in test rigs which have the same conditions of attachment and support as elements of the works, with a supporting structure similar in stiffness to that supporting the works. The prototypes to be tested shall not be influenced by the test chamber.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) Provide details of all jointing, sealing and glazing techniques, materials used, type, number and size of drainage/ ventilation apertures and section properties of the framing members.
- c) The Engineer shall be given at least 7 days notice prior to the erection and dismantling of the prototype construction, as the ENGINEER may elect to observe the assembly and dismantling of the test prototypes.
- d) Tests shall not be carried out without prior notice of at least 7 days being given to the Engineer.
- e) Prior to testing, sufficient time shall be allowed to permit all chemically curing sealants to achieve their proper cure as recommended by the sealant manufacturer.
- f) Before the test is begun, the external face of the specimen shall be thoroughly washed using a mild additive-free detergent and then rinsed.
- g) Testing shall be carried out by an independent laboratory acceptable to the Engineer.
- h) The prototypes shall be tested for air permeability, water leakage, and wind load resistance, plus additional structural loading tests as necessary to demonstrate through calculations/ drawings that the works are capable of accommodating the building movements without degrading the performance of the works.
- i) Details of the testing procedures shall be provided to the Engineer for review and comment.

Standard Test Apparatus and Calibration

Submit details of the following equipment intended for use in the testing process:

- a) Test chamber.
- b) Air system.
- c) Water spray system.
- d) Pressure measuring apparatus.
- e) Airflow-metering system.
- f) Water flow-metering system.
- g) Deflection measuring devices.
- h) Calibration.

Air Permeability Tests

- a) The prototypes shall be tested to determine the air infiltration per unit area for fixed panels, and per unit joint length for any opening lights. A check for regions of concentrated air leakage shall be made after the air permeability test has been completed and such areas marked upon the prototype drawings.
- b) Testing shall be carried out in accordance with BS EN 12153, for cladding, and BS EN 1026, for windows and doors, to a test pressure class of 600 Pa as defined in BS 6375.
- c) In addition, an air ex-filtration test shall be carried out on the prototype to check the performance in relation to the whole building's air leakage test requirements, at a rate of 50Pa to meet the criteria stated in the Building Regulations Part L2.

Weatherproofing and Watertightness Tests

- a) Tests shall be carried out adopting both the static and the dynamic procedures set out below:
 - i) Static Test Method carried out in accordance with BS EN 12155, for cladding, BS EN 1027, for windows and doors, and the requirements of the CWCT Standard for Systemised Building Envelopes.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ii) Dynamic Test Method carried out in accordance with the requirements of the CWCT Standard for Systemised Building Envelopes or equivalent European Standard ENV 13050, for testing for water penetration using the dynamics method.

iii) Resistance to water penetration when tested shall be in the test pressure class 600 Pa or 0.25 the design wind pressure, whichever is the greater, in accordance with the requirements of the CWCT Standard for Systemised Building Envelopes for testing for water penetration by the static and dynamic test method.

b) Performance under Testing:

i) There shall be no leakage into the internal face of the works at any time during the test or within 15 minutes of completion of the test.

ii) At the completion of the test there shall be no standing water in locations intended to drain.

Wind Resistance Tests

a) A serviceability test shall be carried out in accordance with BS EN 12179, for cladding, and BS EN 12211, for windows and doors, as modified by the CWCT Standard for Systemised Building Envelopes.

b) A safety test shall be carried out in accordance with the CWCT Standard for Systemised Building Envelopes.

c) Test pressure: The peak test pressure shall be 1.5 times the design wind pressure for the Safety test, and 1.0 times the design wind pressure for the Serviceability test.

d) Performance under Testing:

i) At both positive and negative applications of the peak test pressure, there shall be no permanent damage to framing members, glass or glazing panels or anchors. Framing members shall not buckle, panels shall remain securely held, glass and glazing shall not be damaged and gaskets shall not be displaced. The glass itself shall not deflect such that edge cover is insufficient to restrain the glass under peak test pressure or such that spacers become visible.

ii) After loading to the positive and negative peak test pressure, permanent deformation to wall framing members shall not exceed 1/ 500 of the span measured between points of attachment to the building one hour after the loading has been removed.

iii) The loads created by specified test conditions shall be accommodated safely, without detriment to the overall design, structural integrity and performance of the works.

iv) The permanent fixings of any component shall be capable of resisting the combined dead load and maximum wind load with a factor of safety of at least 2.2.

e) Tests shall also verify:

i) That all components shall return to their original positions under zero load, providing that the elastic limit to the materials has not been exceeded.

ii) That in all cases, the deflection of members shall not exceed specified tolerances.

iii) That anchorage shall not show permanent signs of slackening off. The deflection of these members shall not be sufficient to damage non-loadbearing members of the inner wall assembly.

iv) That no noise shall occur due to movement of components.

Impact Testing

A soft body impact test shall be carried out in accordance with BS 8200, conforming to category B requirements.

Off-Site Test Sequence

ANNEXURE-E1 TECHNICAL SPECIFICATION

a) The Testing Authority shall witness the installation and dismantling of the prototypes, record any variations to the agreed details on a set of the prototype assembly drawings prepared by the Contractor and shall also record the extent of water penetration into the system.

b) Test Sequence:

i) Preliminary testing: Prior to the full test sequence, the prototypes shall be pre-tested under static pressure at 50% maximum design wind load, followed by water penetration test at 50% of the pressure specified for final tests. Deficiencies observed in the samples during testing shall be recorded, and appropriate corrections made.

ii) The testing sequence shall be followed in accordance with the CWCT Standard for Systemised Building Envelopes Sequence B procedures.

iii) Further tests shall be carried out in accordance with the CWCT Standard for Systemised Building Envelopes Discretionary Test procedures as necessary. c) No test shall be carried out unless all previous tests in the sequence have been passed to the satisfaction of the Testing Authority.

d) If any modification is made to the prototype, repeat testing shall be undertaken as detailed in the relevant CWCT procedures. However, If any modification is undertaken that, in the opinion of the independent testing authority or witness, invalidates earlier test results, the sequence shall commence again at the first test. This requirement is not applicable to glass breakage during the wind resistance safety test when replacement of a pane of glass may be carried out without re-starting the whole sequence.

Acoustic Testing

Initial Advance Test

a) Identify the glass configurations and incorporate any acoustically enhanced configurations that may be necessary to meet the Tender Drawings and Specifications.

b) Immediately following the appointment of the curtain walling sub-contractor, arrange laboratory acoustic tests of the proposed glass configurations using similar framing to that intended with similar dimensions and mass per metre run of framing. These prototypes will not be used as visual samples and will not include glass coatings or heat treatments, but are to be used to confirm compliance with the specified acoustic data.

c) From initial results of acoustic testing, provide detailed acoustic assessment of each cladding type for review.

Structural Silicone Testing and Maintenance

a) General:

i) Comply with the requirements of the Tender Drawings and Specifications with respect to the testing of the structural silicone application.

ii) Provide the ENGINEER with documentary evidence that the selection of sealant takes into account any relevant recommendations by the sealant manufacturer as to the use of the sealant.

iii) Compatibility: Submit to the ENGINEER test certificates to confirm compatibility of the sealant used with all substrate materials including aluminium, finishes, glass, glass coatings, gaskets, setting blocks, backing rods, etc. These certificates shall relate to tests carried out by the sealant manufacturer.

b) Submit to the ENGINEER adhesion test data of production samples as tested in accordance with ASTM C 794. These shall establish adhesion performance over the temperatures specified in the Tender Drawings and Specifications.

i) Where the structural silicone bonds glass to the cladding framework, the weakest element in the line of stress shall have a minimum strength of 600kPa or 6 times the design strength, whichever is the greater in accordance with ETAG 01/ 015 or ETAG 002 documents which set out the requirements for use of

ANNEXURE-E1 TECHNICAL SPECIFICATION

structural silicone. This criterion shall be proven with a statistical confidence of 99%. For each combination of substrate and design conditions, provide a report from the sealant manufacturer for the tests performed in the following manner:

ii) Assemble and fully cure under production conditions (not laboratory conditions) a minimum of 12 samples. Each sample shall be a minimum of 150mm long. The sample shall be made of actual substrate material, i.e. glass with actual coating (low E and/ or fritting), aluminium sections with finishes, etc. The joint geometry shall be as accepted by the ENGINEER.

- Double-sided tape or other spacer material shall be installed such that it does not add to the silicone joint strength.
- Weather seals shall not be installed on the samples.
- After full cure the samples shall be totally immersed in tap water at room temperature for 7 days.
- Samples shall be tested in a tensometer 25 hours after removal from the water immersion tank.
- Each sample shall be subjected to a tensile load test. The crosshead speed shall be 50mm per minute. Continue testing until failure occurs or until 830kPa or 6 times the design load, whichever is the greater, is applied to the samples. Report the maximum stress and mode of failure including percentage area of cohesive failure and any area of voids in the sealant for each sample. Adhesive failure area or void cross section area parallel to the substrate face greater than 20% is unacceptable.
- A statistical analysis of results shall indicate a design stress of not less than 600kPa or 6 times the design stress of the sealant, whichever is the greater, with a confidence of 99% over the temperature range as described in the Tender Drawings and Specifications.
- If the sample set does not meet the requirements of the above criteria, the design of the failed element shall be revised and subjected to a re-test. This procedure shall continue until the above requirements have been met.
- Prepare a report of the above testing. No fabrication shall commence until the results have been accepted by the ENGINEER.
- Retain all test results with regard to the structural silicone glazing for a minimum period of 15 years from project completion. These shall be made available to the ENGINEER on request.

c) Maintenance:

i) Recommend a periodic maintenance regime for acceptance by the ENGINEER. This shall be incorporated into the O&M manual. Recommendations shall include:

- Cleaning: Specify acceptable detergents, etc. and methods to be used.
- Details and frequency of close visual inspection requirements, including methods to be employed.
- Inspection: Provide forms to be filled out periodically, each pre-dated with the inspection date and an adequate quantity for the design life of the building. The form shall state the full procedure for the inspection.
- Recommendations for periodic cut-out of structural seals and weather seals (if appropriate) to check shore hardness and tensile properties of the seal.

ii) Each of the procedures shall clearly state pass/ fail criteria and indicate action required when a failure is obtained as a result.

Site Hose Testing

A Site water hose test shall be carried out in accordance with the recommendations of CWCT Standard for Systemised Building Envelopes.

Testing of Fixings

ANNEXURE-E1 TECHNICAL SPECIFICATION

As the work proceeds, allow for bolts as required and witnessed by the Structural Engineer to be proof load tested.

Results and Certificates

- a) Tests and inspection results shall be submitted immediately they are available.
- b) Submit certificates relating to the materials used in the work as confirmation of tests carried out in accordance with the relevant British Standards, and/ or other national standards as appropriate.
- c) Maintain, until the end of the defects liability period, records of all inspections and tests performed, material certification, inspection and test plans, drawings, and any other documentation to substantiate conformity with the Tender Drawings and Specifications, including those carried out by sub-contractors.
- d) The records shall be stored in such a way that they are identifiable to the component to which they refer and are retrievable.
- e) The records shall be available for inspection by the ENGINEER and copies of records shall be given to the ENGINEER upon request. At the end of the defects liability period they shall be submitted to the ENGINEER.

PERFORMANCE REQUIREMENTS

General

- a) Comply with following specific performance requirements.
- b) The works generally shall be designed, constructed and installed to BS 8200 and the recommendations of the Centre for Window Cladding Technology (CWCT) Standard for Systemised Building Envelopes.
- c) Should two standards, or a standard and specification conflict, the Contractor should draw attention to this and the more onerous standard shall apply unless otherwise agreed.
- d) Mullions, transoms, louvres, head and base framing component sizes shall comply with the sizes (visual sight line requirements) as indicated on the Tender Drawings which represent the visual design intent.
- e) Co-ordinate the Detailed Design with that for all related works and accommodate the specified movements and tolerances for structural elements as specified in the Structural Engineer's specification. Be responsible for providing all shims and fixings to all primary and secondary structures.

Structural Performance

Specific Movements For movements, deflections and tolerances associated with the primary structure, refer to the Structural Specifications prepared by the Structural Engineer.

Deflections

- a) The allowable deflection of any glazed element of the works, when carrying full design loads, shall comply with BS 6262 as applicable.
- b) Unless otherwise specified, the maximum allowable deflection for any general framing members, panels, glass components shall be in accordance with the requirements of the CWCT Standard for Systemised Building Envelopes and all relevant standards as applicable.
- c) The works shall not deflect under loading in any way that is detrimental to any element of the works or adjacent structural or building elements.
- d) All components, couplings and fixings shall be capable of accommodating all of the above deflection without permanent distortion, deformation or failure.
- e) The works shall accommodate defined differential structural movements arising from any loads imposed by adjacent structures. f) The magnitude of the allowable deflections shall be reduced if they are detrimental to any part of the works, their support structure or internal finishes.

ANNEXURE-E1 TECHNICAL SPECIFICATION

g) Calculations of deflections for structural aluminium shall recognise criteria contained in BS 8118: Part 1 limiting deflections.

Design Loads

a) The system shall be designed to withstand the loads as specified below without affecting the system's ability to meet the specified performance requirements and/ or the exceptional loads specified herein. Unless otherwise stated, the system shall also be designed to comply with all prevailing relevant British Standards as appropriate, including, but not necessarily limited to BS 6180 and BS 6399.

b) When calculating design loads the worst combination shall be considered, taking account of the fact that the pressure coefficients at various locations may determine more than one design criterion.

c) Self-weight Gravity Loads: The works shall be capable of accommodating the self-weight of the system including all of its framing and supporting system.

Imposed Gravity Loads

The works shall be capable of accommodating loads imposed by adjacent and/ or attached elements that bear onto, are suspended from or fixed to the system. Refer to the Tender Drawings for information on such elements and/ or required load capacities. No elements from other trades shall be fixed to and/ or supported by the curtain wall, unless accurately specified, shown on the Tender Drawings and/ or agreed by the ENGINEER.

Live Loads

a) The works shall be capable of accommodating the following live loads without any reduction in performance:

i) All loads resulting from movements of the building structure and cladding support structure.

ii) Horizontally applied loads acting on the surface of framing members and glazing arising from maintenance and cleaning operations. The works shall sustain safely, without reduction in performance and without permanent deformation to any component, a static 500N load applied horizontally through a square of 100mm sides on any part of the framing.

iii) A horizontal line load applied to the works, due to the occupants, in accordance with BS 6180 and BS 6399: Part 1. iv) Known impact loads, or transferred impact loads, that occur during its service life, without deterioration in performance and without sustaining non-repairable damage.

v) Loads imposed during replacement of panels/ units.

vi) Wind loads.

vii) Horizontal and vertical loads of similar magnitude to those which are imposed upon adjacent or attached elements. Refer to the Tender Drawings for information on such elements and/ or required load capacities.

Imposed Movements

The works shall be capable of accommodating loads imposed upon the system by defined movements of its supporting structure and/ or other adjacent elements.

Wind/ Air Pressure Loads

a) The works shall be designed to withstand the effects of wind loads. Calculated pressure loads shall include the effect of internal air pressures within the building, taking into account the presence of significant openings, which might arise occasionally within the building enclosure.

Thermal Movement

a) Allow for local thermal movements exerted due to the psychrometric data.

ANNEXURE-E1 TECHNICAL SPECIFICATION

b) The works, including all necessary support structure, shall be designed to accommodate changes in dimension and shape of its components resulting from changes in service temperatures and from differential surface temperatures between the inside and outside of the building without any reduction in the specified performance. The design shall cater for all temporary and permanent conditions envisaged for the works.

c) The annual surface temperature ranges for the materials used in the works shall be confirmed during the Detailed Design period, both for external surface temperatures and internal temperatures when the building is in normal use and when empty or out of use. Due regard shall be made to the effects of orientation of the building towards the sun and thermal stress calculations and risk assessments shall be submitted by the Contractor for review.

Inertial Loads

The works shall be capable of accommodating inertial loads arising due to the acceleration/ deceleration of moving sections including opening lights, doors and vents of the building or enclosure.

Exceptional Loads

a) If specifically required by the ENGINEER, the system shall also be designed to withstand exceptional loads as follows. For such exceptional loads only, the system may be allowed to sustain a degree of damage.

i) Vandal resistance: To be confirmed.

ii) Impact loads: To be confirmed, including but not limited to the impact of flying cricket balls.

Strength of Doors

a) Ensure that the doors, including ironmongery, meet the 'heavy duty' category as defined in DD 171 or an equivalent international standard. At the same time doors shall comply with and not compromise the other stated performance criteria for the works.

b) Provide evidence to demonstrate that the doors, including ironmongery, have been tested to meet the minimum acceptance criteria given in DD 171 for the following:

i) Slamming shut impact.

ii) Slamming open impact.

iii) Heavy body impact.

iv) Hard body impact.

v) Torsion.

vi) Download deformation.

vii) Closure against obstruction.

viii) Resistance to jarring and vibration.

ix) Abusive forces on door handles.

c) Glass in doors:

i) Comply with BS 6262.

ii) Impact performance to achieve class A (class 1B1) to BS 6206 and BS EN 12600.

d) Ensure that the maximum opening pressures required to open fire rated or non-fire rated doors on disabled access routes are in accordance with the requirements of BS 8300.

Thermal Performance Requirements

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) Detail the works to minimise cold/warm bridging in any area of the system. The maximum thermal permitted transmittance (U-value) for the various areas of the works shall be as follows:
- i) Double glazed vision and translucent area for external façades: Refer to the glass types specified below.
 - ii) The area weighted average U-value for solid panels, metal cladding and metal spandrel panels shall comply with the requirements of the Tender Drawings and Specifications.
 - iii) The area weighted average U-value for the works (double glazed vision area and frames): Refer to the glass types specified below.
- b) The average U-value through the works shall comply with the above requirements and meet all Statutory requirements.
- c) Submit thermal calculations for the various components and the average thermal performance of the proposed works to comply with the specified requirements.
- d) Ensure that thermal movements shall not result in unacceptable levels of audible noise.

Solar Performance Requirements

a) General:

i) Data sheets for project specific glass build-ups in accordance with BS EN 410 (light transmittance, radiant transmittance of glazing) with tolerances of $\pm 3\%$ for flat glazing, shall be submitted in respect of solar and visible light performance confirming compliance with the Tender Drawings and Specifications. Facilities shall be maintained to evaluate and report on expected solar performance under varying conditions of solar radiation and external/ internal air velocity.

ii) The works shall be designed to ensure that the glazing does not crack or distort or is damaged in any way through differences of temperature on the surfaces of the glazing.

iii) All specified criteria are nominal values.

b) Confirm the total solar transmission (G-value) for each glass type specified for review by the ENGINEER. Glass manufacturers and types shall be acceptable to the ENGINEER only if they meet the performance and visual requirements defined by the Tender Drawings and Specifications.

c) Individual GL Types:

i) Glass Type shall be double glazed clear glass units, as Saint-Gobain Cool-Lite SKN 174II, or acceptable equivalent, with low E coating meeting the following criteria:

- Light transmission factor: Not less than 67%.
- External light reflectance: Not greater than 11%.
- Total solar transmission (G-value): Not greater than 41%.
- Colour rendition index of glass: Not less than 92%.
- U-value: To meet the requirements of the Mechanical Engineers's Specification.
- High performance coating: As required.
- Low E coating: Yes.
- Safety glass requirement: Inner pane and outer pane.
- Acoustic treatment: tba

d) Values indicated are regarded as the minimum the glass must achieve.

e) All inner panes of the double glazed units are to be safety glass to BS 6206 and BS EN 12600.

Air Permeability/ Infiltration

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) The Detailed Design shall minimise airflow from the outside to the inside of the building through joints/ junctions to control concentrated airflow.
- b) The works shall resist the passage of air such that its air leakage rates, if measured in accordance with the CWCT Standard, shall not be exceeded in both the initial and repeat tests.
- c) The works shall have a maximum air infiltration rate of:
 - i) 1.5 m³/ hr/ m² for fixed lights.
 - ii) 2.0 m³/ hr/ per metre length for opening lights/ smoke vents.
 - iii) 3.0m³/ hr/ per metre length of opening for framed and rebated doors.
- d) Items i), ii) above shall be tested at a pressure of minimum 600 Pa when tested generally in accordance with the CWCT Standards. For lower pressures the performance shall follow the relevant graph in the CWCT Standard for Systemised Building Envelopes.
- e) Air leakage shall be distributed and not concentrated at any one location.
- f) Provide actual air leakage results from tests for acceptance.
- g) Where appropriate, analyse details of pressure equalisation proposals for all areas of rainscreen cladding taking into account variable external pressure gradient for acceptance by the ENGINEER.

Condensation

- a) Except under extreme conditions where the relative humidity is in excess of the value specified by the Services Engineer, condensation shall not form, either on internal or external surfaces of framing members, glazing, solid panels or louvres, or interstitially within the construction of infill panels forming a part of the works, such that it may lead to damage or staining under the psychrometric conditions specified.
- b) Condensation shall be permitted in non-visible drained and ventilated rebates subject to condensation not having a deleterious effect on performance or durability.
- c) Provide a condensation risk assessment with the Tender return based upon the psychrometric conditions specified, for review by the ENGINEER

Capillarity

The Detailed Design, gaskets, seals, etc. shall take into account and eliminate any possibility of water migration to the inside of the building due to capillarity.

Weather and Water Penetration Resistance

- a) The works shall be weatherproof and watertight, ensuring the prevention of water leakage onto the internal face of the works and any other part of the system that may be adversely affected.
- b) The works, including flashings and junctions with adjacent parts of the building, connections to gutters etc shall be weatherproof and watertight under all conditions with full allowance made for deflections and other movements.
- c) The Detailed Design of the works shall not be based on a single line of defence. The cavities between the lines of defence shall be drained and ventilated to the exterior. Wet applied seals for the purpose of preventing the ingress of water shall not be accepted with the exception of the structural silicone seals or wet seals used for sealing the works against adjacent interfacing systems.
- d) The Detailed Design and construction of the works shall be such that all rigid or fixed joints shall remain rigid and accommodate all specified thermal, building structure or other movements and any applicable loads without compromising its watertightness. All movement joints shall also be finally designed and constructed to accommodate such loads or movements without compromising the glazing's watertightness.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Local Factors

- a) Visit the Site in order to become familiar with local requirements. Local microclimatic conditions shall be taken into account and grades of materials assessed as suitably durable for the location shall be selected.
- b) An assessment of microclimatic conditions shall be made with due allowance for any factors likely to have an adverse effect on materials intended for the works. More appropriate materials shall be substituted if adverse effects are predicted.

Acoustic

Acoustic Performance Requirements

- a) The works shall effectively insulate the internal areas of the building from high levels of noise.
- b) The works shall provide internal sound reduction between floors.
- c) The works shall provide internal sound reduction between adjoining areas on the same floor.
- d) Evidence shall be provided that the acoustic performance requirements given herein can be achieved.

Flanking Transmission

- a) Flanking transmission requirements t.b.a.
- b) Any acoustic tests are to commence at a time agreed with the ENGINEER, in a recognised independent laboratory, with a comprehensive test report being submitted, in writing, to the ENGINEER within three weeks of completion of the tests.
- c) Where existing test data is available from a recognised independent laboratory, it shall be considered acceptable providing the tests have been carried out for the exact system being offered. Test data for similar constructions may be accepted if supporting computations are offered to account for any differences between the proposed and tested construction.

Durability

General

The performance criteria shall be satisfied for the full service life of the works, as stated in the Tender Drawings and Specifications, provided always that the maintenance has been carried out as specified.

Impact and Abrasion Resistance

- a) The works shall resist abrasion from agreed cleaning methods and maintenance systems without any noticeable change in surface appearance. Generally, surfaces shall be sufficiently hard (including glass coatings) to resist all reasonable impacts from hand-held objects in accordance with BS EN 356.
- b) Impact tests shall be carried out to all assemblies adjacent to pedestrian areas in accordance with the recommendations of BS 8200 . Tests shall conform to category B requirements.
- c) The extent of any damage determined through testing shall be recorded and, where possible, quantified. Samples shall also be submitted to the ENGINEER.

Demountability

- a) Elements of the works shall be individually and independently removable ensuring access for maintenance and/ or replacement of glazed units in the event of breakage.
- b) The removal of glazed units shall not affect the performance or safety of adjacent or any other part of the works. Provide a method statement for removal and replacement of glass panels for acceptance.

Fire

General

ANNEXURE-E1 TECHNICAL SPECIFICATION

All elements of the works shall be either non-combustible or not easily ignitable with low flame spread characteristics, and shall not produce excessive quantities of smoke or toxic gases.

Surface Spread of Flame

- a) The external wall, where necessary, shall meet unprotected limitations as specified in the Fire Strategy Report.
- b) All materials used internally and externally (excluding sealants and gaskets) shall have a Class 0 surface spread of flame classification when tested in accordance with BS 476: Parts 6 and 7, unless otherwise specified.

Fire and Smoke Stopping

- a) Be responsible for the provision of all cavity barriers in the external wall and for fire stopping, as specified, at the junction of the external wall with all other fire-resisting elements of the structure, to meet the requirements of the Building Regulations Approved
- b) All fire and smoke stops shall be positively fixed in position in such a manner that they shall not become dislodged in the event of a fire. The fixing shall secure the stop in position for a period at least equal to that required for the compartment wall or floor against which the works abut.

Fire Resistance

- a) If fire resistance is required in the works for space separation purposes
- b) Where fire-resisting glass is required, comply with the specified fire ratings and Section Z25 and ensure that beadings, gaskets, etc. are suitable for the fire rating to be achieved.
- c) Each floor in the building is a fire-resisting compartment floor. The junction of the floor and the cladding shall preserve the integrity and insulation of compartmentation, to prevent fire spread from floor to floor. Materials used to complete the junction shall accommodate movement between slab edge and cladding, and their fire resisting performance shall not be affected by water from sprinkler discharge.
- d) Reaction to fire properties: The external surfaces of the cladding shall comply with functional requirements.
- e) Any insulation in the external wall construction that is exposed in a ventilated cavity shall be of limited combustibility

Fire Stopping between Floors

- a) There shall be floor to floor fire separation at the perimeter of each level in accordance with the requirements of the Fire Strategy Report.
- b) Submit details of suitable products, including fire tests information complying with BS 476: Part 20, test method.

Components

Primary Components

Primary components are all components with a predicted service life of not less than the Design life of the curtain wall without the need for maintenance (with the exception of glass), other than regular cleaning. The following components shall be considered primary components:

- a) All framing and its fixings and means of attachment to the structure.
- b) Panels and their fixings.
- c) Thermal insulation and vapour barriers.
- d) Flashings, gutters, cappings, and similar metal weathering elements.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- e) Support steelwork.
- f) Sealants, which are concealed within the system and which cannot be inspected without dismantling the works.
- g) Finishes to metal components.

Secondary Components

- a) Secondary components are all components with a predicted service life of less than the design life of the curtain wall, assuming regular cleaning and maintenance in accordance with information to be provided by the curtain wall supplier. The following components shall be considered secondary components:
 - i) Internal linings. ii) Window and door equipment. iii) Gaskets and compression seals. iv) Other sealants. v) Glass and glazing components. vi) Motors, actuators and ancillaries.
- b) Secondary components shall be capable of replacement without dismantling the works, or compromising the structural or weatherproof integrity of the system. Components shall be capable of replacement without progressive dismantling of the works.
- c) The predicted service life of secondary components shall be stated and guidance on the required maintenance provided.

Services

Cables within Box Sections

- a) As specified, aluminium box sections shall be capable of containing electrical cables serving security/access equipment to doors, activators to opening vents, others, as indicated on the Tender Drawings.
- b) Openings for the installation of cables shall be provided by the Contractor, after discussion and agreement with the PM.

PRODUCTS AND FABRICATION

MATERIALS AND COMPONENTS

Frames

Frames Generally

- a) Glass retaining frames shall be manufactured from extruded aluminium unless otherwise shown on the Design Drawings. Working Drawings shall show the final extrusion design while strictly maintaining the PM's visual requirements.
- b) All corners shall be jointed and sufficiently flush, flat and true to comply with the specified tolerances. c) Frames shall be fully gasketed with vulcanised corners where in the same plane and forming the air and vapour barrier. No butting on Site shall be permitted.
- d) Frames shall be factory-glazed, delivered and installed in one piece.
- e) The frames shall safely and securely retain the glass by means of a combination of dry gaskets, structural silicone and/ or adequate aluminium/ stainless steel locating pieces.
- f) All framing shall utilise the minimum cross section necessary to maintain rigidity and performance.
- g) Framing shall include a glazing chamber separated by two seals, one outside the glazing chamber the other at the back. The glazing chamber shall be drained to the outside, this system shall comprise:
 - i) An outer seal designed to prevent water ingress into glazing or other chambers to substantially inhibit water penetration and to prevent heavy wetting of the back seal. Designs having full width gasket seals shall incorporate capillarity breaks to prevent the ingress and entrapment of water between surfaces in continuous contact.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ii) A back seal. This seal shall act as an air seal to minimise air permeability up to limits as specified. If subjected to light wetting in localised patches it shall prevent the ingress of this water to the inside face of the works. (Note: Designs relying upon single stage seals shall not be used).

iii) State, in the Contractor's Proposals, the spacings of drainage outlets for acceptance by the PM and demonstrate the adequacy and suitability of such spacings.

Frames (Structural Silicone Glazing System)

a) Provide prefabricated, unitised, aluminium frames made of aluminium extrusions for the structural silicone glazed units including glazing gaskets between glass panels.

b) The concept of the framing shall be a four-sided structural silicone glazing system with minimal framing being visible from the outside. Gaskets to be mitred at junctions between vertical and horizontal panels.

c) The framing shall be based on the pressure equalisation principle incorporating an external skin acting as a water and weather barrier and an internal skin providing the required air and vapour tight seal. Special openings in the framing shall comply with current glazing recommendations in size, spacing and location and shall be provided to the exterior of the frames in order to ventilate around the double glazing units, creating a drainage system for any water or moisture. All draining provisions shall be provided at the lowest level of the glazing rebates or framing system cavities to positively prevent any residue water from remaining within.

d) Allow for all glazing frame members to consist of two separate aluminium profiles complying with all structural and surface treatment requirements. Such aluminium extrusions shall be assembled using composite framing profiles with a proven continuous thermal break material. The thermal break system shall minimise the thermal transmittance, noise transfer and shall inhibit condensation on any of the internal surfaces of the framing members, the composite metal panels or the glazing under the extremes of the design temperatures stated herein.

e) Where structural silicone is specified as the preferred means of panel fixation, it is the visual intent achieved by this method of fixing that is required. Where secondary means of retention/ support are required to satisfy the performance requirements and/ or local statutory requirements, these shall be minimal and inconspicuous. All means of retention/ support shall be clearly indicated as part of the tender return and also after Detailed Design on the Working Drawings for acceptance by the PM.

f) The aluminium profiles shall be detailed to allow for the secure attachment of continuous sealing, vapour and air seals within the glazing rebates and for the four-sided structural silicone glazing, fixing brackets, etc. All of this shall be with due consideration to the structural requirements, the specified type of surface treatment and to achieve the specified solar shading, thermal transmittance and sound reduction values.

g) The aluminium profiles shall be factory assembled into unit frames by means of mitred corners, mechanically jointed with cleats or with butted corners and the appropriate additional sealant. The frames shall be structurally sound to fully comply with all applicable and specified wind and dead load forces that may act on them, in particular during transportation and erection on Site. The whole framing system shall be detailed to accommodate, without distortion or other adverse effects, any differential structural and thermal movements.

h) Thermally broken or separated split mullion expansion joints shall be incorporated into the works wherever required to allow for the thermal movement within the assembly. The outside dimensions and appearance of these split mullions shall correspond exactly with the standard frame profiles so that there is no visual distinction between these components. The split mullions shall be rigid and able to safely withstand any additional forces which may act on the units, either during transportation or erection on Site, taking into account structural requirements, the surface treatment, thermal transmittance and sound reduction values. The entire split mullion system shall be detailed to accommodate, without distortion or other adverse effects, any differential structural and thermal movements.

ANNEXURE-E1 TECHNICAL SPECIFICATION

i) Weather seals shall be provided at all interfacing connections. The vapour barrier shall always be installed on the warm side of the thermal insulation to provide a continuous air and vapour tight seal at all interfacing joints and intersections between the units and the building structure.

j) All framing shall be detailed in order that any necessary replacement of damaged glazing units, as well as doors, windows and structural silicone glazed components, can be carried out from outside the building with minimum disturbance to occupants, except for any inner leaf single glazing and atrium glazing.

Frames with Dry Pressure Glazing System (if required, and to the approval of the PM)

a) Prefabricated, unitised, aluminium frames made of thermally broken or separated aluminium extrusions for the glazed units.

b) The concept of all the framing shall be detailed to receive a fully pressure equalised glazing system. The principle shall incorporate an external skin surface acting as a water and weather barrier and an internal skin surface as an air and vapour tight seal. Special openings shall comply with the current glazing recommendations in size, spacing and location and be provided to the exterior of the horizontal glazing and cladding in order to guarantee air ventilation around the double glazing units and the insulated spandrel panels and to create a drainage system for any water or moisture. All draining provisions shall occur at the lowest level of the glazing rebates or framing system cavities to positively prevent any residue water from remaining within.

c) All glazing frame members consisting of two separate aluminium profiles shall comply with all structural and surface treatment requirements. These aluminium extrusions shall be fixed to composite framing profiles with a proven continuous thermal break material. The thermal break system shall minimise the thermal transmittance and noise transfer while inhibiting condensation on any of the internal surfaces of the framing members.

d) The aluminium profiles shall be detailed to incorporate any necessary glazing beads, continuous sealing gaskets, vapour and air seals, gaskets within the glazing rebates, connections for thermal break strips and provision for seals, connection spigots, corner cleats, clip-in aluminium profiles, fixing brackets, etc. All of this shall be with due consideration to the structural requirements, the specified type of surface treatment and to achieve the specified thermal transmittance sound reduction values.

e) The thermally broken or separated aluminium profiles shall be factory assembled into unit frames by means of mitred corners, mechanically jointed with cleats and the appropriate additional sealant. The aluminium frames shall be structurally sound to fully comply with all applicable and specified wind and dead load forces, being sufficiently rigid to safely withstand any forces that may act on them during transportation and erection on Site. The whole framing system shall be detailed to accommodate, without distortion or other adverse effects, any differential structural and thermal movements.

f) Weather seals shall be provided at all interfacing connections. The vapour barrier shall be installed on the warm side of the thermal insulation to provide a continuous air and vapour tight seal at all interfacing joints and intersections between the window and cladding units and the building structure and/ or the precast elements respectively.

g) All aluminium window framing shall be detailed in order that any necessary replacement of double glazing units can be carried out from inside/ outside the building (To be agreed with the Construction Manager).

h) Special thermal break provisions shall be employed in the case of the curved window frames to achieve all of the specified performance requirements of these special window units. The curved aluminium profiles shall display a uniform radius and shall be free of any rolling marks, imprints, scratches or distortion.

i) All aluminium extrusions and components shall be composite profiles or units with integral continuous thermal break provisions. Under extremes of design temperatures and relative humidity, no condensation shall appear on any internal surface of the framing member, the composite metal panels or the glazing.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Glass to Glass Corners

- a) Glazed corners shall be cantilevered where the transoms cantilever horizontally to support elements of the cladding. Details shall accommodate movements of the building without compromising the weather resistance and watertightness. Corners shall stay rigid and maintain their appearance.
- b) Glass to glass corners shall have an internal aluminium extrusion for stability and sealing purposes.

Joints

Movement Joints

- a) The requirement for any movement joints within the works shall be ascertained to accommodate all movements stated herein. The works shall accommodate all movements of the joint in a manner that does not compromise weather resistance and watertightness.
- b) Maintenance of the works joints shall be by visual inspection. Externally and internally, vertical movement joints shall appear as similar to the standard glazing system joint as possible. The material used at the movement joint locations shall not be thermally broken or separated.

Windows

Opening/Sliding Windows/ Casements

- a) Provide prefabricated, unitised aluminium frames incorporating opening casements/ windows with structural silicone glazing, comprising thermally broken or separated aluminium.
- b) Where required, opening windows/ casements shall be fabricated using cantilevered front pane double glazing with aluminium inner framing (referred to as frameless). The glazing shall be supported using factory applied structural silicone jointing between back framing and glazing. All opening vents shall open to the outside/ inside as shown on the Tender Drawings.
- c) Opening casements shall comprise manually and automatically operated, top hung, opening out casements, with concealed restrictor stays being installed into the framing in lieu of the fixed light glazing, wherever indicated on the Tender Drawings. Smoke control provision shall be maintained in accordance with BS 5588: Parts 5 and 11 and BS EN 12101: Part 6 and as required by the District Surveyor/ Building Control Officer and/ or the Fire Brigade respectively.
- d) Where required to open automatically, opening windows shall be fitted with electrically powered actuators geared to open and close the windows automatically, and to retain them safely open. Opening windows shall be provided with a local control panel, to be mounted in location agreed with the ENGINEER, with control wiring from control panel to window actuator; all fire rated in accordance with BS 5839 and BS EN 54. Panels shall include stand-by batteries for continuous operation of vents for a 3-hour period in the event of loss of mains power.
- e) Opening frames shall be mitred at the corners and sufficiently accurately cut to prevent the display of unfinished metal at mitre joints.
 - f) Section profiles shall comply with glazing rebate depth, width and edge clearance specified by the glass sealed unit manufacturer or, in the absence of such specific recommendation, with the provisions of BS 6262. The sealed unit manufacturer's fabricating tolerances shall be accommodated. Frames shall be sufficient to restrain the glass under maximum positive and negative wind pressures.
 - g) Include for all framing members of the opening casements to comprise two separate aluminium profiles, to comply with all structural and surface treatment requirements. The aluminium extrusions shall be fixed to composite framing profiles with a proven continuous thermal break. The thermal break system shall minimise the thermal transmittance noise transfer and shall inhibit condensation on any of the internal surfaces of the framing members.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- h) The external dimensions and appearance of the framing for the opening casements shall correspond exactly to the perimeter aluminium sub-frames for the fixed light glazing so that no visual distinction between these components can be made. The framing of the opening casements shall be fixed into the supporting window frames by means of heavy-duty aluminium or stainless steel hinges and concealed opening restrictor stays. The interfacing joint between the opening casements and the window frames shall be provided with a minimum of two perimeter sealing gaskets inserted into corresponding grooves in the aluminium profiles, creating an external rain barrier and the internal airtight vapour barrier required for a pressure equalised window system. The space between these gaskets shall be ventilated and drained to the outside of the assembly.
- i) Special aluminium extrusions shall be installed into corresponding grooves in the external side of the framing profiles of the opening casements to provide the loadbearing bonding surfaces between structural silicone joint and the supporting framework.
- j) Special aluminium extrusions shall be installed into corresponding grooves in the external side of the glazing sub-frame profiles to provide the dead loadbearing support for the cured silicone glass setting blocks.
- k) Special aluminium extrusions shall be installed from the outside to the perimeter glazing sub-frames to provide a slim perimeter mechanical safety restraint for the structural silicone glazed double glazing units. This continuous external perimeter glass restraint framing shall be detailed to provide minimal metal visible externally. The external surface of these perimeter safety restraints shall be flush with the external surface of the double glazing units.
- l) The aluminium extrusions for the framing of the opening casements shall be detailed to allow for the secure installation of continuous sealing gaskets, vapour and air seals, gaskets within the glazing rebates as well as connections for thermal break strips and provision for seals, corner cleats, clip-in aluminium profiles, such as the special natural anodised aluminium extrusions for the bonding of the structural silicone and the continuous perimeter aluminium safety rails for the four-sided structural silicone glazing, heavy-duty aluminium or stainless steel hinges, concealed stainless steel opening restraints, concealed multi-point locking devices with budget locks, etc. All of this under due consideration of the structural requirements, the specified type of surface treatment and to achieve the specified thermal transmittance and sound reduction values.
- m) The frame profiles shall be factory assembled into opening casement unit frames by means of mitred corners, mechanically jointed with cleats and the appropriate additional sealant. The entire opening casement assemblies shall be structurally sound to fully comply with all applicable and specified wind and dead load forces. They shall be sufficiently rigid to safely withstand any additional forces that may act onto these assemblies, in particular during transport and erection on Site. The opening casements shall be detailed to accommodate, without distortion, water leakage, noise or other adverse effects and/ or any differential structural and thermal movements.
- n) All opening casements shall be detailed in order that they may be removed from outside the building in the event of replacement of damaged double glazing units, so as to create minimum disturbance to the occupants of the building.
- o) The heavy-duty hinges shall be manufactured from aluminium or austenitic stainless steel to fully comply with all applicable and specified wind and dead load forces. They shall be sufficiently rigid to safely withstand any additional forces which may act onto the opening casements whilst being operated or when they are in their closed or open position.
- p) The opening casements shall incorporate two fully concealed mechanical opening angle restrictors with a built-in mechanism to hold the opening casement rigidly in its open position under the full specified design wind load until the locking latch is manually released.

Doors

ANNEXURE-E1 TECHNICAL SPECIFICATION

General

All doors shall prevent unauthorised entry by removing hinges or locking devices and with fixings from secure side.

- a) Generally all doors to be of a robust nature. Where fire rated doors are required, these shall incorporate fire rated glazing and glazing methods including fire rated seals.
- b) The ENGINEER to advise on the mastering requirements.
- c) Comply with the requirements of BS 8300.
- d) All cables/ conduits to be integrated and concealed in door frames. Draw wires to be provided for connections by others.
- f) All doors opening outwards unless otherwise shown on the Tender Drawings.
- g) Door frames and associated glazing to achieve the required maximum air leakage rates, weathertightness, acoustic performance and U-values as specified.

Framed Glazed Doors (if required and to the approval of the ENGINEER)

- a) Where forming solid doors within the system, doors shall be robust 'heavy-duty' grade doors, with frames designed to prevent the ingress of water and tested as specified for water penetration and air permeability.
- b) Provide prefabricated, unitised aluminium frames incorporating single leaf doors with structural silicone glazing, fabricated in thermally broken or separated aluminium extrusions.
- c) Doors shall be rebated and fixed into the supporting curtain walling frames and hung on heavy-duty grade 1.4401 stainless steel hinges or with heavy-duty pivoting mechanism and fully weather-stripped at head, jambs and sills with compression seals.
- d) Allow for all framing members for the leaf of the doors to comprise two separate standard aluminium profiles to comply with all structural and surface requirements. The aluminium extrusions shall be assembled to composite framing profiles with a proven continuous thermal break material. The thermal break system shall minimise the thermal transmittance noise transfer and shall inhibit condensation on any of the internal surfaces of the framing members.
- e) The aluminium extrusions for the framing of the leaf for the doors shall be detailed to allow for the secure installation of continuous sealing gaskets, vapour, air seals and gaskets within the glazing rebates as well as connections for thermal break strips and provision for seals, corner cleats and clip-in aluminium profiles.
- f) All ironmongery shall be satin stainless steel, to be agreed with the ENGINEER.

Framed Glazed Doors (if required and to the approval of the ENGINEER)

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ANNEXURE-E1 TECHNICAL SPECIFICATION

break system shall minimise the thermal transmittance noise transfer and shall inhibit condensation on any of the internal surfaces of the framing members.

e) The aluminium extrusions for the framing of the leaf for the doors shall be detailed to allow for the secure installation of continuous sealing gaskets, vapour, air seals and gaskets within the glazing rebates as well as connections for thermal break strips and provision for seals, corner cleats and clip-in aluminium profiles.

f) All ironmongery shall be satin stainless steel, to be agreed with the ENGINEER.

Glazing

Systems Generally

- a) Select all glazing materials and systems to comply with the performance requirements.
- b) Frit Types: i) FT-1: Frit percentage to be confirmed. ii) FT-2: Frit percentage to be confirmed.

Blinds

Venetian Blinds to Glazing

- a) Full height venetian blinds to all glazing at Subconcourse, Concourse, Box and Upper levels.
- b) Aluminium or steel perforated slats with natural anodised finish. Width of blinds as shown on the Tender Drawings.
- c) Blinds to be manually operated.
- d) Perforation types to be confirmed.
- e) Blind performance to suit the solar control requirements.
- f) Lower Rail: Width to suit slats, made of extruded aluminium profile, with anodised finish with end-caps to match.

Blinds Generally

- a) Profiles shall be true to the incline of the roof glazing as indicated on the Tender Drawings. The Contractor to provide all associated bracketry/ cleats and fixings to fix blinds to the primary structure.
- b) Obtain all blinds from a specialist manufacturer with a proven track record in supplying work of a similar scope and quality to the acceptance of the ENGINEER.
- c) No product names, manufacturer's names or reference numbers or identifying marks shall appear on the finished surface of any component.

Drive Mechanisms for Blinds

- a) The operating mechanisms shall operate smoothly with concealed adjustable bi-directional slip clutch to allow blinds to stop in any position.
- b) Limit controls: Provide upper and lower stop limits to prevent overwinding.
- c) Manufacture blind control mechanisms with controls capable of being located at either end of the blinds.
- d) All moving parts shall move freely and shall be self-lubricating.

Flashings

- a) Where required, aluminium flashings shall be provided. They shall be treated with anti-drumming insulation on the protected face if required.
- b) Flashings shall be polyester powder coated.

ANNEXURE-E1 TECHNICAL SPECIFICATION

c) Externally exposed flashings shall have continuation and interconnecting joints fully complying with the sealant manufacturer's written recommendations for movement joints; simple butt straps shall not be accepted.

Fixings

Fixings Requirements

a) Refer to Section Z20 for fixings generally.

b) Fixing components shall comply with all statutory requirements (and be to the acceptance of the District Surveyor/ Building Control Officer/ Structural Engineer) both as to strength and type and shall be designed to carry all dead, live and wind loading under due consideration of any applicable thermal movements. Select suitable components and fixings to meet the performance criteria specified.

c) Any sheet mild steel, cleats, angles, fixing brackets, etc. used in the fixing assemblies shall comply with BS 7668, BS EN 10029, BS EN 10210 and BS EN 10025: Parts 1-4 and 6 and rolled sections shall be used wherever practicable or appropriate. Steel sections used shall be hot dip galvanised to the requirements of BS EN ISO 1461 after all cutting, drilling for holes and welding has been completed.

d) Stainless steel fixing components for the works shall comprise components of high grade austenitic stainless steel exterior quality, grade 1.4401 to BS EN 10088, BS EN 10084 BS EN 10250: Part 4, BS EN 10095, BS EN 10048, BS EN 10051, BS EN ISO 9445, BS EN 10259 and BS 8298.

e) All non-visible supporting aluminium sub-constructions shall be corrosion protected. Mill finished aluminium shall not be used. Aluminium sub-constructions shall be separated from concrete by bitumen paint or similar acceptable method. Austenitic stainless steel to BS EN 10088 may be used in lieu of aluminium for any supporting sub-constructions.

f) Fixing bolts, nuts, screws, washers, etc. shall be manufactured from austenitic stainless steel complying with BS EN ISO 3506: Parts 1 and 2. All screw fixings and attachments shall be secured against vibrating loose.

Fixing Directly to Supporting Structure

a) Provide and install all fixing devices, including framing, bearing brackets, movement fixings, etc. and carry out all necessary preparation work such as drilling, plugging, screwing, bolting, cutting for anchor bolts or sockets to be cast in, making good, including grouting-in of anchor bolts, and fixing whatsoever necessary.

b) All fixings shall be co-ordinated with the superstructure design.

c) Submit details of all fixings for review and acceptance by the ENGINEER.

Sealants and Gaskets

Sealants

a) Sealant shall not leak or bleed causing any discolouration and runoff staining below or above horizontal joints shall be avoided either on stone facing or on elements.

b) Structural Silicone Sealants:

i) All glazing requiring structural silicone bonding shall be glazed under controlled factory conditions without any need for Site applied structural bonding sealant, unless accepted otherwise by the ENGINEER.

ii) Structural sealant glazing design shall limit the design tensile stress of sealants to 138kPa.

Gaskets

a) Gaskets shall be made of either Ethylene Propylene material (EPDM/ EP) or of Silicone. The colour of all gaskets shall be black.

ANNEXURE-E1 TECHNICAL SPECIFICATION

b) All visible room side glazing gaskets shall have factory vulcanised corners. All other gaskets shall have overlapping joints with appropriate sealant in between. It is a condition that the internal sealant of the entire envelope system has a continuous vapour and air seal. This also includes all interfacing connections.

Damp-proofing and Insulation

Damp-proof Membrane

a) The membrane shall be impermeable, rot-proof and resistant to specified extremes of movement and environmental temperatures. The membrane shall be vapour resistant, vapour permeable and airtight where necessary.

b) Submit details of proposed materials for review.

c) The material shall be composed of elastomer base (EPDM), or equivalent.

d) Substrates to receive bonding shall be free from dust and grease, free of cavities, ridges and sharp projections and be primed to receive adhesive as recommended by the membrane manufacturer. Surfaces that are not suitable to receive membrane shall be reported to the ENGINEER.

e) Membrane shall be lapped at least 100mm and bonded according to the manufacturer's full recommendations.

f) Other materials/ testing standards may be put forward for review by the ENGINEER.

Insulation

a) Insulation behind cladding elements shall be inert, rot-proof, durable, vermin-proof, non-absorbent and not degradable by moisture or water vapour.

b) Insulation shall achieve the performance requirements.

c) Insulation shall be selected including its method of attachment to eliminate the risk of bulging, sagging, delamination or detachment of the insulation.

Cladding Support Structure

Supports - All Architectural Steelwork

Provide a structural steel cladding support structure, as necessary, having due regard for any requirements in excess of that shown on the Structural Engineer's Drawings and also any requirements shown on the Tender Drawings. The structural steelwork shall comply with the Structural Engineer's Steelwork Specification, including protective coatings

FABRICATION

Fabrication of Curtain Walling Systems

a) Fabricate sections to accommodate and interface with work of other adjacent works by means of rabbets, interlocks, miscellaneous angles, trim and filler sections, as required.

b) Reinforce mullions with aluminium or stainless steel sections as required.

c) All gaskets shall be free from all contact and migration stain and compatible with all substrates, sealants and finishes with which they contact.

d) Fabricate glazing recess of sufficient depth to cover glass edge-seal.

Structural Glazing (SSG Bonding)

a) Structural glazing shall only be carried out in the factory. No structural glazing shall be permitted on site, except for replacement of broken or sub-standard glass or for 'come back' work.

b) Primers and cleaners and their application shall be strictly as recommended and approved by the silicone glazing manufacturer.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- c) Identify each curtain wall panel by a number, record the date of assembly, silicone type and batch, curing time, temperature and humidity within the plant at time of assembly.
- d) Refer and fabricate in accordance with Guideline for European Technical Approved for Structural Sealant Glazing Systems (SSGS) ETAG No. 002.

Tolerances for Manufacture and Element Fabrication

- a) The physical fitting together of any assembly of sub-elements shall be properly allowed for in the Detailed Design of the corresponding sub-elements.
- b) The following tolerances apply to each individual panel manufactured, assembled and ready for installation:
 - i) Length/ Width: Maximum allowed deviation is the lesser of 1.5mm up to 3000mm and 3.0mm above 3000mm of design dimension.
 - ii) Thickness/ Depth (extrusion tolerances nominally): Maximum allowed deviation is +3mm, -0mm.
 - iii) Squareness: Any diagonal length across the panel shall not deviate by more than the lesser of ± 3 mm or $\pm 0.075\%$ of design dimension.
 - iv) Bow: The centre section of the element shall not bow by more than the lesser of 3mm or 0.075% of the length of the element measured from a straight line between the ends of the element.
 - v) Straightness: Any surface or edge shall not deviate by more than +1.5mm from a 2m straightedge placed against it in a direction parallel to the long axis of the element.
 - vi) Flatness: Any surface shall not deviate by more than +1.5mm from a 2m straightedge placed against it in any direction.
 - vii) Twist: No section of the element may be twisted by more than 1° from the section at either end of the element.
- c) Tolerances shall not be cumulative.

FINISHES

Colours

To be selected from non-standard BS or RAL range by the Engineer.

SITE INSTALLATION

Generally

- a) All works shall be true to detail with continuous profiles, free from marks, defects, flaws, steps, waves, or damage of any nature.
- b) Dimensions and levels of the structure shall be verified.
- c) The glazing works shall be set out such that all framing members are installed in the correct position, within tolerance, and in the correct relationship to the building structure.
- d) All fixing bolts and anchors shall be installed in accordance with the manufacturer's recommended procedures.
- e) Materials shall be kept dry until fixed.
- f) Acceptance shall be obtained from the ENGINEER before drilling or cutting parts of the structure, other than where shown on the Working Drawings.
- g) Isolating tape, plastic washers or other suitable means shall be used to prevent bi-metallic corrosion between dissimilar metals.
- h) Bars shall be set out at evenly spaced centres, straight, parallel and truly aligned with other features where shown on the Working Drawings.

ANNEXURE-E1 TECHNICAL SPECIFICATION

i) The finished work shall be square, regular, true to line, level and plane with a satisfactory fit at all junctions.

Installed Blinds Generally

- a) Provide the blinds in continuous lengths over the glazing except where indicated otherwise.
- b) Install blinds to minimise the light leakage through the installation in the closed position.
- c) Secure the blinds with appropriate fixing brackets to withstand all operating forces. Accurately level the head rail to ensure that the blinds hang parallel to the framing.
- d) Adjust the installation to ensure that the blinds hang correctly and operate smoothly with edges aligned and correctly spaced. When operated, the blinds must stop at the open, closed and predetermined intermediate position with their bottom edges aligned and parallel to the framing.
- e) Store installed blinds/ shades in their fully retracted position to avoid damage and accumulation of dust and dirt until Practical Completion.
- f) Retain the protective covering in position, for as long as is practicable. Each individual blind shall be signed off as in working order with the ENGINEER.

TOLERANCES

Installation

- a) The works shall be installed to meet the tolerances as specified below. These tolerances shall be adhered to for the works in its completed installed condition. Make due allowance for any structural deformations caused by the installation itself due, for example, to the effect of the self-weight of the cladding on its supporting structure. In this respect, refer to the Project Common Tolerance and Movement document. In the case of any doubt seek further advice from the Project Structural Engineer regarding the deformations which shall be allowed for in the Detailed Design and installation.
- b) Level: For cladding set out following horizontal bands, each corner of the panel shall be placed to within 2mm of the design dimension to the corresponding Location Reference Plane. Further, the bottom edge of each cladding panel, based on the mean level of the respective bottom corners, shall be placed to within ± 1.2 mm of the design dimensions from the corresponding Location Reference Plane. Unless otherwise stated, the Location Reference Plane shall be defined as the horizontal plane through the mean level of the tops of the primary edge beam elements or slab edge to which each horizontal cladding panel band is placed/ suspended.
- c) Plumbness: For vertical cladding, each panel's reference face (exterior face for external cladding, visible face for single side exposure panels) shall be installed such that the respective offset distances of the top and bottom edges of the panel to an adjacent true vertical line (plumbline) do not differ by more than 2mm or 0.1% of the height of the panel, whichever is less.
- d) Panel Plan Alignment: For Curtain Walling/ Cladding installed following horizontal lines, the panels shall be installed such that the distances of its respective corners of its reference face to the cladding Location Reference Plane are within 3mm of the Design Dimension and do not differ from each other by more than 2mm. This applies both to the top and bottom edges of each panel. Unless otherwise stated, the Location Reference Plane shall be defined as the mean plane of the edges of the primary edge beams or slab edges corresponding to top and bottom widths of each cladding panel.
- e) Transom alignment: The misalignment between the edge of a cladding panel and its supporting transom shall not exceed 1mm.
- f) Joints: Where adjacent elements are designed to have edges, lines or surfaces which line through their common joint, the maximum allowed step across the joint is the lesser of ± 2 mm or $\pm 10\%$ of the joint width in any direction.

ANNEXURE-E1 TECHNICAL SPECIFICATION

g) The works shall be erected plumb and in proper alignment and relation to established lines and grades as shown on the Working Drawings. The erected system shall present true and accurate lines and flat planes. Deviations from lines, planes and verticality shall be limited to long wave formations of minimum wave length of 20m length with a rate of change not exceeding 1:1000 and a maximum amplitude of 3mm. All the above shall be measured from an optical or laser reference line.

h) Submit a detailed list of tolerances to which the works shall be installed within the requirements of the Tender Drawings and Specifications for the overall geometric requirements. All tolerances shall be submitted for review by the ENGINEER.

i) Tolerances shall not be cumulative.

Site Erection

a) Horizontal Plan Position: For any element at any level whose position is defined in relation to a primary reference grid, the maximum allowed deviation from the Design Dimension to that reference grid is $\pm 2\text{mm}$.

b) Where a series of elements are arranged in an array of two or more, the maximum allowed deviation of the horizontal distance between any two adjacent elements is $\pm 2\text{mm}$ from the corresponding Design Dimension.

c) Verticality: For any element connecting two or more reference levels, the maximum allowed deviation of the relative plan position in any direction of that element at any two successive levels is $\pm 2\text{mm}$ from the corresponding Design Dimension.

d) Planarity: Any element or group of elements whose position is defined from a reference plane shall not deviate from the Design Dimension of the reference plane by more than $\pm 2\text{mm}$ measuring perpendicular to the defined plane.

9. TECHNICAL SPECIFICATION FOR KALZIP OR EQUIVALENT ROOF AND WALL CLADDING SYSTEM

This specification covers the general requirements for kalzip oil equivalent roofing work

System Performance

The Kalzip Self Supported Standing Seam Roof System should have the following characteristics:

Appearance

No external fastener fixing exceed at ridge, gable, eaves & penetration details

Continuous sheets with no joints. If the end laps are unavoidable due to the design or construction constraints, the detailing should be provided by manufacturer and approved by Qualify Person (Architect or Engineer) to ensure that the end laps are weather tight.

The height of standing seam rib should be at 65 mm.

The design details that provided by manufacturer should present a uniform and smooth appearance free of unsightly irregularities for overall building geometry.

The structural calculation of roof system should be provided and approved by Professional Engineer.

The Kalzip Self Supported Standing Seam Roof system should accommodate the following movements without any permanent deformation or reduction in the specified performance:

ANNEXURE-E1 TECHNICAL SPECIFICATION

Deflection under design loads

The effects of repeated wind and internal pressure loading.

Changes in dimension and shape of components arising from building movements, including settlement, creep, twisting and racking.

Movement of any joint whether designed to permit movement or not.

Thermal movements.

Loading from maintenance personnel.

Dead Loads

The Kalzip Self Supported Standing Seam Roof system should be capable of accommodating the following dead loads without any reduction in performance:

The Kalzip Self Supported Standing Seam Roof system's own dead load to be accommodated locally, and without causing deflections or movements in the panels.

The dead loads derived from permanent fixtures like roof hatch, wall arrest system, walkways, lightening arrestors or services attached (to be defined by architect, if required) to external surfaces of the Kalzip Self Supported Standing Seam Roof system.

When calculating loads the worst combination should be considered, taking account of the fact that the pressure coefficients at various locations may determine more than one design criteria.

Live Loads

The Kalzip Self Supported Standing Seam Roof system should be capable of accommodating the following live loads without any reduction in its performance:

All loads resulting from movements of the roof support structure.

Vertically and horizontally applied loads acting on the surface of the panels arising from maintenance and cleaning operations. The Kalzip Self Supported Standing Seam Roof system should sustain safely, without reduction in performance and without permanent deformation to any component.

Impact loads, or transferred impact loads, that occur during its service life, without deterioration in its performance and without sustaining non-repairable damage.

When calculating loads, it should be ensured that the worst combination load cases have been considered, bearing in mind that the pressure coefficients at various locations may determine more than one design criteria.

The Roof panel and concealed clips shall be capable of supporting a minimum uniform live load of 0.75 kPa

Deflections

All components, couplings and fixings should be capable of accommodating all of the above deflection without permanent distortion, deformation or failure.

ANNEXURE-E1 TECHNICAL SPECIFICATION

The maximum allowable deflection of Kalzip Self Supported Standing Seam Roof sheet when under imposed load combination shall not exceed $L/200$. Under wind load combination, the deflection of the standing seam roof shall not exceed $L/90$, where L is the clear span in a direction normal to the plane of the element.

The Kalzip Self Supported Standing Seam Roof sheet shall not deflect under loading in any way that is detrimental to any element of the Kalzip Self Supported Standing Seam Roof system or adjacent structural or building elements.

In-Plane Thermal Movement

The Kalzip Self Supported Standing Seam Roof sheet should be designed to accommodate in-plane thermal movement resulting from the maximum and minimum ambient temperature differentials ranging 18 to 45°C. The design should cater for all temporary and permanent conditions envisaged for the works.

The Kalzip Self Supported Standing Seam Roof sheet should be capable of accommodating changes in dimension and shape of its components resulting from the varying surface temperatures without any reduction in the specified performance criteria.

Durability

The natural finish of Kalzip Self Supported Standing Seam Roof sheet has 25 years life expectancy in aggressive marine conditions & 40 years life expectancy in normal environment conditions as certified in British Board of Agrément (BBA).

The Kalzip Self Supported Standing Seam Roof sheet should have an evaluation report regarding the durability performance after long-term exposure (≥ 35 years) at different locations.

Weather & Water Penetration Resistance

The Kalzip Self Supported Standing Seam Roof sheet should be weather tight in accordance with:

AAMA 501.1 where the roof sheet is tested at 500 Pa pressure with water sprayed at a rate of approximately 3.4 litre/min/m² for 15 minutes have no water leakage during the test duration.

Approved by independent third party, German Institute for Building Technology

Approved by independent third party, British Board of Agrément (BBA)

Fire Resistance

The Kalzip Self Supported Standing Seam Roof system is classified as Ext. F AA when tested in accordance with BS 476-3: 2004 (Classification and method of test for external fire exposure to roofs).

The external & internal layers of Kalzip Self Supported Standing Seam Roof system should be classified as Class 0 in accordance to BS 476 Part 6 & Part 7.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Fire & smoke stopping: Contractor should be responsible for the provisions of all cavity barriers in the external wall and fire stopping at the junction of the external wall with other fire resisting elements of the structure.

Thermal Performance (U-value)

The thermal performance of U-value for completed Kalzip Self Supported Standing Seam Roof system should be equal or lesser than **0.35 W/m² K**. The value of U-value should be clarified either by finite element analysis.

Acoustic Performance

The Kalzip Standing Seam Roof system should have following acoustic performance:

Sound Reduction Index (Rw) of **39+/-2 dB** in accordance with ISO 717 Part 1 & together with the independent test report.

Lightning

The Kalzip Self Supported Standing Seam Roof sheet which is a part of the air termination network should compliance with CP33: 1996 or BS6651: 1999.

Kalzip E-clips as down conductors with Aluminium seamed standing seam roof sheet. The roof sheet with Kalzip E-clips has successfully passed the type test in accordance with EN 62305-3.

Warranty

The Kalzip Self Supported Standing Seam Roof system will be guaranteed for **15** years with regards to its composition, surface and tensile strength. In addition, the Roof Contractor must be fully trained and approved by the Kalzip Self Supported Standing Seam Roof system’s manufacturer. The trained & approved Roof Contractor should provide **5** years’ warranty stating that the roof system should be weatherproof and watertight

Material Specification

Roof Construction from bottom to top

The general roof construction should comprise from the bottom to top

Internal Metal Liner Sheets

Steel Liner	Material Specification
Material	Pre Painted Galvalume
Minimum Yield Strength, N/mm²	550
Modulus of Elasticity, N/mm²	210 000

ANNEXURE-E1 TECHNICAL SPECIFICATION

Elongation, %	17
Nominal Thickness (Steel Substrate + Metallic Coating)	0.5
Metallic Coating	
- Material	Al Zinc
- Coating Thickness, μm	(20+5+5)
- Coating Designation	AZ150
- Coating Mass at Both Surface, g/m^2	150
Product Geometry	
- Cover Width, mm	1000
- Pitch, mm	200
- Depth, mm	35
Non-Fragile Compliance	Classified Class B in accordance to ACR(M)001: 2000

Top Hat

Top Hat Bracket & Top Hat	Material Specification
Materials	Galvanized Steel
Nominal Thickness, mm	Minimum 1.6 and 2mm
Minimum Yield Strength, N/mm^2	245
Modulus of Elasticity, N/mm^2	205000
Metallic Coating	
- Material	Zinc
- Coating Designation	Z275
- Coating Mass at Both Surface (g/m^2)	275
- Coating Thickness, μm	15

Vapor Control Layer

VCL	Material Specification
Material	Double sided Aluminum

ANNEXURE-E1 TECHNICAL SPECIFICATION

Thickness, microns	Up to 150
Tensile Strength- MD N/25 mm	150 -170
Moisture Vapor Transmission, g/m ² /24hr	0.08- 0.2

Insulation

Insulation – Rockwool (60 kg/m³)	Material Specification
Density, kg/m ³	60Kgs/m3
Fire Classification	BS 476 Part 4
Thermal conductivity, W/mK at 20°C	Max 0.037
Thickness, mm	100 total

Note : Insulation surrounding skylights , at eaves edges, and ridge, for a 600mm width shall be of higher density of 120kgs/m3. This is avoid ponding due to maintenance at these locations

Kalzip 65/400 STUCCO Embossed /PVDF Coated

Kalzip 65/400	Material Specification
Material	Aluminum Alloy
Aluminum Alloy Designation	EN AW 3004
Minimum Tensile Strength, N/mm ²	200
Minimum Yield Strength, N/mm ²	185
Modulus of Elasticity, N/mm ²	70 000
Minimum Elongation in 50mm, A ₁ = 50%	3
Thickness, mm	0.9 mm
Finish	STUCCO/PVDF on exposed side and primer on rear side
Thickness of PVDF, μm excluding primer & adhesive coatings	18 – 25
Product Geometry	Straight
- Cover Width, mm	400
- Depth, mm	65

ANNEXURE-E1 TECHNICAL SPECIFICATION

Accessories for Kalzip Self Supported Standing Seam Roof System

Extruded aluminium alloy BS EN AW 6063 Gable End Channel

Extruded aluminium alloy BS EN AW 6063 Gable End Clip

Extruded aluminium alloy BS EN AW 6063 Tolerance Clip

Extruded aluminium alloy BS EN AW 6063 Zed Spacer

Extruded aluminium alloy BS EN AW 6063 Drip Angle

Fabricated aluminium alloy BS EN AW 3004 Ridge Closure

Closed cell cross-linked polyethylene ridge foam filler with tearing strength of 1.2. kg/cm

Closed cell cross-linked polyethylene eave foam filler with tearing strength of 1.2. kg/cm

Fabricated aluminium alloy flashing should be same quality, grade, and colour from the roofing elements

Fluorocarbon Coating System

The exterior finish coat should be PDVF paint system containing at least 70% of PVDF resin in dry paint film, as required by approved licensed coating formulations.

The PVDF resin should be either Kynar 500® or HYLar 5000®.

In order to minimise appearance differences; all requirements should be processed in one production run using the same batch of paint.

Gloss – standard colours will have a nominal gloss level of 20 to 35% (60°) - subject to choices of colours.

The coated finish of flashing and roof sheet should have the following properties:

Humidity Resistance tested accordance to ASTM D2247-94 (1000 Hours) with no influence.

Acid Salt Spray tested accordance to ECCA T8 (1000 Hours) with creep age on scribe to bare metal maximum 2 mm.

Resistance to cracking on bending tested to ECCA T7. No crack at $\leq 2T$.

Pencil hardness conforming to ECCA T4 with min F hardness grading.

Reverse Impact tested accordance to ECCA T6 with loss of adhesion index: $Gt \leq 1$.

Heat resistance tested accordance to ECCA T13. No influence in 0.6 hour by 60°C continuous metal temperatures.

Resistance to accelerated weathering topcoat tested accordance to ECCA T10. After 2000 hours, $DE \leq 4$ & gloss retention $\geq 70\%$ max chalk = rating of 8.

Fillers

ANNEXURE-E1 TECHNICAL SPECIFICATION

The type (s) supplied by the cladding manufacturer should accurately match the sheet profile.

Where shown on the design drawings and wherever necessary, corrugation cavities should be closed off from the outside and inside of the building. Ensure a tight fit and leave no gaps.

The material should be closed cell cross-linked polyethylene with a minimum density of 0.035 g/cm³.

The material should have minimum compression strength and tearing strength of 0.4 kg/cm² and 1.2 kg/cm² respectively.

The material must be durable and will not deteriorate under heat, UV exposure and weathering conditions.

Flashing & Capping

Flashing and capping to the roof will be manufactured from the same quality grade and colour of material as the roof elements.

Accessories

General

Cappings, closure pieces, flashings, trims sills, gutters, fillers, spacers, tapes, sealant, fixing etc. where not specified should be types recommended by the manufacturer.

Gutters

Gutter's top skin is to be 1.5mm thick stainless steel or 2mm thick aluminium in mill finish. The aluminium flashing is to be same specifications as the material used for the Kalzip Self-supported standing seam roof top skin.

Vapour control layer should as specified in the gutter areas should be extended to over the gutter liner and into the down pipe.

Sealing Laps

The Sheet Manufacturer should recommend sealant type(s) for the purpose.

The position of sealing laps should be in straight unbroken lines immediately below fixing positions and parallel to the edges of sheets. They should be placed into corrugation and not allowed to stretch or sag in position.

Ensure continuity and effectiveness of seal especially at corners of sheets. Do not over compress.

Fixing Bolts, Anchors, Brackets, Screws, Rivet and Nuts

Stainless steel to be grade 300 series unless specified in the drawing.

Type, size and positioning of all bolts & nuts, anchors, screws and rivets should be shown on the Contractors Drawing, together with full details of their installation technique and torque settings where appropriate.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Where it is not possible to conceal fixings, a maximum of five-exposed bolt/stud threads should be used, subjected to approval from the Architect.

Fall Arrest System (Optional only if required –by client)

The Fall Arrest System on Self-Supported Aluminium Standing Seam Roof sheet is developed to be a part of “complete” system and it should be used for maintenance and access purpose.

Anchor posts are locked onto the upper seam of the Self-Supported Aluminium Standing Seam Roofing System, providing a unique, user friendly system which does not threaten the water proofing integrity of the roof.

This post shall be an aluminium polyester powder coated base plate, secured to the external roof top sheet via 4 x aluminium split clamps that allow for the thermal movement of the roofing system.

The powder coated post body, containing the stainless steel energy absorbing coil, is to be manufactured from aluminium with an electro polished stainless steel dome. Both the base plate and body need to be tested to the following standards and results:

1000-hour Salt Spray to ASTM D1186 Method B – With the result being: No signs of corrosion or delamination or reduction in gloss.

1000 hour Acetic Acid Salt Spray in accordance with BS EN ISO 2360:2003 – With the result being: No signs of corrosion over any area of the coating.

The post shall be installed by a Registered Installer strictly in accordance with the manufacturer’s requirements and specification.

All posts will be placed at a minimum of 6m to a maximum of 10m apart from each other.

All top fittings, brackets, integral tension indicator and critical castings are to be manufactured from stainless steel and electro polished where applicable.

The Transfastener® travelling device will allow for hands free operation either side of the line without detachment from the system.

Performance of Fall Arrest System:

The complete system to be capable of supporting three users working simultaneously at any point along the 8mm 7x7 stainless steel cable, even in the same span.

The manufacturer shall demonstrate that an individual post is capable of absorbing a direct single dynamic load of 300kg dropped through 1.5m without damaging the standing seam roof system. This shall be evidenced by an independent notified test body report (including photographs) indicating peak loads when tested in combination with the roof.

The manufacturer shall demonstrate that the individual post works primarily in a shear force condition and not with a turning moment force, which could seriously damage the roof.

ANNEXURE-E1 TECHNICAL SPECIFICATION

The manufacturer shall demonstrate that each post is capable of absorbing a static load of 20kN held for three minutes.

Once installed, the post shall be capable of absorbing the above load requirements in any direction and evidenced by full scale testing.

The energy absorption of an individual post should not be less than 5000J.

The Fall Arrest System shall compliance to following requirement:

The system shall hold a valid CE Mark and shall hold EC declarations of conformity.

The post shall have an individual serial number clearly marked on the product.

The post shall be independently tested by a notified body in accordance with the European Standard EN795:2012 for Protection against falls from height – anchor devices – requirements and testing to both EN795 Class A & Class C.

The manufacturer should hold a valid ISO 9001 certificate.

The manufacturer shall provide evidence that batch conformance tests using periodic X-ray's of components and periodic static and dynamic tests are carried out to prove component quality.

The manufacturer shall provide an independent test report detailing fall protection tests conducted with Self-Supported Standing Seam Roofing with the steel reinforced glass fibre reinforced polyamide clip (E-clip) and aluminium clip. The report shall reference the loads attained and include detailed photographic evidence.

INSTALLATION

Workmanship

All works should be true to detail with continuous profiles which should be free from marks, defects, flaws, steps, waves or damage of any nature.

All elements of framework and associated beads and strips should be stored on Site such that they will not be damaged, distorted or weathered unevenly.

All roof panels, sealants and gaskets should be stored on Site in accordance with the manufacturer's recommendations.

Dimensions and levels of the structure should be verified using total station.

Setting out should be such that aluminium panels are installed in the correct position, within tolerance, and in the correct relationship to the building structure.

All aluminium panels should be correctly mounted so that they are all consistently orientated.

All fixing bolts and anchors should be installed in accordance with the manufacturer's recommended procedures.

Materials should be carefully stored on site and remain dry until fixed.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Approval should be obtained from the Engineer before drilling or cutting parts of the structure, other than where shown on the approved Shop Drawings.

Isolating tape, plastic washers, or other suitable means to prevent bi-metallic corrosion between dissimilar metals should be used throughout the project.

E Clips should be set out at evenly spaced centres, straight, parallel and truly aligned with other features, where shown on the Shop Drawings.

The finished work should be square, regular, true to line, level and plane, with a satisfactory fit at all junctions.

An Kalzip Self Supported Standing Seam/ Flashings system should be laid, making due allowance for the sequencing of the whole and all interfaces. A secure free draining and completely weather tight roof should be provided.

The installation team should be fully trained approved and certified by the Kalzip Self Supported Standing Seam Roof system manufacturer. In the event that the installation team is not approved by the manufacturer, the manufacturer reserves the right to reject the inspection for the roof and not provide any warranty for the entire roof system. All printed instructions and installation manuals and directives issued by the Kalzip Self Supported Standing Seam Roof system manufacturer should be strictly adhered to.

Tolerances

Account should be taken of the installation tolerance requirements of the Kalzip Self Supported Standing Seam Roof System.

The erected steel purlin top level should be suitable for installation of the roofing system and be within the allowable level difference of + / - 10 mm.

The Kalzip Self Supported Standing Seam Roof system should be erected plumb and true in proper alignment and relation to established lines and grades as shown on the approved Shop Drawings. The erected system should present true and accurate lines and flat planes.

A method statement should be submitted detailing proposals for achieving the specified tolerances. This should demonstrate that a clear understanding of the construction method and the fabrication method of the panels is possessed.

A detailed list of tolerances to which the Kalzip Self Supported Standing Seam Roof system will be installed, within the requirements of the Performance Specification for the overall geometric requirements should be submitted before any starting any installation work. All tolerances should be submitted for review by the Engineer. As a minimum the statement of tolerances should include the following:

Thickness.

Position on plan.

Level.

Alignment.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Joints between panels.

Diagonal.

Eccentricity.

Inclination.

Allowance for sufficient analysis of the erection sequence should be made, thus ensuring and satisfying the Engineer that the installation tolerances stated above will be met.

At the time of handover the visual requirements of the Kalzip Self Supported Standing Seam Roof system are as follows:

The roofing panels should be horizontal/vertical and geometrically shaped as shown on Design Drawings.

All joints should be of equal size and at equal centres, unless shown otherwise on the Design Drawings.

The Kalzip Self Supported Standing Seam Roof sheet should present true and accurate straight lines and slat panels within the plane of the elevations and geometry.

Dimensional Checking: Before work begins on Site the proposed methods of dimensional setting-out and cross-checking with adjacent trades and elements, to satisfy the accuracy requirements, should be submitted to the Engineer's/ Architect's discretion, provided they are agreed in advance of the manufacture of components.

Work should be within the tolerances stated herein and no revisions to the tolerances allow inadequate control should be permitted.

The Kalzip Self Supported Standing Seam Roof sheet when installed should not be subjected to warping or twisting, should be strictly rigid, firm, free from vibration, knocking rattles, squeaks and other noises when subject to the worst combination of environmental conditions and wind loads.

ROOFING MANUFACTURER CREDENTIALS

The roofing manufacturer shall possess the following manufacturing credentials and capabilities:

Accredited with a Quality Management System in compliance with ISO: 9001:2008 for the Sales, Manufacturing and Supply of High Performance Roofing System

Minimum 45 years' experience in manufacturing of Aluminium Self Supported Standing Seam Roof sheet.

Track record to include a minimum of 5 Projects of similar size in India.

Should possess Site Manufactured facility in India with more than 5 mobile roll formers in India at the time of tender.

Should have completed & maintained a minimum of 500,000m² installed in the country of application over a period of no less than 5 years

ANNEXURE-E1 TECHNICAL SPECIFICATION

References

British Board of Agreement for Kalzip Secret Fix Roofing Systems

Deutches Institute fur Bautechnik General Building Inspectorate Approval Z-14.1-181

Under Writer Laboratories (UL-90)

ISO Certificate (ISO 9001)

The proposed Aluminium Roofing System must have FM Approval certification.

SUBMITTALS (INSTALLER)

General:

Submit listed submittals in accordance with Conditions of the Contract

Product Data:

Submit manufacturer's specifications, standard details, (and installation manual.)

Shop Drawings:

Show roof panel system with flashings and accessories in plan and elevation; sections and details. Include metal thicknesses and finishes, panel lengths, joining details, anchorage details, flashings and special fabrication provisions for termination and penetrations. Indicate relationships with adjacent and interfacing work.

Do not proceed with manufacture of roofing materials prior to review of shop drawings and field verification of all dimensions.

Samples:

Submit sample board consisting of panel section, 300mm long x full width panel, showing proposed metal gauge, finish and seam profile. And all accessories including panel clip and gable clip. Ridge accessories and fasteners / and end filers

Test Reports:

Submit copies of design test reports for each of the performance testing standards listed in Section 4 - e of this specification.

Test reports shall be performed by an independent, accredited testing laboratory.

Calculation:

Submit engineering calculations defining cladding loads for all roof areas based on design criteria

Calculation shall clearly indicate clip type, spacing of clips by roof zones, and fastener requirements.

Compute uplift loads on clip fasteners with recognition of prying forces and eccentric clip loading

ANNEXURE-E1 TECHNICAL SPECIFICATION

Calculate pullout/shear strength of fasteners in accordance with test data published by the fastener manufacturer, utilizing applicable material safety factors.

Compute thermal calculation for expansion/contraction forces due to total temperature differential of 30 degrees C.

Compute panel fixed point attachment forces and required fasteners.

Compute in-plane clip forces and indicate required attachment fasteners

MISCELLANEOUS

Preparation

Roof Installer to submit a program schedule to include (non exhaustive)

Material procurement

Drawing submission

Method statement

Material approval

Installation

Roof Installer to submit a detailed documentation to include (non exhaustive)

Quality Assurance and Quality Control plan

Manpower allocation

Method statement

Safety plan pertaining to the roof installation

10. TECHNICAL SPECIFICATION FOR DRY SAND STONE CLADDING

Scope of Work

This scope includes design, engineering, supply, installation and testing of Dry Stone Cladding.

Material

Stone shall be 30mm thick sand stone as approved by the engineer in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified

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

ANNEXURE-E1 TECHNICAL SPECIFICATION

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

Stacking and Storing

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

Scaffolding

As per specification above for Formwork & Scaffolding

Fixing

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

Jointing:

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

Protection:

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

STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification of Structural Steel Works as mentioned above

Fixing of Frame

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

ANNEXURE-E1 TECHNICAL SPECIFICATION

provision of necessary centring/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone

ADJUSTABLE STAINLESS STEEL CRAMPS

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

The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.

Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

Necessary recessed are required to be done in stone slab which is required to be supported by clamps.

The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.

The rate includes cost of materials and other operations mentioned as above.

11. TECHNICAL SPECIFICATION FOR RAILINGS

GI Staircase and Ramp Handrail - 900mm Height

Supplying, Fabricating and erecting in position of GI handrail 900mm clear height from finished step level with Top rail 50mm dia Medium class pipe fitted on Vertical Baluster Pipe of 40mm dia at every 1050mm c/c (Max) and 25mm M.S Squire Bar as vertical at equal distance (115mm max) between the balusters and should be welded with Horizontal pipe of 32 mm Square MS bar , embedded into concrete by fixed with 2 nos of 16 mm square bars as shown in the drawing including necessary tools and plants required etc.and finishing etc.Rate shall include preparation of surface, applying two coats of Zinc chromate/Phosphate primer and two coats of first quality synthetic enamel paint of approved make etc. complete

GI Staircase and Ramp Handrail - 1100mm Height

Supplying, Fabricating and erecting in position of GI handrail 1100mm clear height from finished step level with Top rail 50mm dia Medium class pipe fitted on Vertical Baluster Pipe of 40mm dia at every 1050mm c/c (Max) along with additional railing of 50mm dia at 900mm height from finished step level and 25mm M.S Squire Bar as vertical at equal distance (115mm max) between the balusters and should be welded with Horizontal pipe of 32 mm Square MS bar , embedded into concrete by fixed with 2 nos of 16 mm square bars as shown in the drawing including necessary tools and plants required etc.and finishing etc.Rate shall include preparation of surface, applying two coats of Zinc chromate/Phosphate primer and two coats of first quality synthetic enamel paint of approved make etc. complete

GI Vomitory Handrail – 600mm Height

Supplying, Fabricating and erecting in position of GI handrail 600mm clear height from RCC keb walls and Top rail 50mm dia Medium class pipe fitted on Vertical Baluster Pipe of 40mm dia at every 1050mm c/c (Max) and 25mm M.S Squire Bar as vertical at equal distance (115mm max) between the balusters and should be welded with Horizontal pipe of 32 mm Square MS bar , embedded into concrete by fixed with 2 nos of 16 mm square bars as shown in the drawing including necessary tools and plants required etc.and finishing etc.Rate shall include preparation of surface, applying two coats of Zinc chromate/Phosphate primer and two coats of first quality synthetic enamel paint of approved make etc. complete

GI Balcony Railing - 600mm Height

Supplying, Fabricating and erecting in position of GI handrail 600mm clear height from RCC keb walls and Top rail 50mm dia Medium class pipe fitted on Vertical Baluster Pipe of 40mm dia at every 1050mm c/c (Max) and 25mm M.S Squire Bar as vertical at equal distance (115mm max) between the balusters and

ANNEXURE-E1 TECHNICAL SPECIFICATION

should be welded with Horizontal pipe of 32 mm Square MS bar , embedded into concrete by fixed with 2 nos of 16 mm square bars as shown in the drawing including necessary tools and plants required etc.and finishing etc.Rate shall include preparation of surface, applying two coats of Zinc chromate/Phosphate primer and two coats of first quality synthetic enamel paint of approved make etc. complete

SS Balcony Railing - 600mm Height

Supplying, Fabricating and erecting in position of Stainless Steel (SS304 Grade) handrail 600mm clear height from RCC kebs walls and Top rail 50mm dia Medium class SS pipe fitted on Vertical Baluster Pipe of 40mm dia SS Pipe at every 1050mm c/c (Max) and 25mm SS Square Bar as vertical at equal distance (115mm max) between the balusters and should be welded with Horizontal pipe of 32 mm Square SS bar , embedded into concrete by fixed with 2 nos of 16 mm square bars as shown in the drawing including necessary tools and plants required etc.and finishing etc.Rate shall include preparation of surface, applying two coats of Zinc chromate/Phosphate primer and two coats of first quality synthetic enamel paint of approved make etc. complete

SS Staircase / Bancony Handrail - 900mm Height

Supply and fix Stainless Steel Hand rail using 3 mm thick SS pipe of the following Diameter of pipe - Single Piece bent to shape and Profile, fixed as per drg. Rate shall include for providing the handrail to a height of 900mm high from finished floor level and providing the handrail to any combination of pipes as group Hand rail as shown in the drg. The rate shall include for providing suitable SS base cups, making pockets in existing RC / Masonry surfaces, fixing SS plate of size 100 x 100 - 6 mm thick with 14 mm dia. 75 mm long of Hilti make anchor fasteners and grouting the pockets with CC 1:2:4 and make the surface to the original position etc. complete all as directed. All SS pipes conforming to AISI 304 Grade (ie.Non magnetic SS 304 Grade). Rate shall include necessary tools & Plants, Welding with consumables & buffing charges, welding consumables etc. complete as directed.

SS Staircase Handrail -1100mm Height

Supply and fix Stainless Steel Hand rail using 3 mm thick SS pipe of the following Diameter of pipe - Single Piece bent to shape and Profile, fixed as per drg. Rate shall include for providing the handrail to a height of 1100mm high from finished floor level and providing the handrail to any combination of pipes as group Hand rail as shown in the drg. The rate shall include for providing suitable SS base cups, making pockets in existing RC / Masonry surfaces, fixing SS plate of size 100 x 100 - 6 mm thick with 14 mm dia. 75 mm long of Hilti make anchor fasteners and grouting the pockets with CC 1:2:4 and make the surface to the original position etc. complete all as directed. All SS pipes conforming to AISI 304 Grade (ie.Non magnetic SS 304 Grade). Rate shall include necessary tools & Plants, Welding with consumables & buffing charges, welding consumables etc. complete as directed.

12. TECHNICAL SPECIFICATION FOR SPORTS FLOORING WORKS

1. MAPLE WOOD FLOORING

Hard Maple Surface:

Top surface to consist of a solid, MFMA Certified Hard Maple strip with minimum dimension of 20mm thickness x 57 mm width x RL (random length). Each individual strip of Hard Maple shall include the certification chop of the MFMA (Maple Flooring Manufacturers Association) and manufacturing mill certification number. System must provide a solid Hard Maple top layer of (minimum thickness) 20mm and is to be machined to a smooth finish and varnished after fixing of the individual boards in place at the installation site. Pre-finishing of the boards at the factory is not acceptable.

Maple Fasteners:

ANNEXURE-E1 TECHNICAL SPECIFICATION

Hard Maple boards to be fastened in place by pneumatic machine stapling with a 50mm coated flooring staple. Boards to be secret fastened with the staple applied at a 45 degree angle at the top of the tongue on the side of the board.

Vapor Barrier:

.20mm polyethylene membrane installed over the concrete base, beneath the flooring system as a vapor barrier between the concrete and wood floor.

Plywood subfloor and resilient pads:

1st layer of plywood to be 12mm x 1220mm x 2440mm ISI approved BWR grade plywood. 1st layer of plywood to have the resilient pads affixed to the underside on 30 cm o.c. spacing regiment and to be installed on the concrete with the long dimension of the plywood running at a 90 degree angle to the direction of the hardwood strip flooring

2nd layer of plywood to be 12mm x 1220mm x2440mm MR Grade plywood and fixed to the 1st layer with mechanical fasteners (staples) at a direction in 45 degree angle to the 1st layer.

Shock Pads:

Resilient pads of 19mm thick 2 stage, Polyurethane, resilient shock pads fixed to the underside of the 1st layer of plywood at 30cm o.c. spacing regiment. System must provide a minimum of 10 resilient pads per square meter of installed flooring system.

Shock Pads Tensile Strength should not be less than 5000 psi and must be tested in accordance with STEM

Finishing :

Apply 2 coat of approved sealer and 2 coat of Gym finish per manufacturer's instructions with 2 coat of game line marking

Performance & Quality Certification:

1. Flooring system shall be independently tested and certified to the EN14904 performance standard and certificate from an accredited, independent testing laboratory must be submitted
2. Manufacturer to be a certified manufacturer of the MFMA (Maple Flooring Manufacturers Association)- certificate to be provided as evidence of such
3. Manufacturer to be certified in accordance with ISO9001:2000 standard- ISO certificate to be provided as evidence of such.
4. Flooring system to be tested and certified in accordance with STEM (Structural Testing and Engineering Measures)- certificate to be provided as evidence of such.
5. Shock Pads Tensile Strength should not be less than 5000 psi and must be tested in accordance with STEM testing standards and provide minimum ratings of- certificate to be provided as evidence of such
6. The floor manufacturer should have Certifications from following International federations -
 1. WORLD BADMINTON FEDERATION.
 2. INTERNATIONAL HAND BALL FEDERATION.
 3. INTERNATIONAL BASKET BALL FEDERATION(FIBA)

2. VINYLE SPORTS FLOORING

Supply of 6 mm thick RECREATION-45 synthetic sports surface it consist of 100% pure vinyl wear layer of 1.5 mm thickness, upper surface treated with protecsol to reduce Skin burn and sanosol treatment to avoid fungalgrowth.Double fiber glass grid for sound stability on floor.Width of sheet is 1.5mts, joined with seamless hot welding.Laid with adhesive as per manufacturer's instruction over existing leveled surface including game lines marking with following Technical specification.

Shock absorption under EN 14808 standard not less than 25%

Ball bounce under EN 12235 standards not less than 90%

Abrasion resistance under EN ISO5470-1 < 350mg.

Approved by :- FIBA (Federation International Basketball Association) . WBF (World Badminton Federation) .

ANNEXURE-E1 TECHNICAL SPECIFICATION

3. SPIKE & IMPACT RESISTANT EPDM FLOOR TILES

Supply and installation spike resistance rubber flooring for Locker room it consist of Black rubber granules and 30% synthetic EPDM granules floor should be Environmental friendly, non-toxic, Recycled , non-polluted, anti-slip and anti-fatigue Laid with adhesive as per manufacturer's instruction over existing leveled surface with following Technical specification.

Density (kg/m):1250/1400

Hardness (Shore a):65

Length (m):not less than 10 mtr

Width (m):not less than 1 mtr

Thickness (mm): 10mm (tolarence in thickness not less than ± 0.3 mm)

Tensile Strength ASTM D41206A(2013) :- not less than 2MPa

Tear strength ASTM D62400 (2012) :- not less than 10 kn/m

Compression set ASTM D395-03(2008) Method B:-not less than 12%

4. SPORTS SKIRTING

Supply of 75mm x 100mm rubber base molding to include air channeling in back of base to provide full ventilation of the sub-floor system. Fixed to the wall with a base molding adhesive as recommend by manufacturer.

5. ALUMINIUM SKIRTING

Supply of 2.5 mm thick Aluminum Profile (Reducer) for periphery of sports flooring, Size of Aluminum profile not less than 100 mm wide and 1500 mm long with counter hole and Anodizing.

13. TECHNICAL SPECIFICATIONS FOR STADIUM SEATING

General Requirements for Specialist Subcontractor

- 1) It should also have sufficient expertise and experience in manufacture, supply and installation of Stadium Chairs.
- 2) It should have satisfactorily completed supply & installation of minimum 25,000 chairs of similar nature in last 5 years for a stadium hosting International Cricket Matches, Common Wealth Games, Asian Games and any other International Sporting Event in India. The company must provide documentary proof for the same.
- 3) The applicant should provide mockup of proposed Chair including installation on site at Haldwani, Naintal.
- 4) It should have its own manufacturing facility and shall arrange visit of Employer/Engineer to its Manufacturing Facility and of their completed works.
- 5) It should provide Names of Technical Experts to be deployed by the Company to supervise the execution of the work
- 6) It should provide guarantee to Employer against any manufacturing & installation defect for a period of 5 years
- 7) The specialist subcontractor shall provide detailed Company Profile in soft and hard copy, it should also include but not limited to following details about the company
 - a. Details of Production Capacity
 - b. Details of Manufacturing Facility

ANNEXURE-E1 TECHNICAL SPECIFICATION

- c. Company Financial Details
- d. Details of Stock Inventory of last three months of each type of chair for which the bid is submitted
- e. Credentials of Completed works
- f. Pert Chart defining the schedule of completion from start date, if awarded the work.
- g. Certificate / Compliance for seating meeting FIFA Guidelines / ICC Guidelines
- h. Certificate / Compliance for seating meeting Indian Standards of Fire, Safety, etc

Minimum Technical Requirement of Chairs

Seating in the spectator stands shall be molded single piece seats fixed to the base with suitable fastening devices, and shall conform to the following requirements

1.	Moulded :	Moulded from UV resistant polypropylene with fire retardant additives available, to 180 Kilo Langley Rating.
2.	Fastening:	Tamper Proof Fastenings
3.	Backrest:	Flexible upper back and solid lower back to provide exceptional support and avoids concentrated pressure points
4.	Strength & Durability:	The seat has been designed to pass the most demanding standards and comes with a five year guarantee
5.	Ergonomic:	Seat conforms to the preferred posture and supports movement, as supported by ergonomic studies
6.	Standards:	Seat designed to be "maintenance free" and has tested to Australian, British, European, USA & International Standards
7.	VIP Seat Tip Up:	The tip up operation has an initial stop at the three quarter "wave safe" position and can be held back to the most compact position for increased access.

ANNEXURE-E1 TECHNICAL SPECIFICATION**ELECTRICAL WORK**

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ANNEXURE-E1 TECHNICAL SPECIFICATION**ELECTRICAL WORK****II. TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS****1. TECHNICAL SPECIFICATION FOR TRANSFORMERS(OIL COOLED)****1.0 Scope**

1.1 The scope of work shall cover the supply of transformers suitable for indoor and/or outdoor installation meeting the requirements specified in the Data Sheets. Associated minor building works required for the erection of the transformer are excluded from the scope of this contract.

1.2 Erection, testing and commissioning of the transformers shall be as specified in the section "Substation Auxiliaries And Installation".

2.0 Standard

2.1 The following standards shall be applicable.

1	IS 2026	1977	Power Transformers
2	IS 6600	1972	Guide for loading of oil immersed transformers
3	IS 10028	1985	Code of Practice for selection, installation and maintenance of transformers.
4	IS 335	1993	New Insulating Oils
5	IS 8468	1977	On-load tap changers

All standards shall be the latest

2.2 Tenderers should submit guaranteed performance data as per Appendix B to IS:2026 for proper evaluation of their equipment.

3.0 Construction

3.1 Transformer core shall be built up of low loss non-ageing grain oriented silicon steel insulated laminations and designed to ensure low core losses. Adequate cooling ducts shall be provided to achieve low temperature rise and hot spot temperature. Transformer tanks shall be of robust construction fabricated out of M.S plates. All welded joints and valves shall be tested after fabrication of the tank to withstand a pressure of 1.0 bar in excess of the static head of oil. Bolted joints shall carry non-deteriorating gaskets.

3.2 Transformer cooling shall be as specified in the data sheets with fixed or removable radiator tubes of seamless construction and adequately braced to the tank.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.3 All fittings shall be provided as stipulated in the data sheets.
- 3.4 Winding shall have Class `A` or better insulation graded uniformly to earth. Interturn insulation of tapped windings shall be reinforced to obtain uniform stress distribution. The winding assembly shall be preshrunk by vacuum drying and impregnated with an approved insulation. Adequate ventilating ducts shall be provided in the winding.
- 3.5 Tappings shall be OFF-load or ON-load as shown in the data sheet and brought out from the HV winding and terminated in an external tap switch, Manual switches shall have position indicator and pad locking arrangement. Automatic ON-load tape changers shall be proven units. Transformer output shall remain unaffected for any tap position.
- 3.6 The Transformer shall be supplied under oil conforming to IS:335. The transformer shall be delivered after filtering and drying out to a moisture content of less than 5ppm and the content shall be tested and confirmed before dispatch. The transformer should be ready to be put into commission without further drying out at site. Should however, the precommissioning tests require drying, necessary drying with a stream line filter shall be carried out free of cost. Any other filter process is not acceptable.
- 3.7 RTCC panel colour shall be matched with the LT panels in in electrical room & the same will be confirmed at the time of shop drawing approval.

4.0 Factory Testing

- 4.1 Transformers shall undergo following routine tests as per IS 2026:1997 and shall form part of the test report to be submitted along with the transformer.

Ratio & Polarity tests error	Winding resistance Phase angle Tap contact resistance IR Valves Open circuit,
B D V of oil Index discharge	Short circuit & Impedance tests Polarisation Separate source voltage test Dielectric Induced over voltage test Vector group test Zero sequence voltage test

- 4.2 Vendor should quote for a heat run test as an optional item.

5.0 Installation, testing and commissioning

- 5.1 Installation, testing and commissioning shall be carried out as specified under the section "Substation & Auxiliaries and Installation".

6.0 Mode of measurement

- 6.1 Supply of the transformer including transport to site loading and unloading etc. as specified will be treated as one unit for measurement & payment. Installation and commissioning shall be paid separately.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.2 It heat-run test is to be done, it shall be paid for separately.

2. TECHNICAL SPECIFICATION FOR HV SWITCHGEAR WORKS

1.0 Scope

- 1.1 The scope of work shall cover supply of high voltage switchgear incorporating Vaccum breakers.
- 1.2 Equipment should conform to the specifications and the data sheet.
- 1.3 Installation, testing and commissioning shall be carried out as specified under the section “Substation Auxiliaries”.

2.0 Standards

2.1 The switchgear should meet the requirements of the following standards and rules:

1	IS 3427 – 1997	AC Metal enclosed switchgear & control gear for 1KV and above.
2	IS 13118 – 1991	HV alternating Current Circuit Breakers
3	IS 2705 – 1992	Current transformers
4	IS 3156 – 1992	

All standards shall be the latest

3.0 Type & Construction

- 3.1 The breaker panel shall be a fully factory built assembly to IS 3427 and pressure tested to ensure maximum safety for operating personnel. The panel shall be type tested and all test certificates furnished before inspection. Panels shall be subject to inspection at the factory.
- 3.2 The panel shall be extensible and shall have following insulated compartments:
 - i. Breaker Compartment
 - ii. Bus bar compartment
 - iii. CT & Cable Compartment
 - iv. Relay/Instruments compartment
- 3.3 The breaker compartment shall house the vacuum circuit breaker mounted on a drawout truck. The drawout truck shall have three (Test / service / Isolated) distinct positions. The truck front panel shall house:
 - i. Mechanical ON-OFF indication
 - ii. Spring charge status
 - iii. Manual & Motorised mechanism
 - iv. Breaker control switch
 - v. Operation corner
 - vi. Any other elements considered necessary for the safe operation of the panel.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.4 The bus bars shall be air insulated Aluminium bars supported on cast epoxy insulators, capable of withstanding the forces due to short circuit current as specified in datasheets. The bus bars shall be rated for a normal temperature rise of 30°C over the maximum ambient temperature 45°C.
- 3.5 The CT compartment shall house all instruments and relays with a multiple pin plug socket arrangements duly interlocked with the truck position.
- 3.6 P.T"s shall be resin-cast rack-out type mounted on the panel with necessary protective fuses.
- 4.1 The following safety arrangement shall be provided for the safety personnel and to prevent mall operation of the breakers.
- a) Inter-lock to prevent the circuit breaker from being raised or lowered or moved unless the breaker is open.
 - b) Inter-lock to prevent the truck from being withdrawn or replaced in the fully isolated position.
 - c) Interlock to prevent the breaker from being closed unless it is fully home.
 - d) Interlock to prevent earth connection from being made by the earthing device except when the circuit breaker is open.
 - e) The earthing switch cannot be switched on when the truck is inside the panel and the truck cannot be inserted when the earthing switch is ON.
 - f) Interlock to prevent the local and remote control apparatus from being operative at the same time and the low voltage plug socket cannot be disconnected except in isolated position.
 - g) Automatic insulated dust-proof safety shutters to cover all live sockets with facility for pad locking them in the shut position.
 - h) Pad-locking arrangements may also be provided to lock the with- drawable gear when the breaker carriage is in the „fully withdrawn“ („Earthing“ or Fully Home Position)
- 4.2 The following safety devices shall also be provided :
- 1) Individual explosion vents for breaker / bus bar and cable chambers.
 - 2) Cubicle with the front plate is to be pressure tested for internal single phase to ground fault. (vendor should submit type test certificate)
 - 3) Entire panel including all the conduction components shall be fully earthed.

5.0 **Fittings and Accessories**

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.1 Fittings and accessories required are listed below :

- a) Earth device for earthing either the feeder or bus bar. b) Foundation bolts.
- c) Cable boxes with glands suitable for the specified cable and entry positions i.e. upturn or down turn.

6.0 Instrument Transformers

6.1 CT"s shall be air or epoxy resin insulated with wound or bar primary as required and of the rated burden within the error limits for the specified class of accuracy of meters. The CT design and construction shall withstand system thermal and dynamic overloads. Where CTs are used for both metering and protection they must fulfil the duties specified, for both purposes. Two core CTs are acceptable. Voltage transformers shall be two winding epoxy resin insulated and shall conform to the general requirements of IS 3156 and be suitable for measuring purposes as per part II of IS 3156. Voltage transformers shall be of specified accuracy class.

7.0 Meters and Relays

7.1 All relays, meters and instruments shall be flush mounted and be easily removable for testing and shall be operable from 5A CT secondaries. All relays should conform to IS : 3842.

7.2 The voltmeter and ammeter shall be of square or rectangle with digital read out. Meters shall be electronic/solid state with class 0.5 accuracy or multi- parameter digital meters where specified.

7.3 Overcurrent relays shall be of numerical type multifunction relays with specified definite minimum time complete with indicator. Relays shall be suitable for a current setting range from 50-200 %. Earth fault element shall also be similar with settings from 10-40 % or 20-80 % as specified in the equipment schedule.

7.4 The following general principles may be adopted. Unless otherwise stated in the data sheet.

1	Radial incomer breaker(33KV Panel)	Numerical IDMT	Type O/C 50-200% EF 20-80%
		Standby	EF 10-40%
2	Transformer breaker	Numerical IDMT	Type O/C 50-200% EF 20-80%
		Inter trip	From LT Breaker(Restricted earth fault)

7.5 All relay settings shall be established for the entire system and get approved by the consultants.

8.0 Testing

8.1 The switchgear shall be subjected to the type and routine tests as listed herein and all the tests shall be in accordance with the IS 9920-4/1985.

ANNEXURE-E1 TECHNICAL SPECIFICATION

8.2 Following type tests shall have been conducted on a prototype and test certificates furnished in proof of such testing. (Test certificates shall not be more than 5 years old)

- 1) Tests to verify the insulation level, including withstand tests at power frequency voltages on auxiliary equipment.
- 2) Temperature rise test.
- 3) Making and breaking tests.
- 4) Tests to prove the capability of the switch to carry the rated peak withstand current and rated short-time current.
- 5) Tests to prove satisfactory operation and mechanical endurance.

8.3 All routine tests shall be conducted as per IS 3427 and shall be witnessed by the consultants and owners.

9.0 **Installation, Testing & Commissioning**

9.1 The panel shall be installed, tested and commissioned as specified under "Substation Auxiliaries".

10.0 **Mode of Measurement**

10.1 Supply of HT switchgear panel, loading and unloading at site including all accessories and transport shall be treated as one unit of measurement and installation, testing and commissioning of the same will be treated as another unit of payment.

3. TECHNICAL SPECIFICATION FOR HV CABLING

1.0 **Scope**

1.1 The scope of work shall cover supply, laying and termination of HV cables

2.0 **Standards**

2.2 The following standards

IS : 7098 - 1985 XLPE insulated cables for voltage 3.3 to 33KV

IS : 1255 (Part -2) - 1983 Code of practice for installation & maintenance of cables Upto 33KV.

All standards shall be the latest

3.0 **Cables**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.1 Cables shall be XLPE insulated earthed or unearthed systems conforming to IS 7078. Cable cores shall be of copper or aluminum as specified in the schedule of work with XLPE insulated & wrapping, flat strip armouring and a PVC outer sheath.
- 3.2 Cable terminations shall be heat shrinkable type & standard products of approved manufacturers.
- 4.0 **Installations**
- 4.1 HV cabling shall be laid in accordance with IS:1255. All high tension cables shall be XLPE as specified in the schedule of work. Cables shall be laid and joined in accordance with IS:1255.
- 4.2 No joints are permitted upto 500m length of cable, for higher length, cables shall be jointed in accordance with IS : 1255.
- 4.3 Cables shall be laid in the route marked in the drawings. Where the route is not indicated, the contractor shall mark out the cable route on the site and obtain the approval of the Engineer-in-charge before laying the cables.
- 4.4 Cables in ground shall be laid at a depth of 1.5m from finished ground. Excavation trench shall be carried out neatly with sides at 30° to the verticals. Trenches shall be back filled with clean dry river sand upto 300mm thick over the cables and covered with cement tiles extending to 150mm on either side of the cables. Remaining trench shall be backfilled with sifted earth. Cable markers set in a 300 x 300 cement concrete block shall be provided at every 30m C.C.
- 4.5 Cables laid above ground shall be suitably protected to meet the approval of the Electrical Inspectorate and other statutory regulations. Cables shall be run on MS cable trays with necessary MS frame work supports at every 1m distance including anchor fastners, insert plates etc. for completeness of installation or ready-made masonry trenches with necessary supports of galvanised steel. Plastic identification tags shall be provided at the ends and along the length of cable @ 20m centres.
- 4.6 HV cables shall be tested upon installation with a 1000V DC meggar and the following readings established.
- 1) Continuity on all phases
 - 2) Insulation resistance
 - a) between conductors
 - b) all conductors and earth
 - 3) High potential testing, if required, by the local electrical inspectorate.
- 4.7 For each lot of cables the contractor shall supply a certificate issued by the manufacturer stating its original date of manufacture, constitution and standard to which it complies and the test certificate.
- 4.8 Cable terminations shall be Heat shrinkable.

4. **TECHNICAL SPECIFICATION FOR BATTERY CHARGER**

- 1.0 **Scope**
- 1.1 The scope of work shall cover the supply, installation, testing & commissioning of battery and battery charger.
- 2.0 **Battery Chargers**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.1 One (1) set of thyristor controlled battery charging set shall be provided for each battery bank complete with two identical charging units, each capable of functioning as a float charger or boost charger as well as supplying the DC loads. Each charger shall have provision for auto/manual changeover from float to boost mode and vice versa. Suitable DC contactors shall be provided for this purpose. One common manual selector switch shall be provided to pre-select any charger to operate in boost mode.
- 2.2 Separate charge bus and load bus shall be formed. Normally, both chargers, the battery and the load shall be connected to the load bus, the chargers being on float charging mode. During boost charging of battery, the charger selected for boost mode shall be connected to the charge bus with battery also connected to the same bus through contactor changeover arrangement. During this period, it shall be ensured that the other charger is healthy and connected to the load bus to supply the specified DC loads. In case, one charger fails, audio-visual alarm as called for subsequently shall be available and the healthy charger shall feed the total load.
- 2.3 In case of main AC power failure with the battery on float charge mode, the battery shall be automatically connected to the load bus for feeding of all loads. When power supply is resumed, then the charger, pre-selected as boost charger, shall start boost charging the battery until the desired battery voltage is reached. During this period, the load bus shall be isolated from the charge bus and the other charger shall feed the load.
- 2.4 In case of main AC power failure during boost charging of the battery, the battery shall be automatically connected to the load bus by a DC contactor. During the time of closure of the auto changeover contactor, the continuity of power supply shall be maintained from the tap cell of the battery through suitable diodes.
- 2.5 During the period of boost charging, if the float charger fails, then the boost charger shall get connected to the load bus automatically through the dropper diodes to feed the load. Normally, the dropper diodes shall remain bypassed by suitable normally closed DC dropper diode bypass contactor. During the time of opening /closing of the auto changeover contactors, the continuity of power supply shall be maintained from the tap cell of the battery through suitable diode. Boost charger shall be designed to cater DC continuous load as well as desired constant current for charging the battery simultaneously. The voltage at the load terminals shall be kept within specified limit through proper selection of dropper diodes.
- 2.6 During the period of boost charging, if the boost charger fails, then the mode of operation of the float charger shall automatically change from float to boost and charger shall start boost charging the battery as well as go on feeding the load through dropper diodes.
- 2.7 Facility shall be provided to manually connect the battery to the charge bus and switch on the selected boost charger when the battery voltage falls below a preset level and charge the battery at a constant recommended starting current upto recommended cell voltage level. After this the charging current shall be automatically reduced to a constant recommended finishing rate and the charging shall be continued and an alarm shall be operative after a

ANNEXURE-E1 TECHNICAL SPECIFICATION

preset time as set by a synchronous timer for manual changeover from boost charge mode of operation to trickle charge mode

- 2.8 In trickle/float charging mode, the selected charger shall be connected to the load bus and shall be cable of floating each cell at the specified voltage and supplying rated Dc load continuously under normal system operation.
- 2.9 The battery charging set shall be housed in floor mounted cubicle made of CRCA sheet steel having minimum thickness of 2mm. The enclosure shall generally conform to IP54 degree of protection. All lamps, meters, switches and push-buttons shall be located within 400 to 1900 mm from the floor level.
- 2.10 415 V, 3-phase, 4-wire, 50 Hz power supply over duplicate feeders shall be taken from the AC distribution board. Suitable changeover arrangement over contactors shall be provided inside the charger panel for automatic changeover to the healthy incoming feeder in case of sudden outage of the running feeder. For momentary voltage dip, the chargers shall not trip.
- 2.11 Each charger shall be self contained with dry type air-cooled transformer suitable for operating from 415 V, 3-phase, 4-wire, 50 Hz supply, full wave, half controlled, thyristor diode units with necessary automatic regulation circuits to deliver stabilized DC output voltage of +2.5% as well as all necessary protection, metering, interlocking, indicating and other devices as required for smooth and reliable operation.
- 2.12 The transformers shall be of self-cooled dry type (AN) generally conforming to IS:11171 as applicable and suitably mounted on vibration dampers to prevent transmission of vibration to adjoining cubicles. It shall be suitable for operation at rated load, with minimum class B insulation. The ratings of the transformers shall be finalised during engineering stage based on calculations to be furnished by the successful tenderer.
- 2.13 Rectifier units
- 2.13.1 The rectifier unit for boost and trickle operation shall conform to IS:4540 and IEC publication 146, 1973 wherever applicable
- 2.13.2 The assembly shall consist of required number of adequately rated diodes/thyristors mounted on heat sinks, and connected in three-phase full wave bridge circuits. The rectifier shall have adequate peak inverse voltage (PIV) rating and the safety factor for the diodes / thyristors shall be more than 2.5
- 2.13.3 The power circuit devices shall comprise incoming MCCB on the 415 V AC side, contactors, thermal overload relay, DC side filter chokes, blocking diodes, DC shunt and DC side MCCB/MCB of adequate rating to meet the full load requirements of the charger unit
- 2.13.4 The diode/thyristor units shall be adequately protected against all abnormal over-voltage, short-circuits, overloads, etc for which necessary devices and relays shall be provided including the following :

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 1) Surge absorbers on the AC side of the rectifier bridges. The surge absorber shall be provided with monitoring system so that in the event of failure, alarm can be initiated.
- 2) Snubber circuit comprising resistor and capacitor across each thyristor cell.
- 3) HRC semi – conductor fuses in series with each rectifier cell complete with trip indicating devices.

2.13.5 The salient features to be provided for the battery charging set and its interconnection with the battery bank shall include but not be limited to the following:

- i) The ripple content in the output DC voltage shall be less than 2%.
- ii) Stabilized DC output voltage for variation of AC supply voltage and DC load by means of suitable control equipment.
- iii) Automatic changeover from boost charging state to trickle charging state and vice versa.
- iv) Automatic and manual control of voltage regulations.
- v) Measurement of AC input and DC output voltage and current.
- vi) Visual indication for “AC supply ON” “Float ON” and “Boost ON”.
- vii) Visual indication for the following abnormal conditions. a) AC supply fail
b) Float charger trip
c) Boost charger trip
d) Float device fuse fail e) Float filter fuse fail
f) Boost device fuse fail g) Boost filter fuse fail
h) Load over-voltage
i) Load under-voltage j) Boost over-voltage
k) Battery under-voltage l) Battery earth fault
- viii) The DC system shall be unearthed with battery earth –fault alarm by battery earth-fault monitoring relay of reputed make.

2.13.6 Provision shall be made for transmitting the signals specified in item 2.13.5(vii) above, grouped together to the audio –visual annunciation system in control panel provided for high voltage switchgear and also to BMS system.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5. TECHNICAL SPECIFICATION FOR SUBSTATION AUXILIARIES INSTALLATION

1.0 Scope

1.1 The scope of work shall cover the following:

- 1) Supply, Installation, testing & commissioning of 33KV HT panel Transformer.
- 2) Supply, laying, termination, testing of HV 33KV cables & LV cables
- 3) Substation earthing, interlocks, safety pads etc.
- 4) Wiring for temperature alarm and tripping.
- 5) Supply & Installation of Switch tripping battery, associated control cables etc.

2.0 Codes & Standards

2.1 The following codes and Standards shall be followed: IS : 10028
Code for practice for selection, installation and maintenance of transformers –
IS : 3043 Code of practice for earthing.

2.2 All codes and standards mean the latest.

3.0 Transformers

3.1 Transformer installation shall be carried out in accordance with IS: 10028 –Pts
1 & 2.

3.1.1 Indoor Installation

3.1.1.1 The most important thing to be ensured with transformer installed indoors is proper ventilation, that is, free movement of air round all the four sides. The level of the transformer base should be higher than the highest flood and storm water level of that area.

3.1.1.2 The transformers should be kept well away from the wall. The minimum recommended spacing between the walls of the transformer periphery from the point of proper ventilation should be as per IS : 10028 (Part II).

3.1.1.3 The site should be so chosen that it is not normally damp because the dampness may find its way to the bushings and may cause them to flash over. There shall be no chance of water dripping either on the transformer or anywhere in the transformer room itself. Chemical fumes, particularly acid fumes, should not be allowed in the transformer room as they corrode the body.

3.1.1.4 For indoor installations the air inlets and outlets shall be of adequate sizes and so placed as to ensure proper air circulation for the efficient cooling of the transformers. The inlet should preferably be as near the floor as possible and the outlets as high as the building allows to enable the heated air to escape readily and be replaced by cool air.

3.1.1.5 The transformer should be so installed that severe vibrations are not transmitted to its body.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.1.2 Outdoor Installation

- 3.1.2.1 Only transformers designed for outdoor use should be installed outdoors. In case of locations where the atmosphere is polluted, it is desirable that the transformer is located in suitable covered shelter to minimize adverse effects of polluted atmosphere.
- 3.1.2.2 The transformer should be so installed that the breather, thermometer, oil level indicator and the top position indicator may be safely examined with the transformer energized.
- 3.1.2.3 Sampling valve or drain valve should be conveniently arranged for drawing oil samples.

The transformers shall be mounted on a concrete plinth. After installation, the rollers shall be locked by wedges or any other means to prevent accidental movement of transformers. Foundation shall be as per details provided by transformer, panel etc. manufacturers.

3.2 The following pre-commissioning tests shall be carried out:

3.2.1 Power Transformer

- 1) Measurement of winding resistance
- 2) Measurement of voltage ratio and check of voltage vector relationship.
- 3) Measurement of impedance voltage / short – circuit impedance (principal tapping) and load loss.
- 4) Measurement of no-load loss and current
- 5) Measurement of insulation resistance
- 6) Dielectric tests
- 7) Tests on on-load tap-changers, where appropriate.
- 8) Visual inspection for broken parts & cracks.
- 9) The insulation resistance shall be tested with a 1000VDC meggar to establish the following values:
 - (a) Between HV 3 phases and between each phase winding and earth.
 - (b) Between LV 3 phases and between each phase winding and earth.
 - (c) Between HV and LV windings
 - (d) Oil BDU
- 10) All transformer mountings and accessories such as the Buchholts protector, breather, gauges, thermometer should thoroughly be checked and adjusted. All such checks and adjustments shall be recorded in the presence of the Engineer.

3.2.2 Distribution Transformers

- 1) Measurement of winding resistance
- 2) Measurement of voltage ratio and check of voltage vector relationship.
- 3) Measurement of impedance voltage (principal tapping), short – circuit impedance and load loss.
- 4) Measurement of no-load loss and current
- 5) Separate –source voltage withstand test
- 6) Induced over voltage withstand test
- 7) Visual inspection for broken parts & cracks.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 8) The insulation resistance shall be tested with a 1000VDC meggar to establish the following values:
 - (a) Between HV 3 phases and between each phase winding and earth.
 - (b) Between LV 3 phases and between each phase winding and earth. (c) Between HV and LV windings
- 9) All transformer mountings & accessories should thoroughly be checked and adjusted. All such checks and adjustments shall be recorded in presence of the engineer.

3.3 After satisfactory testing as above, the transformer shall be energised on no-load and maintained on no-load for a period of 8 hours. Thereafter, the full load shall be built-up progressively over a period of another 8 hours.
Transformer shall be commissioned under supervision of manufacturers service engineer

4.0 **HV switchgear**

4.1 The installation shall be carried out in accordance with IS:3072.

4.2 The following pre-commissioning tests shall be carried out on the breakers & panels.

- 1) Inspection of breaker parts for breakages and mechanical performance.
- 2) Check and confirm all mechanisms and safety interlocks, alignment of contacts, lowering and racking gear.
- 3) The insulation of main breakers shall be tested with a 2500V DC meggar and readings shall correspond to the factory test readings.

5.0 **HV Cabling**

5.1 HV Cable laying shall follow the section 2.6 "HV CABLING".

6.0 **Switch Tripping Battery**

6.1 The switch tripping battery shall be of the rating indicated in the data sheet. Battery shall have high discharge performance cells. The battery should have its own charger for and trickle charging.

6.2 The battery shall meet with the duty of atleast 3 breakers consecutively tripping and closing.

6.3 Batteries shall conform to following IS Standards

- a) IS 8320 – General Requirements & method of testing for Lead Acid Batteries
- b) IS 10918 – Vented type Ni – cd batteries

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 **Earthing**

7.1 System earthing shall follow TN – S form of earthing.

7.2 Copper plate earth stations shall consist of 600 x 600 x 3mm buried in ground to a minimum depth of 3.0 meters. The plate shall be surrounded with a mixture bentonite and earth all round as shown on drawings. The earthing stations shall be complete with cement concrete manhole, CI cover etc. as per IS code 3043 / 1987. Soil resistivity should be maintained at 3 ohm meter through chemical mixing.

7.3 All earthing conductors shall be either bolted with spring washers or riveted. Dissimilar metal joints shall have suitable bimetallic connectors. Entire earthing installation shall conform to IS 3043 . All earth leads connecting the earthing stations shall be provided with testing links.

7.4 All equipment in the substation shall be earthed as shown below:

1. Power Transformer

(a) Neutral Two separate earth connections to as specified in IS : 3043 .
(If NGR is provided then transformer neutral will be connected to NGR and NGR neutral will be connected to earth pits)

(b) Tank & core Two distinct connection to an earth bar.

2. Distribution Transformer

(a) Neutral Two separate earth connections to as specified in IS : 3043 .

(b) core Two distinct connection to an earth bar.

3. HT Switchgear Two distinct connection to an earth bar. Sizes of earth conductors shall be as shown on drgs. and schedule of work.

7.5 The following resistance values shall be measured with an approved earth meggar and recorded:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 1) Each earthing station
- 2) Earthing system as a whole

8.0 Control Cabling / Power Cabling

- 8.1 All cabling shall be 1100V grade (for AC) or 600V (for DC) XLPE insulated sheathed with or without armouring as specified with outer protective sheath. All cables shall have Flame Retardant, Low Smoke sheath (FRLS). Cables shall have high conductivity stranded copper conductors and cores colour coded to the Indian Standards.
- 8.2 All cables running indoor shall be supported with necessary MS cable trays. Cable trays shall be minimum 1.8 mm thick. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

9.0 Mode of measurement

9.1 Transformer

- 1) Installation, testing, commissioning of the transformer including the supply & wiring for temperature alarms will be treated as one unit for measurement and payment.
- 2) Each earthing station shall be paid as a unit.
- 3) Earthing strip shall be measured per unit length.

9.2 HV switchgear

- 1) Installation, testing, commissioning of the HV switchgear complete with the various components specified will be treated as one unit for the purpose of measurement and payment.
- 2) Earthing of the panel and control cabling will be paid for at unit rates separately.

9.3 HV cabling

- 1) All HV cabling shall be measured on the basis of unit length and the cost per unit length shall cover cost of cable, cost of supports, clamps, labour, excavation and back filling, with cable markers, testing and commissioning.
- 2) Cable terminations shall be measured per unit and the cost shall include lugs, gland, all jointing materials, bolts and nuts, earthing etc. and labour.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3) Cable trays shall be measured per unit length for each of the specified widths. This should include necessary supports or suspenders, anchor fasteners, insert plates etc. for completeness of installation for the trays.

9.4 Switch Tripping Battery

Switch tripping battery (STB) with first charge of electrolyte, one set hydrometer, cell testing ammeter, battery charger with rectifier, ammeters, voltmeters, output circuits, sheet steel enclosure shall be considered as one unit of measurement. All cabling to and from the STB will be paid per unit length.

9.5 Earthing

- 1) Providing an earthing station complete with excavation backfilling, electrode watering pipe, soil treatment, masonry etc. shall be paid per unit.
- 2) The following items of work shall be measured and paid at unit rates covering the cost of the earth wires/strips, clamps, labour etc.
 - a) Main equipment earthing grid and connections to the earthing stations.
 - b) Connections to transformers, power panels, distribution boards etc.

9.6 Control cabling/ Power cabling

All cabling shall be measured and paid at unit rates. The rate shall include for cable (armoured XLPE with Al conductor multi-core) supports and terminations. Cable tray shall be paid extra including necessary supports, anchor fasteners, insert plates etc.

6. TECHNICAL SPECIFICATION FOR MV SWITCHGEAR

1.0 Scope

- 1.1 The scope of work shall cover the supply, installation, testing and commissioning of all power panels, incorporating circuit breakers, switch fuses, busbars, interconnections, earthing etc.

2.0 Standards

- 2.1 The following standards and rules shall be applicable:

- 1) IS:13947:1993 Switchgear & Control gear specification
- 2) IS:8623:1993
Parts 1 & 3
Low Voltage Switchgear and Control gear assemblies.
- 3) Indian Electricity Act and Rules

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the applicable Codes of Practices of the Bureau of Indian Standards.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.0 Air Circuit Breakers

3.1 Air circuit breakers shall be heavyduty air break horizontal draw out fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 600V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits specified.

3.1.1.1 Breakers shall be, motorised or manually operated as specified, complete with front-of-the-panel operating handle, isolating plugs with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes and trip free operation. Breakers shall be capable of being racked out into 'testing', 'Isolator' and 'Maintenance' position and kept locked in any position. Breakers for remote and automatic operation shall be motor operated spring charged with closing and trip coils. Breakers shall have minimum 3 NO-NC contacts. Breaker terminals shall be shrouded.

3.3 Construction:

- 1) ACB should be with safety shutter, Anti-pumping and rating error preventer.
- 2) Cradle: Should be service, test, isolate & maintenance positions
Racking handle should be stored in cradle.
Electrical breaker should not close during travel from service and test position and vice versa.
- 3) Inter-phase clearance should be more than 25 mm after termination of bus bar.
- 4) Neutral pole rating should be equal to phase rating unless specified otherwise
- 5) Electrical /Mechanical life: 15000 Cycles up to 2500A and 5000 cycle above 3200A.

3.4 Release:

- 1) All releases in ACB should be communicable microprocessor Based and having over load, short circuit and earth fault protection.
- 2) Release should be operated through magnetic fluxing device direct on trip rod.
- 3) Release should be True RMS, self powered using CT.
- 4) Release should have zone selectivity facility.

3.5 Breaking:

- 1) As per SLD $ICU=100\%ICS=ICW$ for 1 sec
- 2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

4.0 MCCB 's

4.1.1 Construction

- 1) MCCB should be current limiting type, and of trip free mechanism.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2) MCCB operated with rotary handle having door interlock facility.
- 3) All accessories like Shunt release, UV release, Aux & trip contacts should be site fittable.
- 4) Phase to phase barrier should be provided with MCCB.
- 5)

4.2 **Breaking:**

- 1) As per SLD ICU=100% ICS.
- 2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

4.3 **Release:**

- 1) Ratings equal and above 200Amp. should be Microprocessor based with over load ,short circuit ,earth fault protections
- 2) Ratings less then 200A should be adjustable thermal and magnetic type.

5.0 **Switch Fuse Units & Disconnectes**

5.1 Switch fuse units shall have quick-make, quick-break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting.

All switches shall be rated according to the equipment schedule or drawings and shall withstand the system prospective fault current let through.

Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type. All switch fuse unit should be AC23A.

5.2 Fuses shall be HRC cartridge type conforming to IS:2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type diazed fuses are not acceptable for any ratings.

5.3 All disconnecting isolators shall consist of switch units quick-make, quick-break type with silver plated contacts. The switches shall preferably have double breaks. The switches shall have sheet steel enclosure, which in turn is mounted on suitable angle iron frame work. In wet locations switches shall have cast iron enclosures. Disconnects shall have a minimum breaking capacity of 5KA at 415 Volts.

6.0 **Isolators**

6.1 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.

6.2 Painting, earthing and labels shall be provided as generally indicating for MV Switchgear and shown on drawings.

7.0 **Instrument Transformers, Meters & Relays.**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 7.1 Ammeters and voltmeters shall be electronic digital type. Meters shall conform to BS:89 and have grade 'A' accuracy.
- 7.2 Energy meters shall be electronic two element switch board mounting type suitable for unbalanced loads. In case of two incoming feeders, a summing C.T shall be provided with the meter. Meters shall conform to IS: 37.
- 7.3 The energy meters for grid supply and DG supply shall be calibrated and got certified by the respective Electricity Authority wherever required.
- 7.4 CTS shall be cast resin type and conform to IS:2705 in all respects. Rated secondary current shall be 5A unless otherwise stated. Accuracy class of metering CT's shall be 1.0 & for protection 5P20 or as specified in the datasheets. Test links to be provided in secondary connection to facilitate testing of instruments, meters & protection device. CT burden shall be minimum of 10VA but appropriate to the instruments, relays connected or as specified in the datasheets.
- 7.5 Relays and trip devices shall be any one of the following as specified:
i) Adjustable Thermal – Magnetic trips – direct acting ii) Solid state relays with shunt tripping.
iii) Microprocessor controlled relays numerical type with shunt Tripping.
All trips shall be 400/230V AC series type unless shunt tripping is specified for.
- 7.6 LED indicating lamps to be provided for phase indication & breaker position as required.
- 7.7 All wiring for relays shall be of stranded copper with colour coding and labelled with appropriate plastic tags for identification. Minimum size of control wiring shall be 2.5 sqmm stranded copper. All control circuits to be provided with protective MCB's or fuses consistent with short circuit levels.
- 8.0 **Cubicle Boards**
- 8.1 All boards shall be combination of 14 SWG (Main Body) & 16 SWG (Doors & partitions) sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle as per IP 43, flush dead front and of modular construction suitable for 3 phase 415V 4 wire 50 Hertz system TN-S neutrals grounding. All boards shall be accessible from the front or as shown on Drgs, for the maintenance of breakers, switch fuses, busbars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom as specified in drawings. All panels shall be machine pressed with punched openings for meters etc. mounted on a 75mm high base channel frame. All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with powder coating of approved colour applied over a primer. Aluminium anodized Engraved labels having white letters on black background shall be provided indicating the feeder details and capacity. All panels shall be provided with danger boards on bus bar & cable chamber.
- 8.2 The boards shall accommodate air insulated bus bars, air circuit breakers, mccb's switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 8.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an inter-locked door with facility for padlocking. Each switch or MCCB or ACB shall have provision for locking in the OFF position for life safety. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. Glands shall be of heavy duty brass casting, machine finished & complete with check nut, washers etc. The lugs shall be tinned Cu /Al depending upon cable conductor & of solderless crimping type. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 13947. Feeder connections shall be of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required and if insulated, the insulation shall be able to withstand the high temp at the terminals. Internal wiring, bus bar markings etc. shall conform to IS:375/1963. Internal wiring shall have terminal ferrules.

Panels shall be supplied with necessary fasteners.

Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75M from floor level. Cable glands shall form part of the switch board.

- 8.4 Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, 1ph 50 Hz supply. They shall be complete with MCB or HRC fuses, isolating switches & adjustable thermostat.
- 8.5 Each panel shall be provided with 240V 1ph 50Hz , 5A 3pin receptacle with switch located at a convenient position.
- 9.0 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy (E91E) as specified and shown on drawings and rated for a temperature rise of 30 deg C over the ambient temperature specified, (IS:8084-1976). Neutral bars may be of one half the size of the phase bars or as shown on drawings. The main horizontal bus bars shall be of uniform cross section and rated for the incoming switch. The vertical bus bars for the feeder columns should be equal to size of horizontal busbar and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hydroscopic insulator blocks to withstand thermal and dynamic overloads during system short circuits. Feeder connections shall be solid copper bus bars duly insulated with bimetallic damps where we required. Bus bars shall be designed for easy extension in future on either side. All feeder connections shall be rated for 25°C temperature rise over the ambient.
- 10.0 **Earthing**
- 10.1 An earthing bus shall be provided at the bottom & extended throughout the length of panel. It shall be be bolted / welded to the frame of each unit & each breaker earthing bar.

ANNEXURE-E1 TECHNICAL SPECIFICATION

10.2 Protective earthing shall be provided as shown on drawings or as follows:

-----	Phase
	Protective conductor
	conductor
-----	upto 16 sqmm
	equal size
16 to 35 sqmm	16 sqmm
over 35 sqmm	50% of phase conductor

In case of dissimilar materials the Protective Earth Conductor shall be suitably sized for equal conductance.

10.3 Protective earthing of each switch shall be connected to the earth bar.

10.4 All non current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

11.0 **Installation**

11.1 All panels shall be supported on MS channels incorporated in the panel during the fabrication. All such supports shall have two finish coats over a prime coat after completion of the work. All panels shall be touched up for damaged painting.

11.2 All panels shall be megged phase to phase and phase to neutral using a 1000V meggar with all outgoing feeders in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phases and neutral.

11.3 Fabrication drawings of all panels shall be approved by the Consulting Engineers before fabrication.

12.0 **Testing & Inspection**

12.1 All switchboards shall be factory inspected before finishing and dispatch unless waived. Type test reports for all switchgear shall be furnished.

12.2 Certificate for all routine and type tests for circuit breakers in accordance with the IS:2516-1963 shall be furnished. In addition, all panels shall be megged phase to phase and phase to phase neutral, using a 1000V meggar with all switchgear in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

12.3 All meters shall be calibrated and tested through secondary injection tests.

12.4 All field tests shall be witnessed by Consultants and recorded unless waived.

13.0 **Mode of measurement**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 13.1 Each panel will be considered as one unit for the purpose of measurement and shall include the following:
- i) Incoming and Outgoing feeders.
 - ii) Interconnections and controls and instrument wiring with necessary protective fuses.
 - iii) Meters, Relays, Indicating lamps, CT's control fuses etc.
 - iv) Supporting structure, sheet steel enclosure v) Installation, commissioning and testing
- 13.2 Isolators shall each be measured as one unit complete with:
- i) mounting frame ii) switch/fuse
- 13.3 Protective earthing of the panel/Isolator from the equipment earthing system will be measured separately and paid at unit rates.
- 13.4 Outgoing and incoming feeder terminations will be paid at the unit rates separately as specified under cabling.

7. TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARD

- 1.0 **Scope**
- 1.1 The scope of work shall cover the supply, installation, testing and commissioning of lighting and power distribution boards including cable sleeves, anchor fastners etc. Associated minor civil works required for the erection of the DB's such as opening in wall etc. are also included in the scope of this contract.
- 2.0 **Standards**
- 2.1 The following standards and rules shall be applicable:
- 1) IS:2675-1983 Enclosed distribution fuse boards and cutouts for Voltages not exceeding 1000V.
 - 2) IS:375-1963 Marking and arrangement of Switchgear busbars main connections and auxiliary wiring.
 - 3) IS:8828-1996 Miniature circuit Breakers
 - 4) IS:2607-1976 Air break Isolators for voltages not exceeding 1000V.
 - 5) IS:9926-1981 Fuse wire used in Rewirable type Electric fuses up to 650 volts.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6) Indian Electricity Act 1910 and rules issued there under.

2.2 All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

3.0 **Distribution Boards**

3.1 Distributions boards along with the controlling MCB's or Isolator as shown shall be fixed in a mild steel Box with hinged lockable door suitable for recessed mounting in wall. Distribution boards shall be made of 18 SWG sheet steel with hinged lockable spring loaded cover duly rust inhibited through a process of degreasing, acid pickling, phosphating and powder coated to an approved colour over a red oxide primer. The enclosure shall meet IP 43 rating.

3.2 All components shall be mounted on DIN rails and covered totally with a sheet steel cover rendering it finger-safe. Access to the internal connections shall be only through removing the cover sheet.

3.3 Three phase boards shall have phase to phase barriers and a wire channel for internal wiring. All DB's shall be internally prewired using copper insulated high temperature PVC wires brought to a terminal strip of appropriate rating for outgoing feeders.

3.4 Conduit knockouts shall be provided as required/shown on drawings and the entire board shall be rendered dust and vermin proof with necessary sealing gaskets.

The distribution board shall have one main neutral and 3 separate sub - neutral links, one for each phase of adequate capacity as per number of outgoing per phase. The DB shall have earth bar(s) of adequate capacity as per total numbers of outgoing of DBs. Two numbers separate earth terminals, (one on each side) shall be provided on the outer body of DB for its body earthing. The DB shall be supplied complete with cable ties, circuit identification labels and few spare blanking plates. Indicating lamps shall be provided for each phase with fuse back up.

3.5 **Miniature Circuit Breaker (MCBs)**

Miniature Circuit Breaker shall comply with relevant IS / IEC standard i.e. IS-8828-1996 & IEC – 60898 and ISI marked on each MCB. MCBs shall be quick make and quick break type, suitable for 230 / 415V AC

50 Hz, breaking capacity should be 10kA and marked on MCB. MCB shall be classified as B, C, D curve type suitable marked on MCB. MCB's for Lighting & power sockets shall be C-curve, all MCBs used on UPS circuit shall be D-Curve only. MCB's shall have quick make can break non welding self wiping silver alloy contacts.

The housing shall be made from heat resistant thermoplastic material and shall have high impact strength. All 2P, 3P and 4P miniature circuit breakers shall have a common trip bar independent to the external operating handle to ensure opening of all the poles simultaneously on faults.

1) The MCB shall be current limiting type (Energy Limitation

ANNEXURE-E1 TECHNICAL SPECIFICATION

Class – 3) and it shall be clearly marked on the product and terminals shall comply to IP2X degree of protection.

2. MCBs terminals shall have provision for DUAL TERMINATION facility for mounting bus bar and cables separately on same side of the MCB & suitable accommodate accessories like Aux contact, Trip, under voltage & shunt trip.
3. MCBs shall have Positive Contact Indication and shall be suitable for Isolation.
4. MCBs shall have pad locking facility to lock it in ON or OFF

ANNEXURE-E1 TECHNICAL SPECIFICATION

RCCBs

1. RCCBs shall comply to IS 12640 / IEC 61008 standards. RCCB shall be current operated type and shall be independent of the line voltage; current sensitivity shall be of 30 mA / 100mA / 300 mA at 240/415 volts AC as specified in BOQ.
2. A test trip push button shall be provided on front face to check the integrity of the earth leakage detection system and the tripping mechanism healthiness.
3. RCCBs shall have positive contact indication and earth leakage trip indication.
4. All RCCBs used on UPS circuits shall be HIGH IMMUNITY type to protect against nuisance tripping.

3.6 Fuses shall be HRC link type or rewirable with necessary fuse carriers and with S.C rating of not less than 50 KA. Bottle type fuses are not acceptable. Fuse carrier terminals shall be suitably shrouded. Rewirable fuse carriers shall be porcelain.

3.7 Boards shall meet with the requirements of IS 2675 and marking arrangement of busbars shall be in accordance with IS 375. Bus Bars shall be of copper and rated for the incomer switch rating and sized for a temperature rise of 30 deg. C over the ambient. Neutral and earth bars shall be of copper and rated as follows:

	<u>Neutral</u>	<u>Earth Bar</u>
LDB's	Same as phase	Same as phase
PDB's	1.5 x phase bar	Same as neutral bar

There shall be one earth terminal for single phase boards and 2 for 3 phase boards. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed.

3.8 In the case of MCB distribution boards, the backup fuses wherever shown shall be not less than 63A with a delayed characteristic and a minimum prearcing time of 0.5 sec. at 10 KA fault current.

3.9 All outgoing feeders shall terminate on a terminal strip which in turn is prewired to the MCB/Fuse base by means of insulated single conductor high temperature PVC copper wires as follows:

LDB's	2.5 sqmm
PDB's Upto 15A	4.0 sqmm
25A	6.0 sqmm

3.10 Each DB shall have indicating lamps preferably neon type denoting power availability in the board after the switch. Indicating lamps shall be complete with fuses.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.11 In the case of Dimmer DB's, the DB's shall incorporate the Dimmer panels as a part of the DB generally as shown on drawing and as approved.

4.0 **Installation & Testing**

4.1 All distribution boards shall be mounted on wall or recessed, with necessary angle iron frame work. All mounting frames shall have one prime coat and two finish coats after the completion of the work. All distribution boards shall be touched up for damaged painting.

4.2 All boards shall be meggered phase to phase and to neutral using 1000V megger with all switches in closed position. the megger value should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

4.3 Fabrication drawings of all boards shall be approved by the Consultants before fabrication and the boards inspected before dispatch, unless waived in writing.

4.4 Aluminium anodized Engraved labels having white letters on black background shall be provided indicating the DB details.

5.0 **Mode of measurement**

5.1 The distribution board complete with the various components specified, indicating lamps, supporting frame, internal wiring, erection etc., will be treated as one unit for the purpose of measurement and payment.

5.2 DB's with dimmers shall be separately counted.

8. TECHNICAL SPECIFICATION FOR MEDIUM VOLTAGE CABLING

1.0 **Scope**

1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- | | |
|--------------------------|-------------------------------------|
| 1) IS: 1554 Parts I & II | PVC Insulated Heavy duty cable |
| 2) IS: 3961 | Recommended current Rating of cable |
| 3) IS: 7098 | XLPE Insulated cables |

All codes and standards mean the latest.

3.0 **Cables**

3.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armoring as specified and with an outer PVC protective sheath. All cables shall have

ANNEXURE-E1 TECHNICAL SPECIFICATION

Flame Retardant, Low Smoke Sheath (FRLS) and meet, ASTM norms for the smoke density and Oxygen Index norms. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards.

3.2 XLPE cables shall be same as PVC with an FRLS outer sheath.

3.3 All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm spacing.

4.0 **Installation**

4.1 Cables shall be laid in the routes marked in the drawings. Contractor shall install all conduits/Pipes required for the cable work as per drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

4.2 All cables running indoor shall be supported with necessary GI cable trays. Cable trays shall be hot dip galvanized & minimum 1.8 mm thick. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance (for Rod supports every 1.0m distance) including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

Cable support dimensions shall be as per table 1.1.

Sr. no.	Size	Cable Support
1	1500MM wide	2nos x 40 x 40 x 5MM GI Angle
2	1200MM wide	2nos x 40 x 40 x 5MM GI Angle
3	1000MM wide	2nos x 40 x 40 x 5MM GI Angle
4	750MM wide	2nos x 32 x 32 x 5MM GI Angle
5	600MM wide	2nos x 32 x 32 x 5MM GI Angle
6	For 2 Tier	2nos x 32 x 32 x 5MM GI Angle
7	450MM wide	2nos 8MM DIA GI RODS
8	300MM wide	2nos 8MM DIA GI RODS
9	150MM wide	2nos 8MM DIA GI RODS

4.3 Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer’s recommendations whichever is higher.

4.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles as shown on drgs. Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cable markers at every 35 meters and at all loop points.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid, on aluminium tag. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have double compression lugs (If panel busbars & Cable conductor are of different material then Bi-metalic lugs to be used). Cable terminations shall have necessary brass glands and all lugs shall be double compression type whether so specified or not. The end terminations shall be insulated with a minimum of six half-lapped layers of Heat resistant, 1100V grade PVC tape. Cable armouring shall be earthed at both ends.

4.6 Each cable shall be tagged with number that appears in cable schedule & Panel/Distribution board from where it is being laid., tag shall be of aluminium.

5.0 Testing

5.1 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

6.0 Mode of measurement

6.1 Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:

For cables laid indoors:

- i) Cables and clamps
- ii) Installation, commissioning and testing
- iii) Cable marking

OR

For cable buried underground:

- i) Cables and protective bricks & tiles
- ii) Installation, commissioning & testing
- iii) Cable markers

6.2 Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) Galvanised steel tray with necessary suspenders and frame supporting the tray, anchor fastners, insert plates & necessary support arrangement for completeness of the installation.
- ii) Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.

6.3 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

- i) Lugs, glands, bolts, nuts ii) All

jointing materials

- iii) Installations, testing and commissioning iv) Earthing

the glands

6.4 For cables buried under ground excavation shall be paid for additionally for the following per unit volume:

- i) Excavation and back filling
- ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost as stated above.

9. TECHNICAL SPECIFICATION FOR CONDUIT WIRING

SCOPE

This specification covers the general requirements for flooring and dadoing of various types of finishes

1.0 Scope

- 1.1 The scope of work shall cover supply, installation testing and commissioning of all conduit wiring.

2.0 Standards

- 2.1 The following standards and rules shall be applicable

- 1) IS : 732: 1989 Code of Practice for Electrical wiring installation (System voltage not exceeding 650V)
- 2) IS :1646:1982 Code of Practice for fire safety of building (General) Electrical Installation.
- 3) IS : 1653:1972 Rigid steel conduits for electrical wiring
- 4) IS : 2667:1976 Fittings for rigid steel conduits for electrical wiring

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5) IS : 3480:1966 Flexible steel conduits for electrical wiring
- 6) IS : 3837:1976 Accessories for rigid steel conduit for electrical wiring
- 7) IS : 694:1977 PVC insulated wires.
- 8) IS : 2509:1973 Rigid non-metallic conduits for Electrical wiring
- 9) IS : 6946 Flexible (Pliable) non-metallic conduits for electrical installation
- 10) IS : 1293 3 pin plugs and sockets
- 11) IS : 8130 Conductors for insulated electric cables and flexible cord
- 12) IS:9537- 1980 Specification for conduits for Electrical installations
- 13) Indian Electricity Act 1910 and rules issued there under.
- 14) Regulations for the electrical equipment in buildings issued by the Tariff Advisory Committee of the Insurance Association of India.

2.2 All standards and codes mean the latest.

3.0 Materials

3.1 General

3.1.1 All materials used shall conform to latest Indian standards and be stamped. They should also be standard products of approved manufacturers.

3.1.2 Materials used on the job shall be new and samples got approved by the project-in-charge. Approved samples shall be neatly mounted on a board and exhibited on the site all the time for comparison.

3.2 Conduits and Raceways.

3.2.1 Conduits can be

- i) mild steel - black enamelled
- ii) mild steel - galvanized (Heavy duty)
- iii) Rigid PVC (Heavy duty)

as specified and required by the schedule of work. Wall thickness in each case shall be as follows:

Outside Dia	Steel		PVC
	Black enamelled (mm)	Galvanised (mm)	

ANNEXURE-E1 TECHNICAL SPECIFICATION

(a) Upto 32 mm dia	1.4	1.4	2.0 mm
(b) Over 32 mm dia	1.6	1.6	2.0 mm

3.2.2 Heavy duty M.S type and shall be used only where the conduits are embedded in concrete or wall chases with adequate cover.

3.2.3 Flexible conduits shall be heavy duty M.S type with PVC coating IP40 quality and connected with appropriate fittings. Flexibles without end fittings shall not be accepted. Wherever permitted, PVC flexibles may be used.

3.3 Accessories

3.3.1 Conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs, junction boxes & inspection boxes etc. shall be heavy duty specifically designed and manufactured for their particular application. All conduit fittings shall conform to IS: 2667-1964 and IS: 3887-1966. Wherever galvanised conduits are specified in the schedule of work, the fittings also shall be galvanised. In the case of PVC conduits, heavy duty PVC fittings shall be used.

3.4 Wires

3.4.1 All wires shall be single core multi-strand copper. PVC insulated to IS : 694 and shall be 1100V grade as specified and required in the schedule of work. The PVC insulation shall be halogen free unless otherwise specified.

3.4.2 All wires shall be colour coded as follows :

<u>Phase</u>	<u>Colour of wire</u>
R	Red
Y	Yellow
B	Blue
N	Black
Earth (if any)	Green (insulated) Control Grey

3.5 Switches & Sockets

3.5.1 Switches shall be moulded modular design with silver-plated contacts. Sockets shall be 3 pin with switch. All switch & socket mounting boxes shall be electro-galvanised steel specially made for the switches and sockets used. Combination of multiple switch units and sockets should be used in appropriate manner to minimise the no. and size of switch boxes.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.5.2 Weather and water proof switches / sockets of approved make shall be used in all out door situations and where shown.

3.5.3 For industrial applications, industrial type of sockets with a pad lockable switch in a suitable galvanised steel box/fire retarded toughened plastic box shall be used. Cover plates shall be of galvanised metal in industrial applications.

4.0 Installation

4.1 The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 20 mm dia unless otherwise indicated or approved. Size of wires shall be not less than 1.5 sq. mm copper or 2.5 sq. mm aluminium, but shall be as specified in the schedule of work.

Nominal Cross sec. Area (mm ²)	Overall dia (mm)	Conduit diameter (mm)			
		20	25	32	40
		Number of wires			
1.50	3.4	3	6	9	-
2.50	4.2	2	4	8	-
4.00	4.8	2	3	6	-
6.00	5.6	-	3	6	-
10.00	7.0	-	2	4	5

Raceways should not be filled for more than 30%

4.2 Conduits shall be kept at a minimum of 100 mm from the pipes of other non-electrical services.

4.3 Separate conduits / raceways shall be used for each of the following:

- 1) Normal lights and 5A 3 pin sockets on lighting circuit
- 2) Power outlets - 15A 3 pin, 20A/ 32A industrial outlets.
- 3) Emergency lighting
- 4) Telephones & Data
- 5) Fire alarm system, Public address system
- 6) Call bell wiring

4.4 Shop drawing for Conduit layout shall be prepared by the contractor taking into account the site conditions and got approved before proceeding with the work. Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors

ANNEXURE-E1 TECHNICAL SPECIFICATION

- etc., shall be installed in flexible conduits. No flexible extension shall exceed 1.25m in length.
- 4.5 Conduits run on surfaces shall be supported on galvanised steel 6 mm thick saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm. Fixing screws shall be with round or cheese head and of cadmium plated brass. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building. Unseemly conduit bends and offsets shall be avoided by using fabricated galvanised steel junction/pull through boxes for better appearances. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.
- 4.6 Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but final finish will be done by the building contractor.
- 4.7 Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the Engineer, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete. Suitable galvanised steel fish wires of not less than 0.63 mm dia shall be drawn in all conduits before they are embedded. Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.
- 4.8 Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90 degree solid bends or equal. All junction and pull boxes shall be covered by an approved cover plate truly cut and fixed with cadmium plated brass screws. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the cover for painting and refixing. No separate charges shall be allowed except where specially mentioned.
- 4.9 Conduits shall be free from sharp edges and burs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32mm deep and the termination shall be rigid with check nuts and a smooth bushing. No wires shall be exposed in any part of the installation.
- 4.10 An insulated earth wire of not less than 2.5 sq.m copper shall be run in each conduit as specified in the schedule of work.

5.0 **Lighting & Power Wiring**

- 5.1 All final branch circuits for lighting and appliances shall be stranded single conductor cables run inside conduits. The conduit shall be properly threaded and screwed into

ANNEXURE-E1 TECHNICAL SPECIFICATION

sockets, bends, junction boxes. No part of the wiring shall be exposed without a suitable conduit piping.

- 5.2 Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.
- 5.3 Final branch circuits shall preferably be kept in a separate conduit upto the Distribution Board. A conduit should carry only circuits belonging to the same phase unless it is a 3ph supply. Each lighting branch circuit shall be loaded conservatively so that the circuit current is substantially lower than the current carrying capacity of the conductor or as shown on drawings. Each conduit shall not hold more than three branch circuits of the same phase.
- 5.4 Flexible cords for connection to appliances, fans and pendants shall be 650/1100V grade (three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the Engineer's approval.
- 5.5 Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the subcircuit, submain or main is more than the length of the standard coil.
- 5.6 Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in 14 SWG galvanised steel boxes. Cadmium plated brass screws shall be used.
- 5.7 Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 25 mm and wires not less than 2.5 sq.mm copper shall be used as specified in the schedule of work. Power outlets belonging to two phases shall maintain a minimum distance of 2.0m
- 5.8 Every conductor shall be provided with identification ferrules at both ends matching the drawings.

6.0 Testing

- 6.1 The entire installation shall be tested for:
- a) insulation resistance
 - i) between phases
 - ii) between each phase and earth
 - b) earth continuity
 - c) polarity of all switches

No installation shall be commissioned unless and until the insulation resistance is 2.0 megohms between phases and 1.0 megohms between phase and neutral. All tests shall be witnessed by the Engineer-in-charge and attested.

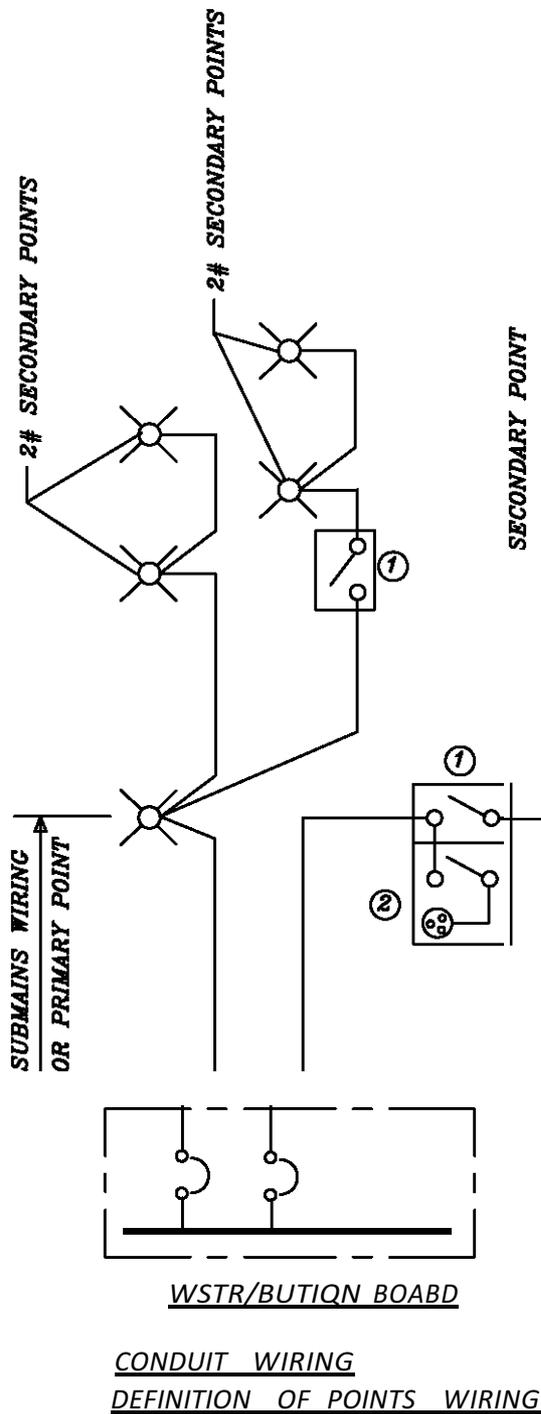
A test certificate shall be submitted as required

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 Mode of measurement

- 7.1 The definition of point wiring shall be in accordance with the enclosed sketch drawing.
- 7.2 The final subcircuit wiring commencing from the distribution board till the first switch box or light fitting shall be considered as a circuit or primary point.
- 7.3 All other continuing wiring shall be regarded as secondary point. Secondary point should include wiring from circuit point onwards together with all junction boxes, connectors, earthwire, fixing accessories, connection to all light fittings switches etc. as specified and shown on drawings.
- 7.4 All switches sockets with boxes, inter connections, earthing shall be paid for per unit of 1 switch, 2 switch, 3 switch, 4 switch units, 5A switch-sockets, 20A/30/60A M.C sockets generally as shown in the schedule of work.
- 7.5 All empty conduit runs, including junction boxes, fish wires etc. shall be paid on the basis of unit length.
- 7.6 Buzzer indicator of the ways specified shall consist of indicating lamps, reset button, electromagnet, cover plate, chromium plated brass screws etc. shall be considered as one unit for measurement and payment.
- 7.7 Two way light points shall be classified as separate point and shall consist of 2 Nos 2 way switches, wiring from the 1st 2 way switch to the 2nd 2 way switch and to the first light controlled. Subsequent lights, if any, shall be measured as secondary points.

ANNEXURE-E1 TECHNICAL SPECIFICATION



NOTES

- 1) SWITCHES & SOCKETS TO BE PAID PER UNIT INCLUDING SWITCH BOX. INTERNAL WIRING ETC.
 - 2) 5A SOCKET MOUNTED ALONG WITH THE LIGHT CONTROL SWITCH SHALL NOT BE COUNTED AS A SECONDARY POINT. THIS SHALL BE PAID AS A SWITCH+SOCKET (INCLUDING INTERNAL WIRING) AS DEFINED IN NOTE(J) ABOVE.
-) SAME DEFINITIONS APPLY FOR POWER SOCKETS AS WELL.

10. TECHNICAL SPECIFICATION FOR LIGHT FIXTURES & FANS

1.0 **Scope**

ANNEXURE-E1 TECHNICAL SPECIFICATION

1.1 The scope of work shall cover the supply, installation and testing of light fixtures including lamps and ceiling fans.

1.2 Where fixtures are supplied, the scope shall cover installation only with all the accessories as specified in the schedule of work.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- | | | |
|----|---|---|
| 1) | IS 3646 - 1968 | Code of practice for interior illumination |
| 2) | IS 1913 - 1969 | General and Safety requirements for electric lighting fittings. |
| 3) | IS 8030 - 1976 | Luminaries for Hospitals |
| 3 | IS 374 - 1966 | Electric ceiling type fan & regulators. |
| 4 | Indian Electricity Act and Rules issued thereunder. | |

2.2 All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

3.0 **General Requirements**

3.1 All fixtures shall be complete with accessories and fixings necessary for installation whether so detailed under fixture description or not.

3.2 Fixture housing, frame or canopy shall provide a suitable cover for the fixture outlet box or fixture opening.

3.3 Fixtures shall be installed at mounting heights as detailed on the drawings or instructed on site by the Architects/Consultants and individually earthed with 2.5 Cu sqmm wire.

3.4 Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening other than shown on the drawings or herein specified shall be submitted to the Architect/Consultant for approval.

3.5 Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation as per Architect's/Consultant's instructions.

3.6 Flush mounted and recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.7 Fixture mounted on outlet boxes shall be tightly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation.
- 3.8 Fixture shall be completely wired and constructed to comply with the regulations and standards for Electric Lighting Fixtures, unless otherwise specified. Fixtures shall bear manufacturer's name and the factory inspection label unless otherwise approved.
- 3.9 Wiring within the fixture and for connection to the branch circuit wiring shall be not less than 1.5 sqmm copper for 250 volt application. Wire insulation shall suit the temperature conditions inside the fixture and wires bypassing the choke shall be heat protected with a heat resistant sleeve.
- 3.10 Metal used in lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with the specification or standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burrs and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.
- 3.11 Ferrous metal shall be bonderized and given a corrosion resistant phosphate treatment or other approved rust inhibiting prime coat to provide a rust-proof base before application of finish.
- 3.12 Non-reflecting surfaces such as fixture frames and trim shall be finished in baked enamel paint.
- 3.13 Light reflecting surface shall be having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by finish and free from irregularities. Finish shall be capable of withstanding 72 hours continuous exposure to an ultraviolet sun lamp placed 10 cm from the surface without discoloration, hardening or warping and retain the same reflection factor after exposure. Test results shall be furnished for each of fixtures.
- 3.14 Fixture with visible frames shall have concealed hinges and catches. Pendant fixtures and lamp holders shall be provided with ball type aligners or similar approved means. Recessed fixtures shall be constructed so as to fit into an acoustic tile ceiling or plaster ceiling plaster rings/flanges shall be provided for plaster ceiling. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining device to prevent the diffuser from moving.
- 3.15 Detailed catalogue cuts for all fixtures, or, if so required by the Architect/ Consultants sample fixtures shall be submitted for approval to the Architect/Consultants before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Architect/Consultant.
- 3.16 Recessed fixtures shall be constructed so that all components are replace- able without removing housing from the ceiling.
- 1) Lamp shall be supplied and installed in all lighting fixtures furni- shed under this contract. All lamps shall be rated for 250 volts.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2) Lamps used for temporary lighting service shall not be used in the final lamping of fixtures units.
- 3) Lamps shall be of wattage and type as shown on the drawings and schedule. Where not shown, the details shall be ascertained from the Architect/Consultant before procurement.
- 4) Lamps for permanent installation shall not be placed in the fixtures until so directed by the Architect/Consultant, and this shall be accomplished directly before the building portions are ready for occupation.

4.0 Fluorescent fittings

- 4.1 Only single and /or two lamp ballast shall be used in any one fixture. All ballasts shall be low loss electronic ballasts unless specified otherwise.
- 4.2 All fluorescent fixtures shall be provided with separate wiring channel with cover plate and an earth terminal. All screws shall be chromium brass screws. Lamp and starter holders shall be out of tough moulded plastic with spring loaded rotor type contactors rendered shock and vibration proof. Condensers shall be low loss paper impregnated hermetically sealed complying with IS 1969-196. Internal wiring shall be neatly clipped and where by passing the ballast, a suitable heat resistant barrier or sleeve shall be provided.
- 4.3 Surface mounted fixtures longer than two feet shall have one additional point of support besides the outlet box fixture stud when installed individually. Pendant individually mounted fixtures four feet long and smaller shall be provided with twin stem/conduit hangers. Stems shall have ball aligners or similar devices and provided for a minimum of 25 mm vertical adjustment. Stems shall be of appropriate length to suspend fixtures at required mounting height.
- 4.4 Lamps shall have bi-pin bases and a minimum approximate rated and guaranteed life of 6000 hrs. Colour spectrum of light shall be equivalent to 'Philips White.' Lamp starter and ballast shall match the lamp.

5.0 Incandescent fittings

- 5.1 Incandescent fittings shall be of the type generally specified on the drawings. Contractor should have sample approved by Architects/ Consultant before procurement.
- 5.2 Incandescent fixtures shall be equipped with porcelain, medium base, screw type sockets for lamps up to and including 200 watt and mogul screw type base for lamps 300 watt and over.
- 5.3 Relamping the fixture shall be possible without having to remove the fixture from its place.
- 5.4 Incandescent lamps shall be inside frosted or clear type as required by the Architect/Consultants.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.0 **Ceiling Fans**

6.1 Ceiling fans shall be complete with fan suspension stem canopies and regulators. 30 cm suspension stem shall be standard accessory and stems shall be heavy duty M.S steel tubes to IS 1239-1958.

6.2 Fans shall be mounted on a pre-embedded hook with hard rubber isolator. Regulators shall be no-step type mounted in the switch box. The box in all such cases shall be large enough to accommodate the regulator and switches. One sample box with top cover shall be got approved before procurement.

7.0 **Mode of measurement**

7.1 Each fixture shall be measured as a unit complete with lamp, connectors, earthing, mounting arrangement, clamps, all accessories & supports etc. necessary for completeness of installation.

7.2 Suspension stems for light fittings shall be measured as bare conduits and paid at the rate per unit length.

7.3 Fans shall be measured as a unit complete with all accessories, suspension rods, fan hook, etc.

7.4 Where light fixtures and fans are supplied by the client, the installation shall be paid per unit and the cost shall include all suspension, installation materials, connectors, earthing, clamps, all accessories & supports etc. required for completeness of installation.

11. TECHNICAL SPECIFICATION FOR PROTECTIVE EARTHING

GENERAL :

1.0 **Scope**

1.1 The scope of work shall cover earthing stations, laying aluminum/ copper earth strips and connecting the power panels, DBs and switch boards.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- 1) IS:3043 - 1966 Code of Practice for earthing.
- 2) Indian Electricity Act and Rules

2.2 All codes and standards mean the latest.

3.0 **Plate Earthing Station**

3.1 The substation earthing shall be with copper plate earthing station unless otherwise specified.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.2 The earthing station shall be as shown on the drawing. The earth electrodes shall be 600 x 600 x 3mm copper plate. The earth resistance shall be maintained with a suitable soil treatment and watering arrangement as shown on drawings. Excavated soft soil shall be thoroughly mixed with bentonite material and the earth pit is back-filled 300 x 300 earth chamber with cast iron cover shall be provided to house the earth terminal and water pipe & funnel.

3.3 The resistance of each earth station should not exceed 3 ohms.

3.4 The earth lead shall be connected to the earth plate through copper/brass bolts as shown on the drawing.

Pipe Earthing Station

4.1 The pipe earth station shall be as shown on the drawing and shall be used for equipment protective earth grid. The earth electrode shall be 2.5m long 50mm dia 5mm thick galvanised steel pipe. The earth resistance shall be maintained with a suitable soil treatment as shown on drawings and as for plate electrodes. An earth chamber shall be provided as for plate earth station.

4.2 The resistance of each earth station should not exceed 5 ohms.

4.3 The earth lead shall be fixed to the pipe with a clamp and safety set screws. The clamps shall be permanently assessable.

Earth leads and connections

5.1 Earth lead shall be bare copper or aluminium or galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 percent. Aluminium and galvanised steel buried in ground shall be protected with bitumen and Hessian wrap or polythene faced hessian and bitumen coating. At road crossings necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles on wall so that the strip is atleast 6mm away from the wall surface.

5.2 All earth strip shall be jointed as follows:

Copper : Copper riveting with 80mm fish plate and brazing

Aluminium : Riveting with 2Nos 100mm long bimetal fish plates using copper rivets

Galvanised Steel : Lap welding with 50mm minimum lap

5.3 All strips shall be run on walls/beams with 6mm thick galvanised steel earth saddles at 500mm centre to centre as shown on drawings.

Equipment earthing

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<i>Size of phase conductor</i>	<i>Copper</i>	<i>Aluminium</i>	<i>Galvanised steel</i>
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs.	> Minimum
(base)	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	

The protective earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

6.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

6.3 Armoured cables shall be bonded to the earth by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 P h. DB's a single e art h connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

6.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

7.0 Earthing Installation

7.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

8.0 **Testing**

8.1 The following earth resistance values shall be measured with an approved earth meggar and recorded.

- 1) Each earthing station
- 2) System as a whole
- 3) Earth continuity

9.0 **Mode of measurements**

9.1 Providing earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

9.2 The following items of work shall be measured and paid per unit length covering the cost of the earth wires/strips clamps, labour etc.

- (a) Main protective earth terminal and connections to the earthing stations
- (b) Connections to the switchboard, power panels, distribution boards etc.

9.3 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

- a) Motors - earthing forming part of the cabling/wiring for the motors.
- b) Isolating switches and starters should form part of mounting frame, switch starter etc.
- c) Light fittings - form part of installation of the light fittings. d) Conduit wiring - should form part of the wiring
- e) Cable armouring - should form part of the cable termination.
- f) Street lighting - should form part of the external cable which shall incorporate a protective earth-conductor which shall be used for earthing of the pole etc.

12. TECHNICAL SPECIFICATION FOR LIGHTING PROTECTING SYSTEM & AIRCRAFT WARNING LIGHTS

1.0 **Scope**

ANNEXURE-E1 TECHNICAL SPECIFICATION

1.1 The scope of work shall cover supply, installation and testing of air termination with necessary support, low impedance down conductors, performance recording equipment & earth terminations. It also covers the supply and installation of aircraft warning lights.

2.0 **Standards**

2.1 The following standards shall apply:

- 1) IS 2309 - 1969 Code of practice for the protection of buildings and allied structures against lightning
- 2) IEC 61024, NFC 17102 Early streamer emission system
- 3) IS:3043 - 1966 Code of practice for earthing.
- 4) IS:5216 - 1969 Safety procedures and practice in electrical work.
- 5) Indian Electricity Act 1910 and Rules issued there under.
- 6) British Standard Code of Practice 326 - 1965.

2.2 All codes and standards means the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of practice or the relevant British Standard Codes of Practice in the absence of Indian Standard.

3.0 **Lightning Conductor System**

3.1 **Air Terminal**

3.1.1 Lightning conductor system shall follow the early streamer emission principle meeting the IEC 61024.

3.2 The terminal shall be non-electronically activated Early Streamer Emission (ESE) type of approved make meeting IEC 61024. The terminal shall be manufactured out of stainless steel and tested in an approved high tension laboratory for a lightning impulse of 200KA 10/350 microsecond wave form. The terminal shall be selected to offer a protection radius which shall cover the entire building it is provided to protect. The terminal does not require any external power supply to achieve the desired level of emissions.

3.2 **Down Conductor**

3.2.1 The down conductor carries the lightning discharge from the Air Terminal (AT) to the Ground Terminal (GT) and shall be a copper conductor of not less than 50mm². Each air terminal shall have two down conductors following the most direct path between the AT and the GT. Bends shall be avoided as far as possible and where unavoidable the radius shall be not less than 300mm. The down conductor shall be connected to the AT through appropriately designed clamps and each down conductor shall be terminated in an independent GT.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.2.2 The down conductor shall be clamped to the building outer wall at 600 mm centres. Joints in the down conductors shall be avoided as far as possible. However, joints shall not be made below ground level. Where joints are made care shall be taken so as to exclude any moisture and preferably exothermic connections. Bimetallic connectors shall be used where dissimilar metals are to be jointed.

3.2.3 A testing link shall be provided for each down conductor along with a lightning counter with a counting power range of 2 to 100KA and 8 / 20 or 10 / 350 microsecond wave form. The counter shall be in a IP65 enclosure and not need any external energy source.

3.3 Ground Terminal

3.3.1 The ground terminal shall be a 3m long perforated steel pipe deep galvanized for long life buried in an excavated pit of 450 x 450 and 3m long with a surface chamber of masonry and a hinged C.I cover. The pit shall be filled with any special chemicals or bentonite which retains moisture of long duration without watering. A watering pipe also shall be provided.

3.3.2 The ground terminal shall be shall be interconnected to the building ground terminal bus and all neighbour metallic pipes shall have an equipotential bonding.

4.0 Aircraft Warning System

4.1 The aircraft warning system shall consists of dual-head non-flickering aircraft warning lights located at the highest point of the building. The warning lights shall be of cast aluminum body with twin lamp head, red prismatic glass dome with smooth exterior, weather-proof construction necessary gasket & cable entry arrangement. The lamp shall be of LED for long life.

4.2 The lamp shall be wired with PVC insulated and sheathed cable and shall be earthed as generally specified under 'EARTHING.'

5.0 Testing

5.1 The entire lighting conductor installation shall be tested in accordance with the Indian Standard Code and the following ground resistance values shall be recorded.

- i) Earthing Terminal (each)
- ii) Earthing system (as a whole including down conductor)

6.0 Mode of measurement

6.1 ESE lightning system comprising.

- a) Air terminal (with necessary foundations/mounting arrangement)

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) Ground terminal with lightning conductor c)
Event counter

Shall form one unit of measurement complete with clamping, welding joints, excavation for ground terminal.

Down conductor shall be measured on per meter basis including clamping etc. for completeness of the installation.

- 6.2 Each aircraft warning light shall be measured as one unit for payment and shall include:

- i) Light fittings, lamp and accessories ii) Internal wiring
- iii) Installation with all fixing accessories

- 6.3 The wiring for each aircraft warning lights will be measured as one point for payment and shall include:

- i) 3C 2.5 mm PVC insulated armoured cable, clamp and fixing accessories
- ii) Junction box with cover, painting, control switch. iii) Interconnections

13. TECHNICAL SPECIFICATION FOR EXTERNAL LIGHTING

1.0 Scope

- 1.1 The scope of work covers the supply, installation and testing of lighting poles, weather proof light fixtures, wiring to the fixtures, Junction boxes, cable laying & termination, earthing as specified and shown on drawings including necessary minor civil work like excavation & backfilling, foundation for poles etc. for completeness of installation.

- 1.2 Wherever fixtures and poles are supplied by the client, the installation shall include erection of poles, excavation, coping & necessary foundations etc for completeness of installation.

2.0 Standards

- 2.1 The following standards and rules shall be applicable:

- 1) IS: 1913 - 1969 General and safety requirements for light fittings.
- 2) IS: 2944 - 1981 Code of Practice for lighting public thoroughfares
- 3) IS: 3528 - 1966 Water proof electric lighting fitting
- 4) IS: 1239 - 1966 Water tight electric lighting fitting
- 5) IS: 1239 - 1958 Mild steel tubulars and other wrought steel pipe fittings
- 6) IS: 2149 - 1978
- 7) IS: 2149 - 1970 Luminaries for street lighting

ANNEXURE-E1 TECHNICAL SPECIFICATION

8) Indian Electricity Act and Rules

2.2 All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice or the British Standard Codes of Practice in the absence of Indian Standards.

3.0 **Light Fixtures (Weather proof & Water proof)**

3.1 The light fixture construction shall be of die cast aluminium with a separate compartment for integral ballast equipment. The reflector shall be anodized polished aluminium. The glass refractor shall be heat-resistant.

3.2 Lamp holder shall be of porcelain and shall comprise a terminal block of non-hygroscopic material. The luminaries shall have integral ballasts as specified housed in water tight and dust tight metal cases. Ballasts shall be prewired to the lamp socket and terminal block, requiring only power supply leads to the ballast primary terminals.

3.3 The lamp & Luminaire shall be as specified in BOQ.

4.0 **Lighting Poles**

4.1 The lighting poles shall be fabricated from heavy duty cold-rolled steel tubes to IS:1239-1958 and hot dip galvanised or painted as specified. The pole shall have a base plate, a large access panel, and necessary fixture mounting bracket at top. The access panel shall provide easy access to a multiway porcelain connector and fuse board, to be mounted inside the pole. The access shall be specially fabricated with adequate reinforcement and weather gasket to prevent ingress of moisture and vandal proofed. Poles shall have large diameter entries for incoming and outgoing cable and two earth studs. The pole fabrication shall conform to the drawings and , the contractor shall make drawing and have it approved before fabrication.

4.2 The pole shall house a multiway porcelain junction box with MCB and rewirable fuse as shown on the drawings. Pole shall have a concrete coping.

5.0 **Feeder Pillar**

5.1 Feeder Pillars shall be factory fabricated distribution centres housing necessary

- a) Fuses, MCB's with holders
- b) Copper busbars and a separate earth bar
- c) 15A weather proof socket outlet and switch
- d) Atleast 2Nos 9W bulkhead CFL fittings with weather proof switches.

5.2 The feeder pillar shall be fabricated out of 14SWG mild steel with 12 SWG hinged lockable door panel . Hinges shall be heavy duty minimum 100mm long and of CP brass or S.S 304. Mild steel panel shall undergo a rigorous treatment of 7 bath anti- corrosion process and powder coated. The Feeder pillar shall be rendered dust proof, vermin proof and weather proof conforming to IP 65. Feeder pillar shall be mounted on concrete pedestal (400mm

ANNEXURE-E1 TECHNICAL SPECIFICATION

above ground) with suitable provision for entry and egress of cables. Feeder pillar shall be amply sized to accommodate all the internals and at the same time achieve an internal temperature of not more than 40 °C, 2Nos earth studs shall be brought out. All hard-ware such as door handles, hinges, locks etc. Shall be chromium plated brass or stainless steel.

5.3 Feed pillars shall house necessary fuses, mcb's , tag blocks etc. as shown on drawings and as specified.

6.0 **Cable laying**

6.1 Cabling shall be generally as specified in the section 'M V CABLING.'

6.2 Cables shall be terminated in a junction box inside the pole or attached therewith as shown on drawings.

6.3 Cable route shall be as shown on the drawings or the contractor shall mark out the route and lay the cables only upon approval of the route.

6.4 If Flexible wires are used, then they have to be laid in FR RIGID PVC conduits buried in soil. It shall be terminated in terminal block inside the pole. Route shall be as shown on drawings or the contractor shall mark out the route & lay the conduits with wires only upon approval of the route.

7.0 **Earthing**

7.1 All street lights fixtures and poles shall be earthed as specified.

8.0 **Mode of measurement**

8.1 Each light fitting with lamp, control gear, earthing etc. shall be considered as one unit for measurement and payment.

8.2 Each lighting pole, concrete coping, base plate, earthing etc. shall be considered as one unit for measurement and payment.

8.3 Wiring from the junction box to the light fitting shall be considered as one unit for measurement and payment.

8.4 All cabling work shall be measured on the basis of unit length and the cost shall include, cost of cable, minor civil work required for laying cables, laying tiles etc.

8.5 All cable terminations shall be measured as one unit complete with necessary glands, lugs, nuts, bolts, jointing material, earthing of glands etc. for completeness of installation.

8.5 Feeder pillars shall be measured per unit complete with all components as specified.

8.6 Wherever light poles and fixtures are supplied by client, the installation shall be paid per unit and the unit cost shall include excavation, erection, concrete coping, earthing etc.

ANNEXURE-E1 TECHNICAL SPECIFICATION

14. TECHNICAL SPECIFICATION FOR POWER FACTOR CORRECTION SYSTEM

1.0 **Scope**

1.1 The scope of work shall cover supply, installation, testing and commissioning of power factor improvement capacitors, PF relay, contactors etc.

2.0 **Standards**

2.1 The following standards shall be applicable;

i) IS 2834 : 1986 Power Capacitors

3.0 **Capacitors**

3.1 Capacitors shall be Mixed dielectric long life (minimum 100,000 operating hours) without degradation or loss of capacitance. Capacitors shall have low energy loss (less than 0.5W/KVAr) and totally tropicalised. Each capacitor shall have a discharge resistor to bring down the residual voltage to 50V within 60 secs.

3.2 The capacitance output shall be guaranteed for a period of 2 years @ +10% & - 5% of the rated value. All capacitors shall be type tested for dielectric strength, IR value (min. 50 megohms), losses, surge protection etc. in accordance with the IS standards. Capacitor elements shall be canned in a galvanised steel enclosure and sealed to meet IP 52 class. All capacitors shall operate at 135% overload (over voltage or harmonics) without deterioration. Temperature rise shall be as per IS 2834.

4.0 **Control Panel**

4.1 The control panel shall consist of three sections:

- i) Capacitor section
- ii) Switch section
- iii) Monitor and control section

4.2 The capacitor section shall house the capacitors with proper and adequate ventilation using exhaust fans so that the capacitors will not be overheated. The enclosure shall also provide easy access to each capacitor unit for maintenance.

4.3 The switch section shall consist of switch fuses/breakers, contactors, voltmeter, PF meter, ammeter selector switch, push button for opening & closing power circuit, On-Off indication lamps.

4.4 The control section shall contain a microprocessor based control unit with requisite relays to switch the capacitors ON or OFF. The system PF shall be monitored constantly and the switching sequence regulated. The switching sequence shall be capable of being changed or modified so as to ensure that all the capacitor units will have equated run hours. Provision shall be available for manual override through multiple push buttons. Control unit

ANNEXURE-E1 TECHNICAL SPECIFICATION

shall have communication port / potential free contacts or necessary provision to start / stop from IBMS.

- 4.5 The panel and individual capacitors shall be earthed as required under "PROTECTIVE EARTHING".
- 4.6 The control panel shall have no voltage, unbalance protection & short circuit protection. Each section shall have ON-OFF indication.
- 4.7 Following protections shall be provided for the capacitor panel:
i) No voltage protection ii) Unbalance protection iii) Short circuit protection

5.0 **Testing**

5.1 Capacitors units shall be tested to withstand 2500V AC for one minute and shall yield an IR value of 50 megohms after one minute charge with 500V DC meggar. The sequence switching shall be functionally tested.

5.2 All test readings shall be duly recorded and presented.

6.0 **Mode of measurement**

6.1 Each capacitor panel will be considered as one unit for the purpose of measurement and payment and shall include the following:

- i) incoming and outgoing feeder, fuses etc. ii) contactors, PF relay wherever specified
- iii) capacitors in multiple units duly supported and enclosed.
- iii) PF meter, indicating lamps, push buttons, control microprocessor v) supporting frame & painting
- vi) necessary CT's in the main panel, control wiring therefrom.
- vii) installation, testing and commissioning

15. TECHNICAL SPECIFICATION FOR FLOOR TRUNKING & WORK STATION WIRING

1.0 **Scope**

1.1 The scope of work shall cover supply and installation of floor trunking & work station wiring. All minor civil work such as removing tiles and mortar etc. involved shall be covered in the scope of this contract.

2.0 **Trunking & Raceways**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.1 The trunking & raceway shall be products from standard manufacturers and fabricated out of 3mm thick m.s sheet electrogalvanised. The raceway may be of single or two or three compartments as defined in the schedule of work. Multiple compartmented raceways may be used for power cables and other low voltage cables in different compartments.

Sizes and compartments shall be as indicated on drawings and schedule of work/

- 2.2 Single compartment large size raceways are to be similar to the 2-compartment raceway. Such raceways are used as trunk feeders of electrical and data cables, feeding into the 2-compartment raceways. Fabrication and other construction details shall be similar. Such large raceways may be run in the floor or above false ceiling as required.
- 2.3 All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. and the raceway shall be finished with electrogalvanising.
- 2.4 All the junction boxes, joints and right angle bends shall be prefabricated as per approved shop drawings. Raceways may be supplied in sections with jointing strips so that the entire raceway is rendered electrically continuous without additional fixtures.

3.0 Installation

- 3.1 The raceway installation shall comprise the following:

- a) Marking on site
- b) Chasing of floor to the required depth, including removal of tiles wherever required.
- c) Leveling of surface using a thin layer of cement screed. d) Placing of raceway and final leveling
- e) Alignment of raceway and grouting of the left out portion. Installation of extension box and SS cover plate.

- 3.2 The raceway layout shall be marked on the floor prior to the chasing and shall be got approved.

- 3.3 Proper care shall be taken to avoid choke up of raceways with cement screed.

4.0 Power wiring for workstations

- 4.1 All power cables (wires) shall be halogen free copper conductor of minimum 4sqmm. for phase and 4 sqmm for neutral. Protective earth conductor shall also be halogen free 4sqmm copper conductor.
- 4.2 All wires P+N+E shall be looped in and out of a Wago connector (Push-to- connect) at each tap off. The connector shall be suitable for 3 wires-in and 3 wires-out and 3 wire-tapoff (which shall be used for not more than 2 tap off connections)

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.3 Tap Off wiring from the connector to the work station shall be through 3 x 4 sqmm halogen free copper wires drawn in a FR galvanised steel flexible conduits. The tap-off conduit shall be carefully run on the furniture or in the wire management system of the furniture, if any, and terminated in a switch box.

The switch boxes shall be mounted on the furniture as instructed by the Architects and Engineer. All conduits buried in floor should be rigid while flexible conduits may run in the furniture.

- 4.4 A mock-up of the installation shall be got approved before taking up the work.

- 5.0 **Data & voice cabling** (Not Applicable)

- 5.1 Data & Voice cables shall be Cat 6 laid in the raceways. These cables shall be terminated in a Duplex information outlet mounted on the furniture as instructed by the Engineer –in-charge. The cables shall be laid from the Jack or Patch panels in the communication room or closet upto the information outlet without any joint or splicing. Final cable runs from the under floor raceway to the information outlets shall be run in a galvanised steel flexible conduit neatly fixed on the furniture or run through the cable management system, if any.

- 6.0 **Mode of Measurement**

- 6.1 The raceway system shall be measured as follows:

- a) Supply and installation of raceway complete with cover, blank plates, supports connecting flanges, right angle bends for completeness of installation shall measured per unit length.

- 6.2 Wiring for work stations shall be measured as a point as defined below.

- i) All wiring P+N+E as specified from DB to the first power point of the circuit raceway upto the junction box and through FR flexible M.S conduit from Wago connector (including the connector & conduit) as primary point.
- ii) All wiring as specified from Primary point above to various power points on the circuit through raceway upto the junction box and through FR flexible M.S conduit from Wago connector (including the connector & conduit) as secondary point
- iii) Supply and mounting 2 - 15A switches with 2-5/15A sockets below & 2 – 5/15A sockets above the table.

16. **TECHNICAL SPECIFICATION FOR UNINTERRUPTED POWER SYSTEM**

- 1.0 **The Scope**

- 1.1 The scope of work shall cover supply, packing, forwarding to site, unloading at site, erection, testing and commissioning of a static Uninterrupted Power Systems meeting the performance criteria listed in the Data sheets and the specifications. Units may be single or multiple modules as defined in the Data sheets.

- 2.0 **Code & Standards**

ANNEXURE-E1 TECHNICAL SPECIFICATION

2.1 UPS shall be standard products of established manufacturers and shall meet international standards with UL or CSA or CE listing. Safety & EMC standards should conform to EN 50091 – 1 & 2

3.0 **Environment**

3.1 Design ambient operating conditions shall be

Dry bulb	0 to 40°C
RH	0 to 95% (non-condensing) Altitude 1000m above mean sea level (Derate for higher levels)

3.2 Transport & storage conditions shall be

Dry bulb	0 to 70°C
RH	0 to 95% (non-condensing) Altitude 12000m above mean sea level

3.3 Acoustic performance of the units shall meet DIN 45630.

4.0 **System Content & Configuration**

4.1 **General**

4.1.1 UPS may have single module or may consist of multiple modules. Each module shall be supported by a back up battery. In multimodule parallel redundant systems, only one of the modules needs to be redundant in a n + 1 configuration. Each module shall be rated for continuous operation at 100% load with over load capability as specified and shown in the data sheets. Bypass section both for static and maintenance, shall be integral with each module. UPS shall be supported by necessary paralleling cards and software in case of multi module redundant systems

4.1.2 Each module essentially shall consist of A.C input section, AC output section, Bypass section and a back-up battery section and a control and monitoring panel.

UPS shall be supported with EPO (emergency power off) facility and soft start facility.

4.2 **AC Input section**

4.2.1 The AC input power supply is from the utility and the characteristic is defined in the Data sheets. Rectifier shall be IGBT based and shall meet the full load + the quick charging current of the battery. Input current limit shall be adjustable to maximum of 125% of normal full load current. The input circuit breaker shall therefore have trip rating to supply full rated load and recharge the battery at the same time. The breakers shall have an under voltage release to open automatically when the supply voltage is lost.

4.2.2 Input Current distortions shall be limited to the values set in the data sheets. Likewise the input power factor shall be as high as possible and not less than what is stated in the data sheets. In addition, the section shall sustain input surges without damage and in this connection it is desirable to follow the criteria listed in ANSI C62.41 – 1980.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.3 AC Output section

4.3.1 The inverter shall be solid state, pulse width modulated utilizing insulated gate bipolar transistors. Each power IGBT shall be individually fused with a fast acting fuse. Fuse failure shall be displayed in the monitor.

4.3.2 Inverter shall be rated for 100% continuous load at 40°C ambient temperature, for any combination of linear or non-linear loads and 10 times continuous load for 3 cycles without causing the bypass breaker to close. For parallel operation, all inverter modules shall automatically share the load within $\pm 5\%$ unbalance. Parallel load sharing function shall be resident and redundant in each unit without requiring master controllers.

Paralleling of UPS shall allow to switch off inverter of UPS in bank for lower loads but it shall be hot standby.

4.3.3 AC output from the inverter shall be better than what is specified in the data sheets. Voltage distortion, voltage transients, over load performance shall all be good for any load characteristic, linear / nonlinear or any load power factor between 0.8 lagging to 0.9 leading. Provide necessary filters to achieve THD specified in data sheets. There should be no de-rating from point 0.9 lag to 0.9lead power factor.

4.3.4 A dry type isolation transformer (wherever applicable as per datasheets) with double shielded copper windings with input and output surge suppression network shall be provided for true galvanic isolation. The transformer shall employ class H 220°C insulation but the maximum temperature rise shall not exceed 150°C. The rating of the transformer shall match with inverter rating and shall have six full- capacity primary taps (+2 ½ , + 5 , - 2 ½ , - 5 , 7 ½ , 10) Noise / transient suppression shall be not less than 140dB for common mode and 90dB for normal mode. Acoustic noise should not exceed 50 dB at 1.5m and also meet DIN 45630. Efficiency of dry type transformer shall be more than 96%.

4.3.5 An automatic output circuit breaker shall be provided to isolate the malfunctioning module from the critical load. The module should sustain sub cycle current of 300 to 500% and in the case of a sustained short circuit, the inverter shall disconnect automatically from the load bus. An uninterrupted load transfer to by pass shall be initiated should connected critical load exceed the capacity of the available on-line modules.

4.3.6 UPS should have low ripple & temperature compensated charging facility.

4.4 Bypass Section

4.4.1 A static transfer switch and bypass circuit shall be as far as possible, an integral part of the UPS. The static switch is a naturally commutated high speed static device rated to conduct 125% of full load current continuously, 200% for 30 seconds and 2000% for two cycles. The static switch may be provided with a wrap-around contactor as necessary.

4.4.2 The inverter shall track the bypass continuously so that the bypass source maintains a frequency of 50 ± 0.5 Hz. The inverter will change its frequency at 0.1 Hz per second to maintain synchronous operation with the bypass to enable make before break transfer manually or automatically. If the bypass fails to maintain the frequency, the inverter shall revert to a temperature compensated internal oscillator and hold the

ANNEXURE-E1 TECHNICAL SPECIFICATION

inverter output frequency 0.1% from the rated frequency for steady state and transient conditions. Total frequency deviation, including short time fluctuations and drift shall not exceed 0.1% from rated frequency.

- 4.4.3 A manually operated maintenance bypass switch shall be incorporated to each module.
- 4.4.4 Neutrals of all isolation transformers shall be connected to a common earth bus which in turn shall be connected to the earth stations
- 4.5 **Back-up Battery**
- 4.5.1 Each UPS module shall have a matching battery power pack housing batteries for quick discharge. AH rating of the battery pack shall be such as to sustain full load of the UPS for the specified discharge period till 1.7V cell voltage.
- 4.5.2 Recharge time to 95% capacity shall be within 10 times the discharge time. A 2-step battery charge current shall be limited to 10% (1 – 25% adjustable) and 1% (1 – 25% adjustable). Batteries shall have minimum 5 yrs life.
- 4.5.3 Battery charging circuit shall be intelligent to consider battery charging curves as per battery manufacturers specifications, temperature rise and % charge remaining.
- 4.5.4 Battery charger should support to battery banks to provide flexibility in battery configuration so that in case of failure of one battery bank other bank is available.
- 4.5.5 Insulation of inter-cell connectors for batteries shall be of FRLS type, also battery terminals shall have FRLS shrouds (anti static type).
- 4.5.6 Batteries to be installed in earthquake prone areas should include seismic tests on batteries & stands.
- 4.5.6 Vendor should submit data for hydrogen gas evolution under float and boost conditions.
- 4.5.7 Batteries shall be with flame retardant container material.
- 4.6 **Control, Monitoring and Display**
- 4.6.1 The UPS, single or multimodule, shall monitor and control through the use of menu-driven commands. System logic and control programming shall be resident in Application Specific Integrated Circuits and shall be solid state using switches, contacts and relays only to signal status of mechanical devices or to signal user control inputs. Redundant control voltage shall be available for all functional blocks.
- 4.6.2 A microprocessor shall control the display and memory functions of the monitoring system. All voltage and current parameters shall be monitored using true RMS measurements ($\pm 1\%$ accuracy) displaying all three phases of three phase parameters. Display shall show, but not limited to the following:

ANNEXURE-E1 TECHNICAL SPECIFICATION

Input	Output
<ul style="list-style-type: none"> • Voltage (L-L & L – N) • Current • Frequency 	<ul style="list-style-type: none"> • Voltage (L-L & L – N) • Current • Frequency
Battery <ul style="list-style-type: none"> • Voltage • Charging Current • Discharging Current <ul style="list-style-type: none"> • Time left during Battery operation by pass 	<ul style="list-style-type: none"> • KVA • KW • % rated KVA

4.6.3 Alarms listed below shall be displayed in text and audio formats.

- Ambient over temperature
- Equipment over temp.
- Over temp. time out
- Input Under Voltage Over Voltage Under frequency Over frequency Input fail
Input current imbalanced Rectifier fuse blown Blower failed
Reverse power Over load shut down Hardware shut down Inverter fault
Inverter non-synchronized DC over
Voltage shutdown DC ground fault
DC capacitor fuse blown Battery circuit
breakers open Batter discharging
Low battery shut down
- Output
Load on by pass
Auto transfer to By pass
Bypass not available
Bypass – wrong phase sequence Control
power failure Communication failure

The alarm displays shall not be limited to the above.

4.6.4 The system shall provide a connection for a remote terminal in RS485 format through a compatible modem and also a local terminal. All system features and alarms shall be capable of being remotely monitored leading to remote maintenance. In addition the following I/O points shall be provided 6 universal points, 8 potential free contacts.

4.6.5 Battery monitoring system

4.6.5.1 The Battery Monitoring System shall provide for the automatic acquisition, trending, alarming and storage of information from battery bank. It will have the interactive ability to first identify and then provide an isolated equalizing charge current to any individual cell or jar that deviates below a user-specified set point, from the cell average, within the same string or bank.

4.6.5.2 The Battery Monitoring System shall test the relative charge state and health of each individual cell or jar by injecting a DC current, recording the magnitude of this current & comparing it to previous benchmark values. Systems that require battery discharge for testing are not acceptable. The system shall provide estimated backup time remaining during an actual discharge.

4.6.5.3 The Battery Monitoring System shall monitor and maintain historical files for:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) individual cell or jar voltage b) total bank voltage
 - c) discharge current
 - d) ambient and pilot cell temperature e) relative current response value
- 4.6.5.4 Display shall be via local LCD display, with capacity for viewing at a remote terminal. All files shall be written to a fixed solid state disk within the enclosure. All functions shall be accessible via modem using common communications software.
- 4.6.5.5 Cell voltage measurements must be made to within plus or minus 5 millivolts over the entire operating and temperature range.
- 4.6.5.6 Documentation, Manuals and installation documentation for the equipment shall be provided which lists block diagrams, schematics parts list and theory of operating for each unique component of the system. Installation drawings and documentation shall be site specific for each string at this facility.
- 4.6.5.7 The system shall be factory tested fully and completely before shipment.
- 4.6.5.8 Site testing: Each measurement shall be tested and to assure that is properly corresponds to the correct cell location and that the measured value corresponds to a separate measurement taken within a four (4) digit laboratory accuracy Digital Voltmeter which has been calibrated to NBS standards within the past six (6) months. Manufacturer shall submit test procedures for approval
- 4.6.5.9 Support shall be provided as follows:
- a) At least 2 – 4 hour on site training sessions shall be provided after installation and start up is complete with the operation of the battery monitoring system.
 - b) Factory trained field service engineers shall be available for maintenance and repair of the battery monitoring system within 4 hours of the service call.
- 5.0 **Testing, Training and Service**
- 5.1 **Unit Start-up and Testing**
- 5.1.1 Factory testing shall be provided by the manufacturer before to dispatching UPS system. Factory acceptance testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A full 100% load, 24 hour burn in load power test including a 50% battery discharge test shall be provided as part of the standard start-up procedure. Overload test for 10 min. at 125% load and 30 sec. at 150% load. The test results shall be documented, signed, and dated for future reference. Test to be performed at factory.
- i) Power failure test
 - ii) Communication test
 - iii) Power continuity test
 - iv) Load on mains
 - v) Load on inverter

ANNEXURE-E1 TECHNICAL SPECIFICATION

- vi) Uncoupling
- vii) Coupling
- viii) Module exclusion test W/O using manual by pass.
- ix) Remote alarm operation
- x) UPS parameter check on display
- xi) UPS function check
- xii) Battery discharge test

5.1.2 Dedicated engineers shall be engaged on site for testing & commissioning of complete UPS system & for training of UPS system maintenance.

5.2 UPS Maintenance Training

5.2.1 Maintenance training shall be provided for a minimum of 8 hours for maintenance staff. This training will be in addition to the basic operator training conducted as part of the system start-up.

5.3 Manufacturer's Field Service

5.3.1 The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, 365 days/year. Emergency telephone service response time shall be 20 minutes or less, and on site service response time within 4 hours.

5.3.2 Battery manufactures service engineers shall supervise the battery bank installations. Also service engineers shall inspect battery inspection at regular intervals and submit inspection report to facility engineer.

5.4 Replacement Parts Stacking

5.4.1 Parts must be available for guaranteed delivery with 12 hours.

6.0 Warranties

6.1 Provide 3year warranty for full battery replacement (material and labor).

6.2 UPS shall be warranted to be free from defects for a period of 2 years from the date of acceptance of equipment. Warranty and preventive maintenance service shall be performed by factory-trained personnel.

17. TECHNICAL SPECIFICATION FOR BUS DUCTING(SANDWICHED CONSTRUCTION)

1.0 Scope

1.1 The scope of work shall cover the design, supply, installation, testing and commissioning of sandwich type Bus Ducting

2.0 Standards

2.1 The following standards and rules shall be applicable

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) IEC 60439-2 Particular requirement for bus bar trunking system. ii) IEC 60529 Degree of protection
iii) IS 2147 Degree of protection iv) IS 8623 –
1 & 2 For LV Distribution

3.0 **Construction**

- 3.1 The busbars shall be of sandwich construction. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.
- 3.2 The bus duct system shall be a light weight, low impedance, non ventilated naturally cooled and totally enclosed for protection against mechanical damages, vermin protection and dust accumulation with compact and sandwich type.

For each busduct length and fitting shall be included as an integral part while on both internal and external surface, metal trunking shall be made of 1.6mm Electrogalvanized sheet steel with Epoxy Powder Coated by an automated electrostatic process and 50% integral housing ground is standard (UL listed 50% ground path).

The busbars and their connections shall be capable of withstanding without damage, the thermal & mechanical effects of a through fault current equivalent to the short time rating of the switchgear. Busbars shall be of uniform cross sectional area throughout their length with connections as short and straight as possible

4.0 **Bus Bars**

- 4.1 Busbars shall be of high conductivity electrolytic grade single or multiple Aluminum bars with conductivity >61% or of Copper as specified.

The busbars shall be amply sized to carry the rated continuous current under the ambient temp of 40° without exceeding the total temp specified

Access to busbars & the connections directly thereto shall be gained only by the removal of covers secured by bolts or screws.

- 4.2 Copper & aluminium bus bar conductors shall be of tin electroplated. Its entire length shall be insulated over with epoxy resin coated by the machine. This is to prevent it from water and moisture that can cause reduction in dielectric resistance. And in case of fire, the flame retardant will ensure the safety.

On the tin electroplate for the jointing part of Aluminum Bus Conductor, it will be coated by silver for the better conductivity.

5.0 **Insulation**

- 5.1 The busbars shall be insulated throughout their length by epoxy / Mylar. The insulation material used shall be of class F (155°C). The insulation shall be fire retardant, non toxic, chemically inert, stable material.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.0 Joints

- 6.1 Shall be checked for tightness without de-energizing the busbar trunking runs, the joints shall be of maintenance free system of one bolt (M14) type with through bolts with at least 80mm overlap. The high strength bolt shall be insulated by an insulation, resistant for heat and impact forces.

For the uniformed distribution of the clamping force over the joints, all the bolted connections must be equipped with Two Belleville washers. The joints design shall permit safe practical testing of joints for tightness without de-energizing the busbars and it is possible to remove any one section in a run without disturbing the two adjacent busbars sections. Joints shall preferably have an adjustability of ± 14 mm for the precise alignment and to facilitate an easy field installation.

The joints are provided with torque bolts and maintenance free nuts where the outer head will be twisted off once the specified tightening torque of 12 kg-m is reached and it will then acts as a lock nut.

7.0 Plug in Hole

- 7.1 Each plug in unit that rated 400Amp and below shall be mechanically interlocked with the busduct housing to prevent installation or removal of plug in units while the switch is in the 'ON' positions. It is equipped with an operating handle which always remains in control of the switching mechanism.

Before the jaws make contact with the busbar, the plug in unit enclosure shall make positive ground connection to the busduct housing. The grounding method is that it shall not be damaged by future painting of the busduct housing. The plug in units are also equipped with internal

insulation barriers due to prevent accidental contact of housing plate and conductors with live parts which are on the line side of the protective device during time of wire pulling.

To prevent the cover from being opened while the switch is in the 'ON' position, the covers of all plug in units shall have 'releasable' type of interlocks. The plugs shall be provided with means of padlocking the switch in the 'OFF' position.

For IP65 bus trunking the tap off unit arrangement also must achieve IP65 without requiring any additional sealing at site.

8.0 Expansion Joints

- 8.1 Expansion joints shall be provided when necessary and it shall be capable of taking up all thermal expansion, assuming fully loaded conditions.

9.0 Support of Busduct

- 9.1 Supporting space of horizontal runs shall not exceed 2.0 meters. Vertical riser runs of bus duct shall be supported adequately with rigid and / or spring hangers at each floor. Immediate supports shall be provided if the floor to floor distance exceeds 5 meters.

10.0 Temperature Rise

ANNEXURE-E1 TECHNICAL SPECIFICATION

10.1 The temperature rise at any point in the busduct / rising mains shall not exceed 55°C rise above the ambient temperature of 40°C when operating at load current.

11.0 Short Time Current Capacity

11.1 The short-time current capacity of the busduct shall be not less than the value specified.

12.0 Impedance Value

12.1 The impedance of the busduct shall not exceed the value specified.

13.0 Testsing

13.1 Vender shall furnish following type test certificates of bus duct from CPRI, not older than 3 years.

- i) Short circuit withstand capacity for 1 sec. ii) Temperature rise test.
- iii) Fire retardant test.

ANNEXURE-E1 TECHNICAL SPECIFICATION

13.2 Following routine tests shall be carried out in the presence of owner & 3 sets of test certificates shall be submitted.

i) Visual Inspection.

ii) One minute power frequency voltage withstand test iii) Insulation resistance test

13.3 Bus duct shall be tested upon installation with a 500V megger and the following readings must be taken:

i) Continuity of all phases ii) Insulation resistance

- a) between conductors &
- b) all conductors & ground

All test readings shall be recorded.

14.0 Application Data

14.1 Busduct voltage grading: 1100 Volts
Withstanding Voltage: 10000 Volts

14.2 Class of insulation and insulation materials : Class F, 155°C with epoxy / mylar / cast resin.

14.3 System configuration : 3 phase 4 wire or as specified.

14.4 Degree of protection : For Indoor minimum IP 54 and Outdoor minimum IP65 / IP68.

14.5 Busbar Conductor : Tin coated for anit-corrosion and better conductivity. Extendable at both ends, Phase colours – R, Y, B.

15.0 Earthing

15.1 All metal parts, other than these forming part of an electrical circuit shall be connected to a hard drawn, high conductivity earth conductors on each unit.

15.2 It shall be bolted to the main frame and located so as to provide convenient facilities for earthing cable sheaths and for use with earthing devices.

16.0 Installation

16.1 Bus ducts shall be installed in the positions shown. The contractor should survey the route and ensure that there is no obstructions for fixing the busducts.

16.2 Rating of busducts, voltage & danger sign shall be stenciled in bright yellow at every floor.

ANNEXURE-E1 TECHNICAL SPECIFICATION

17.0 Mode of Measurement

17.1 Bus duct shall be measured on the basis of unit length & the cost shall include bends, all supporting system, Jointing, end supports, testing & commissioning.

18.0 Painting

The busduct & supporting frames shall be epoxy painted to the following colour code.

- i) Supporting frame : Black
- ii) Busduct : Siemens Gray

Bus bars shall have following colour code:

- i) R phase : Red
- ii) Y phase : Yellow
- iii) B phase : Blue
- iv) Neutral : Black

18. TECHNICAL SPECIFICATION FOR RISING MAINS(SADWICHED CONSTRUCTION)

1.0 Scope

1.1 The scope of work shall cover the design, supply, installation, testing and commissioning of sandwich type Rising mains.

2.0 Standards

The following standards and rules shall be applicable

- i) IEC 60439-2 Particular requirement for bus bar trunking system.
- ii) IEC 60529 Degree of protection
- iii) IS 2147 Degree of protection
- iv) BS 5468
- v) IS 8623 – 1&2 For LV distribution

3.0 Construction

3.1 The busbars shall be of sandwich construction. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

3.2 The rising mains system shall be a light weight, low impedance, non ventilated naturally cooled and totally enclosed for protection against mechanical damages, vermin protection and dust accumulation with compact and sandwich type

For each busduct length and fitting, firestop or barriers shall be included as an integral part while on both internal and external surface, metal trunking shall be made of 1.6mm Electrogalvanized sheet steel with Epoxy Powder Coated by an automated electrostatic process and 50% integral housing ground is standard (UL listed 50% ground path)

The busbars and their connections shall be capable of withstanding without damage, the thermal & mechanical effects of a through fault current equivalent to the short time rating of the switchgear. Busbars shall be of uniform cross sectional area throughout their length with connections as short and straight as possible

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.3 Fire resistant inter floor barrier boxes shall be 150mm in length packed with 65Kg / cum (4 lbs / cft) white glass wool between two 6mm thick steel sheets. The fire barrier shall comply with fire insurance regulations and fire officers requirements
- 3.4 The busbars shall be supported with non-hygroscopic insulators and shall withstand the dynamic & thermal overloads during system short circuits and also take into account the linear expansion due to temperature variations, without inducing stresses in the bars. Busbars shall be provided with thrust block insulator at the bottom to give extra support to the busbars. Self adjusting spring loaded supports shall be provided at the top in addition to expansion joints and cater for the expansion or contraction of the busbar.
- 3.5 Tap off boxes shall be provided as required. The tap off boxes shall be provided with make before and break after earthing arrangements to ensure safety.
- 3.6 a) Tap off boxes shall be fabricated out of 14SWG galvanized sheet steel with lockable door latch arrangement and suitable for fixing HRC fuses/ MCCB's / Switch fuse units etc. & it should be mechanically locked with housing.
b) It shall be externally earthed by flexible jumper so that earth continuity shall not be damaged by future bus bar painting.
c) It shall be possible to position the box on the bus trunking system without using tools.
d) Suitable arrangements to be provided for plugging the tap off box in one direction only so as to avoid change in phase sequence.
- 3.7 Terminal enclosures shall be 2mm thick with Epoxy powder coating & the size of the holes shall match with the rising mains.
- 3.8 Feeding terminal box shall be 2mm thick with Epoxy powder coating & the size of the holes shall match with the rising mains & it should be sized to take multiple incomer cables as specified in SLD.
- 4.0 Bus Bars**
- 4.1 Busbars shall be of high conductivity electrolytic grade single or multiple Copper / Aluminum bars with conductivity >61%.
The busbars shall be amply sized to carry the rated continuous current under the ambient temp of 40° without exceeding the total temp specified.
Access to busbars & the connections directly thereto shall be gained only by the removal of covers secured by bolts or screws
- 4.2 Copper and aluminum busbar conductor shall be of tin electroplated. Its entire length shall be insulated over with epoxy resin coated by the machine. This is to prevent it from water and moisture that can cause reduction in dielectric resistance. And in case of fire, the flame retardant will ensure the safety.
On the tin electroplate for the jointing part of Aluminum Bus Conductor, it will be coated by silver for the better conductivity.
- 5.0 Insulation**
- 5.1 The busbars shall be insulated throughout their length by epoxy / Mylar. The insulation material used shall be of class F (155°C).
- 5.2 The insulation shall be fire retardant, non-toxic, chemically inert, stable material.
- 6.0 Joints**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.1 Shall be checked for tightness without de-energizing the busbar trunking runs, the joints shall be of maintenance free system of one bolt (M14) type with through bolts with at least 80mm overlap. The high strength bolt shall be insulated by an insulation resistant for heat and impact forces

For the uniformed distribution of the clamping force over the joints, all the bolted connections must be equipped with Two Belleville washers. The joints design shall permit safe practical testing of joints for tightness without de-energizing the busbars and it is possible to remove any one section in a run without disturbing the two adjacent busbars sections. Joints shall preferably have an adjustability of ± 14 mm for the precise alignment and to facilitate an easy field installation.

The joints are provided with torque bolts and maintenance free nuts where the outer head will be twisted off once the specified tightening torque of 12 kg-m is reached and it will then acts as a lock nut.

7.0 Expansion Joints

- 7.1 Expansion joints shall be provided when necessary and it shall be capable of taking up all thermal expansion, assuming fully loaded conditions

8.0 Support of Rising mains

- 8.1 Supporting space of horizontal runs shall not exceed 2.0 meters. Vertical riser runs of rising mains shall be supported adequately with rigid and / or spring hangers at each floor. Immediate supports shall be provided if the floor to floor distance exceeds 5 meters

9.0 Temperature Rise

- 9.1 The temperature rise at any point in the busduct / rising mains shall not exceed 55°C rise above the ambient temperature of 40°C when operating at load current.

10.0 Short Time Current Capacity

- 10.1 The short-time current capacity of rising mains shall be not less than the value specified.

11.0 Impedance Value

- 11.1 The impedance of rising mains shall not exceed the value specified

12.0 Painting

- 12.1 Inside – outside Electro-galvanized & Epoxy powder coated.
Outside enclosure shall be orange peel Epoxy powder coated.

13.0 Application Data

- 13.1 Operating Voltage : 2,000 volts
Withstand voltage : 10000 Volts
- 13.2 Class of insulation and insulation materials : Class F, 155°C with epoxy / mylar / cast resin

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 13.3 System configuration : 3 phase 4 wire or as specified
- 13.4 Degree of protection : For Indoor minimum IP 54 and Outdoor minimum IP65 / IP68.
- 13.5 Busbar Conductor : Tin coated for anit-corrosion and better conductivity. Extendable at both ends, Phase colours – R, Y, B.
- 14.0 **Earthing**
- 14.1 All metal parts, other than those forming part of an electrical circuit shall be connected to a hard drawn, high conductivity copper earth conductors on each unit.
- 14.2 It shall be bolted to the main frame and located so as to provide convenient facilities for earthing cable sheaths and for use with earthing devices
- 15.0 **Installation**
- 15.1 Rising Mains shall be installed in the positions shown. The contractor should survey the route of busbar and ensure that there are no obstructions for fixing the rising mains
- 15.2 Supporting brackets shall be grouted into the wall or fixed with shear fasteners. A minimum gap of 50 mm shall be left between the wall and rising main. Where tap-offs occur, necessary additional supports shall be provided. A rain hood shall be provided on top of the rising main. Floor barriers shall be fixed at every floor and the space around shall be filled up and sealed to achieve the original fire rating.
- 15.3 The isolating switch shall be mounted at the start of the rising main and connections into the trunking shall be double sealed, with one 12 mm phylum sheet and one 4 mm galvanised sheet
- 15.4 A continuous earth bar shall be laid connecting to one set of earth terminals while the other terminals are interconnected with same size earth jumper. Similar jumpers shall be provided across the fire barriers also.
- 15.5 The rising mains and the supporting frames shall be painted with two coats of glossy oil paint over two coats of red oxide to the following colour code.
- | | | | |
|---------------------|---|--------|--------|
| i) Supporting frame | : | Black | ii) |
| Rising Mains | : | Red | iii) R |
| phase | : | Red | |
| iv) Y phase | : | Yellow | v) B |
| phase | : | Blue | |
- 15.6 Rating of the rising main, voltage and danger sign shall be stenciled in bright yellow at every floor.
- 16.0 **Testing**
- 16.1 Vender shall furnish following Type test certificates of rising mains from CPRI, not older than 3 years.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) Short circuit withstand capacity for 1 sec. ii) Temperature rise test
- iii) Fire retardant test
- 16.2 Following Routing test shall be carried out in the presence of owner & 3 sets of test certificates shall be submitted.
 - i) Visual inspection
 - 2) One min power frequency withstand test
 - 3) Insulation resistance test.
- 16.3 Rising mains shall be tested upon installation with a 500V meager and the following readings established :
 - i) Continuity of all phases ii) Insulation resistance
 - a) between conductors &
 - b) all conductors & groundAll test readings shall be recorded
- 17.0 **Mode of Measurement**
- 17.1 Rising mains shall be measured on the basis of unit length and the cost shall include end box for the isolator switch, all supporting system, jointing, end supports, fire barriers, earth jumpers, continuous earth bus testing and commissioning.
- 17.2 Tap-off boxes shall be measured per unit and the cost shall include the box, fuses, mcbs / mccb's, erection, testing and commissioning
- 17.3 The isolating switch shall be paid for separately per unit.

19. TECHNICAL SPECIFICATIONS MATV SYSTEM

1.0 **Scope**

1.1 The scope of work shall cover supply, installation, commissioning and testing of:

- i) MATV wiring
- ii) MATV distribution equipment (T.V.Outlet & Splitter)
- iii) Antenna outlets (NOT APPLICABLE)
- iv) Head end equipment (NOT APPLICABLE)

2.0 **Conduits**

2.1 The conduits shall generally be as specified as below.

Indoor

ANNEXURE-E1 TECHNICAL SPECIFICATION

- a) Surface run : Heavy Duty M.S Conduit
- b) Concealed : FRLS Heavy Duty M.S (2mm thk) Outdoor

FRLS Heavy Duty PVC (2mm thk)

3.0 Cables

- 3.1 The co-axial cable shall be copper core of 0.8mm dia tinned, PE solidly insulated and shielded with tinned copper braid with necessary protective foil and white PVC outer sheath. The cable characteristic impedance shall be 75 ohms.

4.0 Installation

- 4.1 All cable shall be drawn inside the conduit and terminated into splitter / Tap-off in PVC JB.

5.0 Distribution elements

- 5.1 Splitters shall be suitable for the entire frequency range with an insertion loss not exceeding 4.5 dB at 8 MHz. The isolation between the outputs shall exceed 17 dB and return loss at input and output shall be 14 dB and 12 dB respectively. Splitters shall have a characteristic impedance of 75 ohms at both input and output and the RF shielding factor shall be greater than 70 dB. The entire unit shall be housed in an PVC box and shall be suitable for an ambient of 45⁰ C.

- 5.2 Tap-off units shall be multitap and shall be suitable for the entire frequency range. The insertion loss shall not exceed 3 dB at 8 MHz and the tap off ratio shall be around 26 dB at 8 MHz. The isolation shall exceed 36 dB between tap and output and the return loss shall be around 20 dB at input, output and taps. The entire unit shall be housed in PVC box and shall be suitable for an ambient of 45⁰ C. The characteristic impedance shall be 75 ohms at input, output and tap ports.

- 5.3 Antenna outlets shall be frequency flat and the insertion loss shall not exceed 0.5 dB. The outlet shall have a characteristic impedance of 75 ohms and the outlet shall be coaxial plate type cover compatible with all other switch and socket outlets.

- 5.4 All distribution elements shall be bi-directional to suit interactive television, unless stated otherwise.

6.0 Head end equipment (NOT INCLUDED)

- 6.1 The head end equipment shall consist of:

- a) Power supply module

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) 4 input amplifier modules
 - c) Video cassette player with frequency changer / modulator, band filters
- or any other equipment required for the efficient receipt and transmission of video and audio signals.
- 6.2 The power supply module shall be suitable for 220-230 V 50 Hz supply with self-regulating features and the secondaries being of 12/24 VDC capable of delivering upto 1000 to 1200mm.
- 6.3 The amplifier shall be high gain 60 dB and of modular construction similar to the power supply module. Amplifier modules shall have an input built-in attenuator adjustable upto 20 dB and with maximum outlet level of 120 dB / dB V LED indicators. Amplifiers shall be assembled with adequate frequency gap between channels. All amplifiers shall be duly screened achieving a screening factor of 80 dB and noise level of 70 dB V. The amplifier pack shall have provision for necessary bridge connectors, terminal resistors (75ohm) and be suitable for input and output co-axial cables with characteristic impedance of 75 ohms. All amplifiers shall be suitable for off-air and in-house video input signals.
- 6.4 The video cassette recorder / player shall be suitable for PAL/SECAM colour standards. The player shall have facility still frame, frame by frame double speed and slow motion. Video output shall be 1 Vpp at 75 ohms and shall be fed into the amplifier rack through frequency changer / module and band filters. The video channel selection shall have sufficient frequency gap to achieve the desired intermodulation ratio of 54 dB.
- 7.0 **Net work distribution**
- 7.1 The co-axial cable shall be copper core of 0.8/1.1 mm dia tinned, PE solidly insulated and shielded with tinned copper braid with necessary protective foil and white PVC outer sheath. The cable characteristic impedance shall be 75 ohms.
- 7.2 All splitters, tee-off's etc shall be RF shielded and selected for minimum through loss. Units could be selected for a constant side loss with supplemental line adjustable attenuators so that the tee-off units could be inter-changeable.
- 8.0 **Mode of measurement**
- 8.1 Wiring from Head-end equipment to the various outlets using 0.8 mm dia Cu Coax cable in conduits including junction boxes pull through boxes, conduit supports etc. and shall be measured and paid per unit length.
- 8.2 The splitters, tap-offs and antenna outlets shall be measured item wise and shall be complete with junction box, installation and cable termination at either ends.

ANNEXURE-E1 TECHNICAL SPECIFICATION

8.3 Supply of the antenna array, and all Head-end equipment shall be each considered as one unit for measurement and payment.

20. TECHNICAL SPECIFICATIONS STRUCTURED CABLING

1.0 Scope

1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of the following:

1. UTP Cable
2. Fibre Cable
3. Connecting Hardware

2.0 Standards:

2.1 The following standards shall generally apply:

EIA/TIA 568	Building facilities design guidelines for telecommunications (568-A & 568-B)
EIA/TIA TSB-36	For UTP Cable Specifications
EIA/TIA TSB-40	For UTP Connecting Hardware
EIA/TIA TSB-67	Recommendations for testing UTP Cabling
ISO-IEC	International Cabling Standards
Fibres	ITU-T-G652 / 651 Series EN 188000 IEC 793 Test Standards
Cables	IES 794 Test Standards EN 187000

All codes and standards mean the latest.

3.0 UTP Cable

3.1 UTP cable used in the horizontal wiring system shall be 100 category 5 and shall consist of 24AWG copper conductors with thermoplastic insulation formed into 4 – individually twisted pairs and enclosed in a thermoplastic jacket. The cable shall meet all the requirements of ANSI / ICEA publication for both plenum and general applications.

3.2 Characteristic values, tested and corrected to 20C, shall be as follows:

ANNEXURE-E1 TECHNICAL SPECIFICATION

Frequency MHZ	Characteristic Impedance (Ohms)	Max. Attenuation (dB per 305m)	NEXT coupling loss for worst pair dB@305m
0.772	102 ± 15%	6.8	43
1.0	100 ± 15%	7.8	41
4.0	100 ± 15%	17.0	32
8.0	100 ± 15%	26.0	28
10.0	100 ± 15%	30.0	26
16.0	100 ± 15%	40.0	23

3.3 Cables shall be colour coded as follows:

Pair 1 W-BL / BL Pair 2
 W – O / O Pair 3
 W – G / G Pair 4
 W – BR / BR

3.4 Backbone UTP cables shall have 24 AWG conductor with thermoplastic insulation formed into groups of 25 pairs forming a bound core which is covered by a thermoplastic metallic sheath. The cable shall have the same characteristic values as for UTP horizontal wire and colour coded to industry standard composed of 10 distinct colours. Large cables shall be assembled in units or sub units of 25 pairs and each 25 pairs bundle duly identified.

4.0 Fibre Cable

4.1 Fibre cable for horizontal wiring shall be multimode graded index optical wave guide with 62.5 / 125 micron nominal core / cladding diameter and should conform to all the requirements of the EIA / TIA specifications.

4.2 The cable shall meet the following performance parameters.

Wave length (nm)	Max attenuation (dB / Km)	Band width MHZ - Km
850	3.75	160
1300	1.5	500 (FDDi)

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.3 Fibre cable for backbone service shall meet with the same performance parameters as for horizontal wires.

4.4 Horizontal cables shall contain a minimum of 2 fibres and 6 or 12 fibres for backbone cables.

5.0 Connecting hardware

5.1 The connecting hardware consists of

- 1) S110 connecting blocks in standard EIA 19" modular units with suitable wire management system suitable for patching.
- 2) Modular cords, jumpers, plugs and cables, both at the Patch panels and telecom terminal outlets.
- 3) Information outlets at work area (WA)

All hardware components shall be compatible with the media used (100 ohm UTP or Fibre optic cable) with attenuation and Next performance equal to or better than the media cable performance.

5.2 Connecting blocks / Patch panels shall create gas tight IDC connections with well over 200 terminations without physical or electrical degradation. The reliability, durability and transmission performance requirements shall be better than ANSI / EIA/ TIA – 568 & TSB 40A Category 5 compliant. Panels shall employ high impact self – extinguishing plastics.

5.3 Panels (LIU) for Fibre optic media shall be mountable on EIA 19" rack with removable tray cover. All connectors shall be ST standard with bayonet coupling.

5.4 All panels shall have suitable wire management systems.

5.5 Patch cords and jumpers shall be 4 pair with terminal connectors and compatible with category 5 horizontal media (100 UTP or Fibre optic cable)

5.6 Work area (WA) terminals shall be single, duplex or quaduplex outlets as specified.

6.0 Installation

6.1 The installation shall be carried out in accordance with the TIA/EIA 568-A cabling standard. Horizontal cables shall be laid from the telecommunication out let in the work area (WA) to the patch panels or horizontal cross connect in the telecommunication closet (TC). All cables shall be drawn in steel conduits or floor trunking as specified or shown on drawings. Horizontal cable runs from the WA outlet to the TC shall not exceed 90m excluding the patch cords / jumpers, equipment connections in the WA which shall not exceed a total of 10 meters. All horizontal cabling shall follow a star topology.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.2 The backbone cables shall be limited to the main cross connect / Equipment Room and Telecom closet (TC) and TC to TC and the total length shall be limited to 500m. Equipment connections to backbone shall be limited to 30m. Entire backbone cabling shall be in star topology. Cables shall be laid on trays or conduits as specified or shown on drawings.
- 6.3 Cable bending shall not exceed 4 times the O.D of horizontal cables and 10 time the OD of multipair backbone UTP cables. Pulling tension shall not exceed 110N. UTP cable shall be away from electrical cables generally as shown below:

	Minimum Upto 2 KVA	Separation 2.5 KVA	More than 5 KVA
1 Data cables in metal conduit			
a) Power lines in metal conduit	-	75mm	150mm
b) Power lines in non – metal conduit	65mm	150mm	300mm
2 Data cables in non metal conduit			
a) Power lines in metal conduit	65mm	150mm	300mm
b) Power lines in non – metal conduit	125mm	300mm	600mm

Labeling, markings and colour coding shall be provided in accordance with ANSI / TIA / EIA – 606 Pair twists shall be maintained as close as possible to the point of termination.

7.0 Testing

7.1 The system shall be tested and commissioned by a qualified and accredited technician to establish system performance in all its aspects and all such tests shall be witnessed and test readings attested by the Engineer-in-charge.

7.2 All wiring shall be checked for proper connections and tested for

1. Signal verification at each and every device and the attenuation values
2. Next values

8.0 Mode of Measurement

8.1 The mode of measurement shall follow the schedule of work.

ANNEXURE-E1 TECHNICAL SPECIFICATION

FIRE FIGHTING WORK

III. TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING WORKS

1. TECHNICAL SPECIFICATION FOR FIRE HYDRANT SYSTEM

1.0 Scope of work

1.1 The scope of work shall cover supply, installation, testing and commissioning of the fire hydrant system covering the following:

- i) Fire pumps, electric or diesel driven as shown in the equipment schedule and drawings.
- ii) Booster pumps at terrace and jockey pumps, electric driven as shown in the equipment schedule and drawings.
- iii) Fire pump panel, cabling, earthing.
- iv) Hydrant mains, external and internal ring and yard and internal hydrants.
- v) Wet risers in the building as specified and shown on drawings.
- vi) Landing valves, hose reels.
- vii) Service connection to fire tanks and hydrant ring. viii) All piping valves, pressure gauges.

2.0 Standards

2.1 The fire hydrant installation shall conform to and meet with the requirements set out by the following:

- 1) IS : 1648 - 1961 Code of practice for fire safety of buildings (General) Fire Fighting Equipment and its maintenance.
- 2) IS : 3844 – 1989 Code of practice for installation of internal fire hydrant in multi-storeyed building.
- 3) Compliance with the local fire brigade and the fire enforcing authorities.

3.0 Fire Pump

3.1 The fire pump shall be single or double suction centrifugal type with split casing / end suction or multi stage and direct driven by electric motor or diesel engine as specified. The pump rating and performance shall conform to the Equipment Schedule and meet the TAC duty requirements.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.2 Pump shall have a bronze impeller and pump casing shall be of close grained cast iron. The shaft sleeve shall be brass or S.S 304 and the trim shall be brass or bronze.
- 3.3 Pump shall be capable of delivering 150% of the rated capacity at 65% of the rated head and the no-delivery head shall be not more than 120% of the rated delivery head for horizontal pumps and 140% for vertical turbine pumps. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
- 3.4 The pump shall be either electrically driven or diesel driven with direct flexible coupling.
- 3.5 The electric drive motor shall be squirrel cage induction conforming to IS 325 - 1978 and rated for continuous duty (S1). Motor shall have not less than class B insulation and minimum enclosure of IP22. The starter shall be air cooled fully automatic star delta or auto transformer type. Starters shall conform to IS 8544 and rated for AC-3 duty conditions.
- 3.6 Drive Motor rating shall be based on the largest of the following :
- 1) Rated pump discharge at rated head
 - 2) 150% of rated discharge @ 65% of rated head
 - 3) Maximum power absorbed by the pump in its operating range i.e. no-delivery to free discharge.
- 3.7 The diesel engine shall be naturally aspirated (non-turbocharged) and electrically started. The engine shall have a speed governor to regulate the rated rpm within 5 % of its rated speed. The engine shall be complete with starting batteries full-wave selenium rectifier charger, isolator, leads, mounting frame etc. Engine rating shall be same as for the electric motor or as shown on the data sheets.
- 3.8 Pumps and prime movers shall be truly aligned by suitable instruments. Record of such alignment shall be provided with the handing over documents. Contractor shall provide necessary test certificates, performance curves of all the pumps
- 3.9 All the pumps shall be provided with approved type of Mechanical seals.
- 3.10 On the suction and delivery lines, double flanged reinforced neoprene flexible connectors shall be provided. Connectors shall be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1.5 times the operating pressure. Necessary test certificates shall be provided before installation.
- 4.0 Accessories**
- 4.1 The fire and jockey pumps shall be complete with the following accessories:
- 1) suction and discharge eccentric reducers and flexibles as above.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2) pump coupling guard.
 - 3) common base frame, fabricated mild steel or cast iron.
- 4.2 Each pump shall have independent set of pressure switches. The pressure switch shall be snap action SP DT switch rated 10A @ 220 V operated through a stainless steel diaphragm. The switch shall have a pointer for manual adjustment of set point, and all electrical connections shall be terminated in a screwed terminal connector. The entire unit shall be encased in a cold drawn steel enclosure. The diaphragm shall be designed for a maximum operating pressure of the system. Each pressure switch shall be provided with a pressure gauge in parallel as shown on the drawings and all gauges and pressure switches shall be mounted in an instrument panel with necessary control piping and drainage facility.
- 4.3 Flow switches shall be paddle type SPDT snap acting contacts rated 10A@220 V. The paddle shall be made of either brass or phosphor bronze terminated in a screwed terminal connector. The entire unit shall be encased in cold drawn steel enclosure and the maximum operating pressure of the parts in contact with the liquid shall be consistent with the system pressure.
- 5.0 System Operation and Control Panels**
- 5.1 The fire pump shall be started automatically on loss of pressure and the operation sequence of the booster and fire pumps shall be as follows:
- i) Booster or jockey pump shall start when the system pressure drops by 35kPa and stop when the system pressure is re-established.
 - ii) The fire pump shall start when the system pressure drops by 100kPa and shall continue to run until manually switched off.
 - iii) Booster/jockey and fire pump startings shall be indicated on the panel with a red indication lamp. It should also be indicated on the MFACP.
- 5.2 The motor starters (direct on line or star-delta) shall consist of electrically actuated contactors. The starter shall be complete with ON-OFF push buttons, timers and auxiliary contacts and shall be fully automatic. There shall be an indicating lamp with each of the pumps and an ammeter and selector switch with the fire pumps. Fire pump startings shall be announced through the MFACP. A remote start stop facility shall be provided in the Fire Control Room.
- 5.3 The starter along with isolator shall be housed in a 14 SWG M.S box duly rust inhibited through a process of degreasing and phosphating.
- 5.4 All cabling to and from the pumps to starter and control switch shall be carried out through armoured XLPE (FRLS) cables of approved makes. Cables shall be laid in accordance with section "M V CABLING". The pump motors and panels shall be double earthed in accordance with IS 3043-1966 or as shown on drawings.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.0 Fire Hydrants, & Hose Reels

6.1 Hydrants shall be provided internally and externally as shown on the drawings. Internal hydrants shall be provided at each landing of an escape staircase and additionally depending on the floor area as shown on drawings. Landing valve shall be single or double headed gun metal valve with 1-63 mm dia outlets and 100 mm inlet conforming to IS 5290-1969. Landing valve shall have flanged inlet and instantaneous type outlets and mounted at 1.0 m above the floor level. Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for 63 mm dia fire brigade hoses. Wherever necessary, pressure reducing orifices shall be provided so as to limit the pressure to 500 kPa or any other rating as required by the local fire brigade.

6.2 Each landing valve shall have a hose reel cabinet of 1800x900x450 mm housing or as shown on drawings or as approved.

- i) Landing valve with single or double 63 mm dia capped outlets and one 100 mm inlet.
- ii) First-aid hose reel with 30 m long 20 mm dia high pressure rubber hose & 20 mm dia ball valve.
- iii) 2-15 m long 63 mm dia canvas hoses reinforced rubber lined and wire wound with instantaneous couplings.
- iv) One copper branch pipe with bronze rings to take the nozzles at one end and fit into the instantaneous coupling at the other.
- v) One leaded-tin-bronze nozzle of 25 mm dia.

The first aid hose shall conform to IS 884-1969 and be wound on a heavy duty circular hose reel with a cast iron bracket. The hose shall be permanently connected on one end to the stand pipe through a 20 mm ball valve with necessary hose adapter and a gun metal nozzle at the other end. The reel shall swing out by 270° .

Canvas hoses shall be in two lengths of 15.0 m each, of reinforced rubber lined wire wound canvas type with instantaneous couplings, neatly rolled into bundles and held in position with steel brackets. Canvas hoses shall be tested and certified by the manufacturers, to withstand an internal water pressure of not less than 3.5 MPa without bursting. The hose shall also withstand a working pressure of 700 kPa without leakage or undue sweating.

The hose cabinet shall be fabricated from 2 mm mild steel sheet duly rust inhibited through a process of degreasing and phosphating. The cabinet shall have double flapped doors with 4 mm clear glass and shall have necessary openings for riser main and brackets for all internals. The cabinet shall receive two coats of red oxide primer both inside and outside before two after coats of final paint of approved colour shade. The design and size of the cabinet shall be got approved before fabrication. Wherever shown, all hydrant elements may be neatly mounted in the masonry niche.

6.3 External Hydrants shall be stand post type over-ground unless shown otherwise.

ANNEXURE-E1 TECHNICAL SPECIFICATION

All external hydrants shall be single or twin headed oblique valves with 80mm or 100mm inlet connection. Hydrants shall be located at least 2 m away from and within 15 m from the building wall.

flax canvas or controlled percolation hoses with couplings. Wherever shown, the cabinet may contain a branch pipe and nozzle. The cabinet shall be 900x600x400 fabricated out of 2mm mild steel sheet duly rust inhibited through a process of degreasing, phosphating etc. The cabinet shall receive two coats of red oxide primer, inside and outside, before 2 coats of final painting of approved shade. The cabinet shall be wall-mounted or free standing with its own steel legs depending on the site conditions and as shown on drawings. Each hydrant shall be provided with a hose cabinet containing 2x15m 63dia

6.4 A fire service connection to the fire tank and a fire service inlet to the hydrant main shall be provided. These connections shall consist of one or two twin-headed 63mm dia gunmetal oblique outlets enclosed in a 2mm thick sheet steel painted box on a suitable stand and 150dia outlet. Service inlet to the hydrant main shall have a 150dia non-return valve.

7.0 Piping

7.1 All piping shall be as specified under "Piping for Fire Fighting" and the schedule of work for piping.

8.0 Testing & Commissioning

8.1 All hydrant piping shall be tested for a hydrostatic test pressure of 2.0MPa or 1.5 times the working pressure (whichever is high) for a period of 24 hours at the end of which there shall be no loss in pressure.

8.2 The booster & fire pump starting and stopping shall be tested by opening the test valve and record the following:

- 1) Booster pump start / stop
 - System pressure at start up : kPa stop : kPa
 - Time elapsed from start to stop = seconds

- 2) Hydrant Pump start
 - System pressure at start up : kPa

 - Maintained system pressure while discharging the landing valve at the highest point.
 - i) pump end : kPa ii) highest outlet : kPa iii) intermediate points : kPa

ANNEXURE-E1 TECHNICAL SPECIFICATION

Fire Brigade or Insurance Co. Where such requirements are not mandatory the system shall be tested with full 30m length of hose and nozzle.

- i) At one hydrant at the top most point
- and ii) 2 or more hydrants at the ground level depending on the pump capacity.

9.0 Mode of Measurement

- 9.1 Hydrant pump with mounting frame, excluding concrete foundation shall be measured per unit.
- 9.2 Engine driven pump complete with:
 - i) mounting frame ii) flexible coupling
 - iii) engine starter panel with starting battery charger, leads etc.
 - iv) day tank
 - v) exhaust pipe and insulation, silencer etc. vi) remote radiator etc. as specified.
- 9.3 Booster and jockey pump same as Hydrant pump.
- 9.4 Instrument panel with pressure gauges, pressure switches, control-piping enclosure etc. shall be measured as one unit.
- 9.5 Landing valves with or without fire hose cabinet with hose reel, rubber lined, canvas hose, branch pipe, axe, nozzle etc. shall be measured per unit.
- 9.6 External hydrant standpost type with butterfly valve or sluice valve with tail pieces, etc. shall be measured per unit.
- 9.7 Fire brigade inlet connection complete with 1 or 2 nos. 63 dia twin head inlets with or without non-return valve with 150 dia respectively of inlet pipe atleast 1.5 m long shall be measured per unit.
- 9.8 External Hose reel boxes complete with hoses and enclosure etc. shall be measured per unit.
- 9.9 Control cabling from pressure gauge panel to the respective starters shall be measured in running metre and paid at unit rates.
- 9.10 Starter and isolator for each pump housed inside the M.S box shall be measured as one unit and paid. In case the starters are part of the Fire Pump Panel, it shall be part of the panel.

2. TECHNICAL SPECIFICATION FOR SPRINKLER SYSTEM

1.0 Scope of work

- 1.1 The scope of work shall cover supply, installation, testing and commissioning of the sprinkler system covering the following:
 - 1) Sprinkler and jockey pumps, diesel driven as shown in the equipment schedule.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2) Installation valve/s with motor-gong.
- 3) Sprinklers
- 4) Sprinkler piping
- 5) Branch flow switches and tamper switches connected to the building fire alarm system

2.0 Standards

2.1 The sprinkler installation shall conform to and meet with the requirements set out by the following:

- 1) IS 1648-1961 Code of practice for fire safety of buildings.
- 2) Guide lines for Automatic sprinkler Installation - Tariff Advisory Committee rules.
- 3) Local Fire Brigade and Fire Engineering Authorities.

3.0 Pumps

3.1 The sprinkler pump shall be single or double suction centrifugal type with split casing/ end suction or multistage and direct driven by electric motor or diesel engine as specified. The pump rating and performance shall conform to the Equipment Schedule and meet the TAC duty requirements.

3.2 Pump shall have a bronze impeller and pump casing shall be of close grained cast iron. The shaft sleeve shall be brass or S.S 304 and the trim shall be brass or bronze.

3.3 Pump shall be capable of delivering 150 % of the rated capacity at 65 % of the rated head and the no-delivery head shall be not more than 120 % of the rated delivery head for horizontal pumps and 140% for vertical turbine pumps. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.

3.4 The pump shall be electrically driven with direct flexible coupling as specified for Hydrant pumps.

3.5 The electric drive motor shall be squirrel cage induction conforming to IS 328-1978 and rated for continuous duty (S1). Motor shall have not less than class B insulation and minimum enclosure of IP22. The starter shall be air cooled fully automatic star delta or auto transformer type. Starters shall conform to IS 8544 and rated for AC-3 duty conditions.

3.6 Drive Motor rating shall be based on the largest of the following:

- 1) Rated pump discharge at rated head
- 2) 150 % of rated discharge @ 65 % of rated head

ANNEXURE-E1 TECHNICAL SPECIFICATION

3) Maximum power absorbed by the pump in its operating range i.e. no- delivery to free discharge.

4.0 **Jockey Pump**

4.1 Jockey pump shall be similar to the sprinkler pump but need not have split casing.

5.0 **Accessories**

5.1 The sprinkler and jockey pump shall be complete with the following accessories:

- 1) suction and discharge eccentric reducers & flexibles as for hydrant pump.
- 2) pump coupling & guard
- 3) common base frame, fabricated mild steel or cast iron.
- 4) suction and discharge isolation

6.0 **Installation Valve**

6.1 The sprinkler system shall incorporate one or more (as shown on drawings) installation valve assemblies comprising:

- i) A main gate valve
- ii) IN and out pressure gauges
- iii) Test connection of adequate size with valve and orifice plate with pressure connections.
- iv) Water motor and gong with necessary piping, isolating valve and strainer and drain.

6.2 The installation valve shall be straight through type suitable for wet pipe sprinkler systems. Valves shall be of cast iron with gun metal internals and suitable for vertical or horizontal installation. The valve clack shall be of cast gun metal with neoprene seal and retaining ring and shall incorporate a suitable non-return device to compensate for pressure fluctuations which should not mal- operate the clack. The gun metal internals shall provide for smooth waterways for:

- 1) Water valve through a retard chamber
- 2) Test connection and drain

6.3 There shall be two pressure gauges, one for the mains side and another for the installation side. Each gauge shall have pressure damping brass piping with gun metal gauge and drain.

6.4 A test connection of adequate size as shown on drawings or as approved shall be provided with a shut-off gate valve, an orifice plate with pressure connections. The discharge from the test connection outlet shall be led to the nearest sump or drain as shown on drawings or as directed.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.5 The mains water motor and gong shall preferably be of cast gun metal body and internals. The valve shall have an associated gun metal gate valve, strainer preceding the water motor. The water motor and gong shall be located on the discharge lead as shown in drawings or as directed.

6.6 Flow switches shall be as specified under 'Fire Hydrant System'. Tamper switches shall be provided for tap off valves as shown on drawings.

7.0 **Sprinklers**

7.1 Sprinklers shall be temperature-sensitive glass-bulb actuated "quick response" type and be standard products from an established firm of repute and standing and approved by an appropriate authority for fire fighting duty and U.L listed.

7.2 All sprinklers shall be brass castings polished chrome or white (polyester) unless stated otherwise and rated for 1.2MPa and factory tested for 3.4MPa. Sprinklers shall be pendant upright or side wall type as specified and shown on drawings. All sprinklers shall be provided with an adjustable escutcheon finished same as the sprinkler head. Wherever shown and specified, sprinklers shall be recessed type. All sprinklers shall have stainless steel flexible connectors of not more than 1.0m long and all such connectors shall be UL listed.

7.3 Temperature classification of sprinklers in each space shall be as shown on the drawings. Sprinklers shall be selected for the coverage shown on the drawings and ordinarily be 15/10 mm with K factor of 115 (metric). Wherever the specified sprinkler is not adequate, the tenderer may offer appropriate size required.

8.0 **Piping**

8.1 All piping shall be mild steel heavy class as specified under "Piping for Fire Fighting". Necessary line flushing valves shall be provided as shown on drawings or as required to.

9.0 **Testing**

9.1 The entire sprinkler piping shall be tested, with the sprinklers in position, to a hydrostatic test pressure equal to 1.5 times the system pressure for a period of 24 hours at the end of which there shall be no loss in pressure.

9.2 Test valves in each sprinkler installation shall be opened (with temporary drain connection) and the following observations recorded:

- 1) Start-up of jockey pump
- 2) Start-up of sprinkler pump
- 3) Operation of water motor gong
- 4) Operation of flow switch in the appropriate branch.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5) Signal for the standby pump to start with an alarm when the sprinkler main pump is deliberately kept off electrically.

All branches shall be so tested and witnessed and attested by the Engineer-in-charge. All the operating tests shall be carried out in the presence of any local authority, Fire Brigade or Insurance Company.

10.0 Mode of Measurement

- 10.1 Sprinkler pump and jockey pump, motor with mounting frame, vibration mounts excluding concrete foundation shall be measured per unit.
- 10.2 Flow switches shall be measured per unit and excludes wiring to the Fire Alarm panel which shall form part of Fire Alarm wiring. Tamper switches shall be measured as a unit.
- 10.3 Sprinklers shall be identified as pendant, upright sidewall or recessed and paid for per unit.
- 10.4 For piping refer section on 'Piping for Fire Fighting'.
- 10.5 Installation valve complete with test valve, orifice plate etc. shall be regarded as one unit.
- 10.6 Control cabling from pressure gauge panel to respective starter shall be measured in running meter length and paid at unit rates.

3. TECHNICAL SPECIFICATION FOR PIPING

1.0 Scope

- 1.1 The scope of work covers, supply, laying, testing and commissioning of the entire piping system for the Fire Fighting Installation i.e. Fire Hydrant and sprinkler systems.

2.0 Standards

- 2.1 The following standards shall be applicable:

- | | | |
|------|-----------------|--|
| i) | IS 1239 - 1979 | ERW Mild Steel Tubes & Tubulars and fittings upto 150 NB |
| ii) | IS 3589 - 1981 | ERW steel pipes for gas, water and sewerage over 150 NB |
| iii) | IS 1879 - 1987 | Malleable iron fittings |
| iv) | IS 13114 - 1991 | Forged brass gate, globe, check valves |
| v) | IS 1537 - 1976 | Vertically cast iron double flanged pipes |

ANNEXURE-E1 TECHNICAL SPECIFICATION

- vi) IS 7181 - 1986 Horizontally cast double flanged pipes.
- vii) IS 10221 - 1982 Code of practice for coating and wrapping of underground Mild Steel Pipe Lines.

All standards should be the latest.

3.0 Pipes & Fittings

3.1 Pipes shall conform to the following schedule:

NB	Pipe (mm)		Material
	Min.OD	Thickness	
25	33.3	4.05	ERW Heavy class mild steel tube to IS-1239-79 Part I
40	47.9	4.05	
50	59.7	4.50	
65	75.3	4.50	
80	88.0	4.85	
100	113.1	5.40	
150	163.9	5.40	ERW pipes to IS 3589-1981
200	219.1	6.00	
250	273.0	6.00	
300	323.9	6.00	
350	355.6	7.00	
450	406.4	7.00	

All pipes shall be factory fabricated.

- 3.2 All pipes shall be new and from standard manufacturers. All pipes shall be black steel and be prepared for butt or socket welding as specified herein.
- 3.3 All bends upto 65 mm NB shall be hydraulically formed with a minimum R/D of three unless space restrictions inhibit, in which case long radius elbows may be used with the approval of the Engineer-in-charge. For sizes upto 40 mm NB, socket weld fittings shall be used. For larger sizes upto 150-mm dia butt welding wrought steel fittings to BS 1965 and matching with the straight pipe wall thickness shall be used. In the case of larger sizes, the bends shall be fabricated from the same stock of pipe and in at least 4 sections with a radius equal to + / - 1.5 times the diameter. Branch connections to pipes upto 100 dia shall be through suitable weldable fittings. In higher sizes, the branch pipe shall be set – on type made with a suitable profile cutting of the main and branch pipes.
- 3.4 Flanges shall be slip-on carbon steel with plain faces conforming to IS 6392 - 1971. Flange shall be rated for twice the system pressure (pump head) and drilled to suit the equipment or valve flange if already drilled. All bolts & nuts shall be carbon steel and gasket 3-mm fiber reinforced PTFE.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.5 All pipe joints shall be welded except where flange joints are specified. Pipes upto 40 mm NB shall use socket-weld fittings with fillet welding and larger sizes use butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:

- i) Pair of flanges for isolation of equipment
- ii) Mating flanges for equipment flange connections
- iii) Mating flanges for valves, strainers as the case may be iv)
Pair of flanges at every 30 m continuous run of piping

3.2 **Valves**

3.2.1 All valves and the flanges shall be suitable for 1.6 MPa cold non-shock working pressures or twice system pressure whichever is high.

3.2.2 Valves upto 50 mm NB shall be full bore ball valves with forged body and polished hard chrome plated ball with PTFE seal.

3.2.3 Higher size valves shall be butterfly type. Butterfly valves shall have a fine grain cast iron body with mirror smooth finished cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer-type and should be fitted with two slip on type pipe flanges. The valve shall have an easily replaceable molded EPDM sleeve which shall bring about 100 % tight shut off at the design working pressure. Shaft bottom shall have an axial bearing.

3.2.4 Non-return valves upto 50 mm NB shall be swing-type of gun metal construction with flanged ends. Larger sizes shall be of cast iron construction with gun metal internals and flanged ends or

3.2.5 Water strainers shall be either 'Y' or pot type with cast iron bodies for specified test pressure. Strainers shall be complete with brass basket with 3 mm perforations, a dirt blowout plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe and shall have flanged end connections.

3.2.6 Drains shall be provided at all low points and all drain valves shall be gunmetal globe type with hose connectivity. Drain sizes shall be 25 dia or as shown on drawings.

3.2.7 Pressure gauges shall be "Bourdon" type with minimum 100 mm dial and required range. All gauges shall be provided with gun metal plug type gauge cocks and copper or S.S capillary connection to prevent system fluctuations affecting the gauge. Gauges shall be provided wherever shown.

3.3 **Supports & Clamps**

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.3.1 Pipe supports shall be standard factory made galvanised systems or fabricated from steel structural galvanised after fabrication. Supports shall be spaced as follows:

Size	Horizontal	Vertical
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150 & over	3.00 m	3.0 m

3.3.2 Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by the Engineer-in-charge. Pipe hangers shall be from galvanised structural steel, steel inserts in concrete or anchor fasteners, wall brackets or floor supports as decided by the Engineer-in-charge depending upon the location of the support. Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50mm. All supports suspenders and hangers shall be galvanised after fabrication.

3.3.3 Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanised mild steel. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamp- ing arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions.

3.3.4 Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support at the lowest point.

3.3.5 All pipe joints shall be welded except where flange joints are specified. Pipes upto 40 mm NB shall use socket-weld fittings with fillet welding and larger sizes use butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:

- i) Pair of flanges for isolation of equipment
- ii) Mating flanges for equipment flange connections
- iii) Mating flanges for valves, strainers as the case may be

3.3.6 Where valves, strainers, NR valves adjoin, there is no need for additional matting flanges and valve flanges may be used to mate with the other valves, strainers etc.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.3.7 All supports and clamps for sprinkler piping shall be flexible to allow for vibration and movement of the pipe during discharges. All such support systems shall be clearly shown on shop drawings.

4.0 **Pipe Installation**

4.1 **In - building**

4.1.1 All pipes shall be of approved make and best quality without rust marks. Pipes and fittings shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. Pipes and fittings shall be fixed truly vertical / horizontal or in slopes as required in a neat workman like manner. Pipes shall be securely fixed to walls and ceilings by suitable supports at intervals specified.

4.1.2 All in building pipes shall be heavy quality galvanised steel tubes to IS 1239 using malleable or wrought steel heavy duty screwed or weldable fittings. All welded joints shall be painted with zinc rich paint. Flanged joints shall be provided to mate with valves and other equipment or at every 40m run of straight pipe for maintenance and repair. All flanges shall be slip on type and rated for 2.5MPa or 1.5times the system pressure and shall have 3mm reinforced Teflon gasket.

4.1.3 Sprinkler piping shall be supported using slings or clevis type hangers so as to take the vibrations during sprinkler discharges. Floor tapping from vertical risers shall be through a union or a flanged joint. Similarly flow switches shall have unions or flanges on both sides.

4.1.4 All pipes shall be adequately supported from ceiling or walls through structural supports fabricated from steel structural e.g. rods, channels, angles and flats generally as shown on drawings. Fasteners shall be shear type anchor fasteners in concrete walls and ceilings and wrought steel spikes of atleast 75mm long in brick walls.

4.1.5 All low point in the piping shall be provided with 25mm gun metal full-way ball valves with rising spindle for drain ing the system. All valves shall have screwed brass caps.

4.2 **External**

4.2.1 Pipes buried underground shall be galvanised or ungalvanised heavy duty steel tubes as specified and protected against corrosion by wrapping with "pypcoat" as per manufacturer's specification. Fittings shall be weldable wrought iron fittings suitable for butt-welding and 10% of the welded joints shall be radio- graphically tested and found in order. The welded joints shall be random selected for testing in consultation with the Engineer. All flanges shall be slip-on welded flanges to IS 6392 and have a 3mm fibre-reinforced Teflon gasket.

4.2.2 Underground mains shall be laid not less than 750 mm below the ground level and shall be atleast 2m away from the building face and supported on concrete pedestals at every 3.5 m and held on with galvanised iron clamps. Concrete thrust anchors shall be provided at all bends and tees as shown on drawing and as directed. All excavation for pipe laying shall be carried out with sufficient width for making proper joints. Backfilling shall be done only

ANNEXURE-E1 TECHNICAL SPECIFICATION

after the piping is hydro-statically pressure tested. Piping shall be constantly kept clean till tested.

4.2.3 Underground M S Pipes shall be wrapped with 'Pypcoat' or equivalent polymer based corrosion protection tape. The pipe shall be wire brushed to remove milscale and an approved primer applied at 250gm/sqm. The tape is spirally wound, after coating becomes tacky, with an over lap of 15mm and themofused with the pipe including the overlap.

4.2.4 All valves shall be housed in brick masonry chambers over 150mm cement concrete (1:3:6) foundation. The brick walls of the chamber shall be plastered inside and outside with 20mm cement sand plaster 1:4 with a floating coat of neat cement. Chambers shall be 650 x 650 mm clear for depths upto 900 mm and 1000 x 1000 mm for depths beyond. Each chamber shall have a cast iron surface box approved by the local Fire Brigade.

5.0 Painting

5.1 All exposed piping for fire fighting shall be distinctly painted 'Fire Red' shade 536 to IS:5-1978. Pipes shall first receive two coats of red oxide primer uniformly applied and two coats of oil paint applied thereafter. All pipes supports shall be painted black.

6.0 Testing & commissioning

6.1 All piping after installation shall be tested for a hydrostatic test pressures specified for hydrant and sprinkler systems. All joints and valves shall be checked for leaks and rectified and retested. During testing all valves except drain & air valves shall be kept fully open.

6.2 Hydrant system shall be tested by opening any top most hydrants with 30m canvas and nozzle and record pump starting. Likewise test the top most hose reels and record starting of Jockey pumps.

6.3 Sprinklers shall be tested by opening the farthest branch valve and record pump starting. Similarly the drain connection shall be cracked open to record jockey pump starting.

6.4 Hydrant and jockey pumps shall be started through pressure switches. All tests shall be witnessed by the project engineer and recorded. Test results shall form part of the handing over documents.

6.5 Tests shall also conducted as required by the Fire Office and readings recorded.

7.0 Makes of Materials

7.1 The makes of materials are listed in Annexure 2.1-7.

8.0 Mode of measurement

8.1 All external piping shall be measured along the centre line of the pipe and paid per unit length and shall include:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) All pipes & fittings (except to the extent of owner supplied items)
 - ii) All jointing
 - ii) Coating & wrapping
- 8.2 All internal piping shall be measured similarly but shall include for the pipe supports and clamps instead of excavation.
- 8.3 All valves, air valves, drain valves together with flanges or tail pieces shall be measured per unit.
- 8.4 All excavation and concrete supports and thrust blocks shall be measured as per drawing and paid for per cum.

4. TECHNICAL SPECIFICATION FOR PAINTING

1.0 **Scope**

1.1 The scope of work covers painting of:

- i) All equipment
- ii) Piping & pipe supports
- iii) Duct & duct supports
- iv) Electric Panels & cable trays

1.0 All equipment and piping shall be painted in accordance with the following colour code (or other colours if specifically requested for by the Project Manager.)

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
COLD WATER				
Municipal Domestic	Sea green	-	-	- White Brown
Flush	- do -	25	1500	Red Red
Hot water supply	- do -	25	1500	(chain dotted)
Hot water Ret	- do -	25	1500	
	- do -	25	1500	
DRAINAGE				
	Black			
Soil	- do -	-	-	- White White
Waste	- do -	25	1500	(Chain dotted)
Vent.	- do -	25	1500	
Rain water	- do -	-	-	

Development of International Standard Football cum Athletic Stadium with Indoor Sports and shopping
Complex at Jabalpur, Madhya Pradesh

ANNEXURE-E1 TECHNICAL SPECIFICATION

FIRE

Hydrant line	Fire Red	-	-	- White
Sprinklers	- do -	25	1500	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
STEAM				
	Silver grey			
Over 3 kg Upto	- do -	-	-	- Red Red
3 kg	- do -	25	1500	(Chain dotted)
Condensate	- do -	25	1500	
AIR				
Compressed Air	Sky blue	-	-	- OILS
HSD	Light Brown	-	-	- White
LDO	- do -	25	1500	
NATURAL GAS	Light Brown	25	1500	White & Blue
WATER CHILLING UNIT				
a) Compressor b)	Dark Adm.	-	-	- Grey
		-	-	- "
Motor		-	-	- Steel
	Blue			
c) Condenser				
REFRIGERANT PIPING				
a) Hot gas	Signal Red	25	1500	- White
b) Liquid lines c)	Signal Red	25	600	-
Suction	Riveira Blue	-	-	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
PUMPS & MOTORS	Canary Yellow	-	-	-
CHILLED WATER				
a) Supply	Fiesta Blue	-	-	-
b) Return	Fiesta Blue	25	600	White
CONDENSER WATER				
a) Supply	Steel Blue	-	-	-
b) Return	Steel Blue	25	600	White
COOLING TOWERS	Steel Blue	-	-	-
DUCTS & DUCT SUPPORTS	Black or as directed	-	-	-
a) Exposed ducts b) Support	Approved colour			
UNIT COLOUR & AH UNIT & EXPOSED DUCTING	Fiesta Blue (28-9104	-	-	-

ANNEXURE-E1 TECHNICAL SPECIFICATION

ELECTRIC PANELS Steel grey

Notes: 1) All colours and codes refer to ICI DULUX Synthetic Enamel colours. Nearest equivalent acceptable.

2) The painting shall be with synthetic enamel paint unless otherwise specified.

2.0 All surface to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat of red oxide primer shall be applied completely covering the exposed surfaces. Out finish coat of painting shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Project Manager. Black steel ducts shall be painted with a prime coat and above and galvanised steel duct need to be painted without the need of a prime coat.

3.0 **Mode of measurement**

3.1 All painting shall form part of the cost (item rate) of equipment, piping etc. No separate payment shall be admissible.

5. TECHNICAL SPECIFICATION FOR PORTABLE FIRE EXTINGUISHER

1.0 **Scope**

1.1 The scope of work covers the supply and installation of Portable Fire Extinguishers. The following types are envisaged in these specifications and provided as shown in the schedule of portable Fire Extinguishers.

- i) Dry powder extinguisher
- ii) Carbon-Dioxide extinguisher
- iii) Foam type extinguisher

2.0 **Standards**

2.1 The following standards and rules and regulations shall be applicable:

- i) Fire Protection Manual of the Tariff Advisory Committee, Fire Insurance Association of India.
- ii) IS : 2171 Portable Fire Extinguisher
Dry Powder Type

ANNEXURE-E1 TECHNICAL SPECIFICATION

- iii) IS : 2878 Portable Fire Extinguisher
Carbon – Dioxide type
- iv) IS : 2190 : 2010 Selection, installation & maintenance of First Aid Fire Extinguisher v) Local

Fire Brigade

2.2 All standards mean the latest.

3.0 Extinguishers

3.1 Dry Powder type

3.1.1 The extinguishers shall be 2, 5, 10 kg capacity and cartridge type unless specified otherwise.

3.1.2 The body shall be of cold rolled carbon steel Grade D and 1.5 mm thick upto 5 kg and 2 mm for 10 kg.

Approximate dimensions shall conform to following table:

Capacity (Kg)	Outside dia (mm)	Filler opening (mm)
2.00	100	45
5.00	150	45
10.00	175	45

3.1.3 The discharge fitting shall be fitted with hose length not less than 500mm & 10mm dia upto 5 kg and length not less than 750 mm & 12.5 mm dia for 10 kg with a trigger controlled nozzle capable of discharging 85% of the contents as follows:

Capacity (Kg)	Time (sec)	Throw (m)

ANNEXURE-E1 TECHNICAL SPECIFICATION

2.00	8 - 10	2
5.00	15 - 20	4 - 5
10.00	23 - 30	6

3.1.4 A Gas cartridge conforming to IS:4947 shall be fitted in a cartridge holder with an inner shell. A spring loaded piercing device shall be provided in the cap for piercing the seal of the gas cartridge. A syphon tube of copper or PVC shall be provided for upright operation.

3.1.5 All internal and external components and surfaces shall receive anti-corrosive coating of not less than 12 microns conforming to IS 3203 and as indicated below:

i)	Body	Mild Steel	Tin alloy
ii)	Cage for acid bottle and spring	Brass sheets	Lead or Tin alloy
iii)	Discharge fittings	Leaded - Tin bronze	Tin alloy
iv)	Strainer	Brass sheets	Lead or Tin alloy

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.2 Carbon Dioxide type

- 3.2.1 The extinguishers shall be rated for 2.0, 3.0 and 4.5 Kg by weight of Carbon dioxide, unless stated otherwise. The contents shall be with a filling ratio not exceeding 0.667.
- 3.2.2 The body shall be steel cylinder made according to IS:2872 and approved by the Chief Controller of Explosives.
- 3.2.3 The discharge head shall be simple and safe to operate conforming to IS:3224 with a safety release to IS: 5903 set to 18.0 to 20.0 N/mm². A syphon tube of brass or copper or PVC shall be fitted. A non-conducting discharge horn and a high pressure hose (27.5 N/mm² pressure) not less than 1m in length shall be fitted with each extinguisher.

The discharge system shall be designed to expel 95% of the contents in continuous discharge as follows:

Capacity (Kg)	Time (Sec.)
2.0	8 - 18
3.0	10 - 20
4.5	10 - 24

3.3 General requirements

- 3.3.1 All extinguishers shall be Standard products approved by the Tariff Advisory Committee and Local Fire Brigades and manufactured and tested strictly in accordance with the relevant Indian Standard. All markings and test results shall be stamped in the appropriate colour markings according to the Indian Standards.
- 3.3.2 All extinguishers shall have a structurally designed galvanised steel handle and also a suitable wall mounting bracket.

3.4 Mode of measurement

- 3.4.1 Each extinguisher with its mounting bracket shall be measured per unit and paid for.

3.5 Makes of materials

- 3.5.1 The makes of materials are to be considered as given in section 2.1.7

ANNEXURE-E1 TECHNICAL SPECIFICATION

6. TECHNICAL SPECIFICATION FOR MV SWITCHGEAR

1.0 **Scope**

1.1 The scope of work shall cover the supply, installation, testing and commissioning of all power panels, incorporating circuit breakers, switch fuses, busbars, interconnections, earthing etc.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- 1) IS:13947:1993 Switchgear & Control gear specification
- 2) IS:8623:1993 Low Voltage Switchgear and Control gear assemblies.
Parts 1 & 3

ANNEXURE-E1 TECHNICAL SPECIFICATION

3) Indian Electricity Act and Rules

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

3.0 **Air Circuit Breakers**

3.1 Air circuit breakers shall be air break horizontal draw out fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 600V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits specified.

3.2 Breakers shall be, motorised or manually operated as specified, complete with front-of-the-panel operating handle, isolating plugs with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes and trip free operation. Breakers shall be capable of being racked out into 'Testing', 'Isolator' and 'Maintenance' position and kept locked in any position. Breakers for remote and automatic operation shall be motor operated spring charged with closing and trip coils.

3.3 **Construction:**

- 1) ACB should be with safety shutter, Anti-pumping and rating error preventer.
- 2) Cradle: Should be service, test, isolate & maintenance positions
Racking handle should be stored in cradle.
Electrical breaker should not close during travel from service and test position and vice versa.
- 3) Inter-phase clearance should be more than 25 mm after termination of bus bar.
- 4) Neutral pole rating should be equal to breaker rating.
- 5) Electrical /Mechanical life: 15000 Cycles up to 2500A and 5000 cycle above 3200A.

3.4 **Release:**

- 1) All release in ACB should be microprocessor based and having over load, Short circuit and earth fault protection.
- 2) Release should be operated through magnetic fluxing device direct on tripping rod.
- 3) Release should be True RMS , self powered using CT.
- 4) Release should have zone selectivity facility.

3.5 **Breaking:**

- 1) As per SLD $ICU=100\%ICS=ICW$ for 1 sec
- 2) Breaking should be tested by CPRI/ERDA and reputed international authority.

4.0 **MCCB's**

4.1.1 Construction

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 1) MCCB should be current limiting type, trip free mechanism.
- 2) MCCB operated with rotary handle having door interlock facility.
- 3) All accessories like Shunt release, UV release, Aux & trip contacts should be site fittable.
- 4) Phase to phase barrier should be provided with MCCB.

4.2 Breaking:

- 1) As per SLD ICU=100% ICS.
- 2) Breaking should be tested by CPRI/ERDA and reputed international authority.

4.3 Release:

- 1) Ratings equal and above 500Amp. should be Microprocessor based with over load ,short circuit ,earth fault protections
- 2) Rating less then 500A should be adjustable thermal and magnetic type .

5.0 Switch Fuse Units & Disconnectes

- 5.1 Switch fuse units shall have quick-make, quick-break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting.

All switches shall be rated according to the equipment schedule or drawings and shall withstand the system prospective fault current let through.

Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type.All switch fuse unit should be AC23A.

- 5.2 Fuses shall be HRC cartridge type conforming to IS:2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type diazed fuses are not acceptable for any ratings.

- 5.3 All disconnecting isolators shall consist of switch units quick-make, quick-break type with silver plated contacts. The switches shall preferably have double breaks. The switches shall preferably have sheet steel enclosure, which in turn is mounted on suitable angle iron frame work. In wet locations switches shall have cast iron enclosures. Disconnects shall have a minimum breaking capacity of 5KA at 415 Volts.

6.0 Isolators

- 6.1 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.

- 6.2 Painting, earthing and labels shall be provided as generally indicating for MV Switchgear and shown on drawings.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 Instrument Transformers, Meters & Relays.

7.1 Ammeters and voltmeters shall be electronic digital type. Meters shall conform to BS:89 and have grade 'a' accuracy. Scale ranges shall meet with the requirements or as indicated on the drawing.

7.2 Energy meters shall be electronic two element switch board mounting type suitable for unbalanced loads. In case of two incoming feeders, a summing C.T shall be provided with the meter. Meters shall conform to BS: 37.

7.3 The energy meters for DG Set & Transformers shall be calibrated and got certified by the respective Electricity Authority wherever required.

7.4 CTS shall be cast resin type and conform to meter IS:2705 in all respects. Rated secondary current shall be 5A unless otherwise stated. Accuracy class of metering CT's shall be 1.0 & for protection 5P10.

Test links to be provided in secondary connection to facilitate testing of instruments, meters & protection device. CT burden shall be minimum of 10VA but appropriate to the instruments connected.

7.5 Relays and trip devices shall be any one of the following as specified:

- i) Thermal – Magnetic trips – direct acting
- ii) Solid state trips for O/L, SC & E/F.
- iii) Microprocessor controlled relays.

All trips shall be 400/230V AC series type unless shunt tripping is specified for.

7.6 LED indicating lamps to be provided for phase indication & breaker position as required.

7.7 All wiring for relays shall be of CU with colour coding and labelled with appropriate plastic tags for identification.

Minimum size of control wiring shall be 2.5 sqmm. All control circuits to be provided with protective MCB's.

8.0 Cubicle Boards

8.1 All boards shall be combination of 14 & 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and of modular construction suitable for 3 phase 415V

4 wire 50 Hertz system TN-S neutrals grounding. All boards shall be accessible from the front or as shown on Drgs, for the maintenance of switch fuses, busbars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meters etc. mounted on a 75mm high base channel frame. All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with powder coating of approved colour applied over a primer. Engraved plastic labels shall be provided indicating the feeder details, and capacity and danger signs.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 8.2 The boards shall accommodate air insulated bus bars, air circuit breakers, mccb's switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.
- 8.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an interlocked door with facility for padlocking. Each switch or MCCB or ACB shall have provision for locking in the OFF position for life safety. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 2147/1962. Feeder connections shall be of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required and if insulated, the insulation shall be able to withstand the high temp at the terminals. Internal wiring, bus bar markings etc. shall conform to IS:375/1963. Internal wiring shall have terminal ferrules.

Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75M from floor level. Cable glands shall form part of the switch board.

- 9.0 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy as specified and shown on drawings and rated for a temperature rise of 30 deg C over the ambient temperature specified, (IS:8084-1976). Neutral bars may be of one half the size of the phase bars or as shown on drawings. The main horizontal bus bars shall be of uniform cross section and rated for the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hygroscopic insulator blocks to withstand thermal and dynamic overloads during system short circuits.

Feeder connections shall be solid CU bus bars duly insulated with bimetallic clamps where we required. Bus bars shall be designed for easy extension in future on either side. All feeder connections shall be rated for 25°C temperature rise over the ambient.

10.0 **Earthing**

- 10.1 Protective earthing shall be provided as shown on drawings or as follows:

-----	Phase
	Protective conductor
	conductor
-----	upto 16 sqmm
	equal size
16 to 35 sqmm	16 sqmm
over 35 sqmm	50% of phase conductor

ANNEXURE-E1 TECHNICAL SPECIFICATION

In case of dissimilar materials the Protective Earth Conductor shall be suitably sized for equal conductance.

10.2 Protective earthing of each switch shall be connected to the earth bar.

11.0 **Installation**

11.1 All panels shall be supported on MS channels incorporated in the panel during the fabrication. All such supports shall have two finish coats over a prime coat after completion of the work. All panels shall be touched up for damaged painting.

11.2 All panels shall be megged phase to phase and phase to neutral using a 1000V meggar with all outgoing feeders in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phases and neutral.

11.3 Fabrication drawings of all panels shall be approved by the Consulting Engineers before fabrication.

12.0 **Testing & Inspection**

12.1 All switchboards shall be factory inspected before finishing and dispatch unless waived.

12.2 Certificate for all routine and type tests for circuit breakers in accordance with the IS:2516-1963 shall be furnished. In addition, all panels shall be megged phase to phase and phase to phase neutral, using a 1000V meggar with all switchgear in closed position. The meggar values should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

12.3 All meters shall be calibrated and tested through secondary injection tests.

12.4 All field tests shall be witnessed by Consultants and recorded unless waived.

13.0 **Mode of measurement**

13.1 Each panel will be considered as one unit for the purpose of measurement and shall include the following:

- i) Incoming and Outgoing feeders.
- ii) Interconnections and controls and instrument wiring with necessary protective fuses.
- iii) Meters, Relays, Indicating lamps, CT's control fuses etc.
- iv) Supporting structure, sheet steel enclosure
- v) Installation and testing

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 13.2 Isolators shall each be measured as one unit complete with:
- i) mounting frame ii) switch/fuse
- 13.3 Protective earthing of the panel/Isolator from the equipment earthing system will be measured separately and paid at unit rates.
- 13.4 Outgoing and incoming feeder terminations will be paid at the unit rates separately as specified under cabling.

7. TECHNICAL SPECIFICATION FOR MEDIUM VOLTAGE CABLING

1.0 **Scope**

1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- 1) IS: 1554 Parts I & II PVC Insulated Heavy duty cable
- 2) IS: 3961 Recommended current Rating of cable
- 3) IS: 7098 XLPE Insulated cables

All codes and standards mean the latest.

3.0 **Cables**

3.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. All cables shall have Flame Retardant, Low Smoke Sheath (FRLS) and meet, ASTM norms for the smoke density and Oxygen Index norms. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards.

3.2 XLPE cables shall be same as PVC with an FRLS outer sheath.

3.3 All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm spacing.

4.0 **Installation**

4.1 Cables shall be laid in the routes marked in the drawings. Contractor shall install all conduits/Pipes required for the cable work as per drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain

ANNEXURE-E1 TECHNICAL SPECIFICATION

the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

- 4.2 All cables running indoor shall be supported with necessary GI cable trays. Cable trays shall be hot dip galvanized & minimum 1.8 mm thick. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance (for Rod supports every 1.0m distance) including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

Cable support dimensions shall be as per table 1.1.

Sr. no.	Size	Cable Support
1	1500MM wide	2nos x 40 x 40 x 5MM GI Angle
2	1200MM wide	2nos x 40 x 40 x 5MM GI Angle
3	1000MM wide	2nos x 40 x 40 x 5MM GI Angle
4	750MM wide	2nos x 32 x 32 x 5MM GI Angle
5	600MM wide	2nos x 32 x 32 x 5MM GI Angle
6	For 2 Tier	2nos x 32 x 32 x 5MM GI Angle
7	450MM wide	2nos 8MM DIA GI RODS
8	300MM wide	2nos 8MM DIA GI RODS
9	150MM wide	2nos 8MM DIA GI RODS

- 4.3 Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.
- 4.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles as shown on drgs. Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cable markers at every 35 meters and at all loop points.
- 4.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid, on aluminium tag. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have double compression lugs (If panel busbars & Cable conductor are of different material then Bi-metalic lugs to be used). Cable terminations shall have necessary brass glands and all lugs shall be double compression type whether so specified or not. The end terminations shall be insulated with a minimum of six half-lapped layers of Heat resistant, 1100V grade PVC tape. Cable armouring shall be earthed at both ends.
- 4.6 Each cable shall be tagged with number that appears in cable schedule & Panel/Distribution board from where it is being laid., tag shall be of aluminium.

5.0 **Testing**

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.1 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

6.0 **Mode of measurement**

6.1 Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:

For cables laid indoors:

- i) Cables and clamps
- ii) Installation, commissioning and testing
- iii) Cable marking

OR

For cable buried underground:

- i) Cables and protective bricks & tiles
- ii) Installation, commissioning & testing
- iii) Cable markers

6.2 Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include

- i) Galvanised steel tray with necessary suspenders and frame supporting the tray, anchor fasteners, insert plates & necessary support arrangement for completeness of the installation.
- ii) Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.

6.3 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

- i) Lugs, glands, bolts, nuts ii) All

jointing materials

- iii) Installations, testing and commissioning iv) Earthing the glands

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.4 For cables buried under ground excavation shall be paid for additionally for the following per unit volume:
- i) Excavation and back filling
 - ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost as stated above.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ANNEXURE-E1 TECHNICAL SPECIFICATION

HVAC WORK

IV. TECHNICAL SPECIFICATIONS FOR HVAC WORKS

1. TECHNICAL SPECIFICATION FOR CHILLED WATER SYSTEM

1.0 **Scope**

1.1 The scope of work covers supply, installation, testing and commissioning of the chilled water system comprising:

- i) Circulating pumps ii)
Piping & insulation

and meeting the requirements of the data sheets and specifications.

1.2 Manufacturer's catalogues and following data shall be submitted and got approved before procurement:

- i) Manufacture & Model No. and speed ii)
Catalogues
- iii) Performance curves head/flow/power iv)
Physical dimensions & weight

2.0 **Chilled water pumps**

2.1 Chilled water pumps shall be single/multistage/monobloc/centrifugal, end or double suction with split casing as shown on the data sheet. The pump shall have cast iron casing with bronze impeller and trim as specified in the data sheet and direct driven by squirrel cage induction motor. The pumps shall be provided with heavy duty ball and roller bearings with mechanical water seals. The pump and motor shall be mounted on a common cast iron or fabricated base plate. Pump motor rating shall not be less than the rating listed in the data sheet nor shall the maximum BKW absorbed under any operating conditions of the pump exceed the motor rating.

2.2 Each pump shall be provided with a coupling guard, air vent cocks, suction and discharge flexible connections and gate valves, discharge non-return valves, strainer and a pressure gauge generally as shown on the drawings.

2.3 Pump set shall have a factory aligned base plate and installed on a suitable concrete foundation block with spring vibration isolation mounts specified. The concrete foundation shall be made by others to the drawings of the contractor, but the vibration pads shall be supplied and positioned by the contractor.

2.4 Pumps shall be insulated as specified under 'THERMAL INSULATION'.

3.0 **Piping**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.1 All piping shall be of Mild Steel. All piping and insulation shall comply with the relevant specifications under the section 'PIPING & THERMAL INSULATION'. ***Wherever the pipes pass through expansion strips, properly designed flexible connectors shall be provided.(Metallic connectors upto 50mm and single sphere connections)***
- 4.0 **Expansion tank**
- 4.1 **Open expansion tank (N.A)**
- 4.1.1 An open expansion tank of capacity indicated shall be installed as shown on drawing. The tank shall be fabricated out of 3.3mm thick MS sheets and shall be complete with the following accessories:
- a) Water level gauge glass b) Valved drain & overflow
 - c) Vent with mosquito protection d) Manhole with double seal
 - e) Make-up connection with shut off valve and float
- 4.1.2 Expansion tank and expansion lines are also to be insulated. Steel expansion tank shall be coated with 2(two) coats of rust inhibiting bituminous paint before insulation.
- 4.2 **Closed expansion tank**
- 4.2.1 The closed expansion tank shall be a factory fabricated unit complete with necessary make-up pumps. An inline air separator shall be provided wherever specified.
- 5.0 **Testing & Balancing**
- 5.1 Pumps shall be tested for establishing the total head, discharge quantity and power consumption. Pump testing may be combined with chiller testing.
- 5.2 Entire chilled water system shall be balanced to establish the design flows. **An approved commissioning agent shall be employed for the system balancing (air and water) and the results of balancing shall be approved by the Consultants.** If the balancing calls for trimming of the pumps, it shall be done with the specific approval of the consultants.
- 6.0 **Mode of measurement**
- 6.1 The pump together with the drive motor, starter,starter panel,isolator,VFD, coupling, coupling guard, base plate, vibration mounts, thermal insulation, suction and discharge flexibles, erection, testing, balancing and commissioning will be one unit of measurement. Valves and gauges will be paid for separately under piping.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.2 Expansion tank with all the accessories and mountings specified and insulation etc. shall be measured as one unit.

2. TECHNICAL SPECIFICATION FOR CONDENSER WATER SYSTEM

1.0 **Scope of work**

- 1.1 The scope of work covers supply, installation, testing and commissioning of the condenser water system comprising:

- i) Circulating pumps ii) Piping
- iii) Cooling tower

and meeting the requirements of the data sheets & specifications

- 1.2 Manufacturer's catalogues and following data shall be submitted and got approved before procurement:

- i) Manufacture & Model No. and speed ii) Catalogue
- iii) Performance curves head/flow/power iv) Physical dimensions & weight

2.0 **Condenser Water Pumps**

- 2.1 Condenser water pumps shall be single or multistage or monoblock centrifugal end or double suction with split casing as shown on data sheet. The pump shall have cast iron casing and bronze impeller and be direct driven by a squirrel cage induction motor. The pumps shall be provided with heavy duty ball & roller bearings with mechanical water seals. The pump and the motor shall be mounted on a common cast iron or fabricated base plate. Pump motor shall be not less than the rating listed in the data sheet nor shall the maximum BKW absorbed under any operating conditions of the pump exceed the motor rating.

- 2.2 Each pump shall be provided with a coupling guard, air vent cocks, suction and discharge double sphere type flexible connections and gate valves, discharge non-return valves and strainer, pressure gauge generally as shown on the drawings.

- 2.3 Pump set shall have a factory aligned base plate and installed on a suitable concrete foundation block with vibration isolation mounts specified. The concrete foundation will be made by others to the drawings of the contractor, but the vibration pads etc. shall be supplied and positioned by the contractor.

3.0 **Piping**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.1 All piping shall be **Galvanized steel** conforming to the specification under the section 'PIPING'
- 4.0 **Cooling Tower**
- 4.1 Cooling towers shall be forced or induced draft towers meeting the requirements of the data sheet.
- 4.2 Cooling tower shall be manufactured with fibreglass reinforced casing and a fibre glass water basin. The casing may be in one whole or in sections bolted together with necessary sealing gasket to make a leak- tight joint.
- 4.3 All structural frame work shall be designed for imposed loads plus a minimum wind pressure of 3 Kg/sqcm of projected area. All steel members shall be hot-dip galvanised before assembly.
- 4.4 Tower fill shall consist of rigid PVC material duly fire inhibited and rendered chemically inert to atmospheric impurities. Fill shall promote even air flow with low resistance and minimum loss of water due to drift.
- 4.5 Water sprinkler shall be low pressure type providing uniform water distribution. In-take louvers shall be easily removable thus providing easy access to the basin which shall be complete with make-up, quick fill, over flow & drain. In case of multiple towers an external valved equaliser of a size not smaller than 150% of the suction connection or as shown on drawings (whichever is higher) shall be provided.
- 4.6 Fans shall be of the axial flow type or centrifugal type (forced draft towers). The fan assembly shall be balanced to give smooth & vibration-free operation.
- A fan guard shall be provided to cover the fan intakes & outlets. Each fan shall be directly driven by an induction motor with IP 55 enclosure. The entire rotating mass covering the fan, drive shaft, must be statically and dynamically balanced and adequately supported.
- 4.7 Tower noise levels shall not exceed the values specified in the data sheets and tower shall be mounted on suitable vibration mounts specified.
- 4.8 A primary support system (concrete or steel) to dissipate the tower weight will be made by others and necessary steel grillage to suit the tower(s) shall be provided by the contractor. All such secondary structural system shall be epoxy coated.
- 4.9 Vibration mounts shall be spring type appropriately located with a serrated neoprene base.
- 5.0 **Testing**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.1 Pumps shall be tested for establishing the total head, discharge quantity and power consumption. Noise level also be measured and complied with the commitment.
- 5.2 The system shall be balanced as specified for chilled water and impellers trimmed as required.
- 5.3 Similarly, the cooling towers shall be tested for establishing water quantity and heat rejection. Test shall be conducted as nearly as possible at the design ambient wet bulb temperature. Where not possible, readings may be extrapolated for obtaining tower performance at design conditions. All test readings shall be submitted for the approval.
- 6.0 **Mode of measurement**
- 6.1 The pump together with the drive motor starter, starter panel, isolator, VFD coupling guard base plate, vibration mounts, suction and discharge flexible, erection, testing, balancing and commissioning will be regarded as one unit for measurement.
- 6.2 The cooling tower complete with fill, eliminators, fan, drive motor, starter, fan cone, vibration mounts, secondary steel supporting grid, erection, commissioning and testing will be regarded as one unit for measurement.

3. TECHNICAL SPECIFICATION FOR AIR FILTER

- 1.0 **Scope**
- 1.1 The scope of work covers supply, installation and testing of following air filters.
 - 1.1.1 Pre-filters before the cooling / heating coils of an air handling unit.
 - 1.1.2 Fine or microvee filters on the supply air side either independent or as pre-filters to absolute or HEPA filters
 - 1.1.3 Absolute or HEPA filters mounted in a filter plenum or in an air terminal unit.
- 2.0 **Standards: ASHRAE test standards 52 – 76.:**
- 3.0 **Materials:**
- 3.1 **Construction**
- 3.1.1 Prefilters shall be cleanable panel type made of multiple layers of fine HDP mesh stitched or crimped together and arranged in such a fashion so as to give the desired filtration rating. The filter media may be separated by combs and fitted to an aluminum frame. Thickness of frame shall be 1.25 mm and the overall thickness of

ANNEXURE-E1 TECHNICAL SPECIFICATION

the filter panel shall be 50 mm. Filter panels shall be rendered fire retardant. Filter area shall be as specified.

3.1.2 Microvee Filters shall be cleanable panel type and media shall be random fibre mats (non woven) stitched with G1 mesh and suitably pleated. Pleats may be separated by combs and are to be rigidly attached to a aluminum frame. The thickness of the frame shall be 1.25 mm minimum. Filter panel thickness and size shall be as specified. Filters shall be rendered fire retardant.

3.1.3 HEPA filter media shall be water proof, high strength micro fibre glass paper. Corrugated aluminum separators should be provided to ensure uniform media utilisation. The casing shall be aluminum 1.6 mm thickness with leak free installation and dimensional stability. Neoprene (non particle shedding) gasket shall be fitted to the frame on both sides to ensure leak tight installation. The filter media shall be fitted to the filter frame with a suitable adhesive compound providing rigid construction without the need for mechanical fasteners.

3.2 Performance Criteria

3.2.1 Operating performance criteria for various kinds of filters shall be as under:

		Pre-filter	Microvee filter	Absolute filter (HEPA)
1	Filtration efficiency	90% down to 10 microns	99% down to 5 microns	99.97% down to 0.3 microns
2	Air velocity across The filter	1.25 to 1.5 m/s	1.2 to 1.3 m/s	1.2 to 1.3 m/s
3	Pressure drop clean	2 mm of WG	6 mm of WG	20 mm of WG
4	Pressure drop dirty	8 mm of WG	20 mm of WG	36 mm of WG
5	Reuse of filter after cleaning	Yes	Yes	No

4.0 Installation

4.1 The filters should be installed in the frames in such a manner that no air by pass takes place. Filters shall be easily inserted from the sides. Rigidity and sealing effectiveness of the frame are of utmost importance. HEPA filters should be handled and installed with extreme care. Filters should be installed such that the free area is at right angles to airflow to the extent possible and eddy currents should be avoided and air should be distributed uniformly over the entire filter surface. Sufficient space should be provided in front as well as behind the filter to make it accessible for service and access doors of convenient size should be provided to the filter service areas. All doors on the clean airside should be gasketed to prevent infiltration of unclean air and all connections and screws of the ducting shall be airtight. Filter bank must be caulked to prevent bypass in the case of HEPA filters. The filters shall be installed only after ensuring complete cleanliness of the system. After three months or as decided by project manager, after continuous operation the

ANNEXURE-E1 TECHNICAL SPECIFICATION

contractor shall check the status of the filter and replace as necessary at their cost. The damage shall not exceed 25% of the number of filters.

5.0 **Testing**

5.1 All filters used shall have been tested for their efficiency and dust- holding capacity. Each type filter shall have a prototype test certificate and where ever necessary, the contractor should get the filters tested in an approved test facility.

5.2 After installation, all filters shall be tested for leakage in an approved manner.

6.0 **Mode of Measurement:**

6.1 Prefilters forming part of AHU's or Fan Sections shall form part of the AHU or Fan section.

6.2 Microvee Fine filters shall be paid for total bank including filter frame, filters, access panels, entry and exit plenum etc. as one unit.

6.3 HEPA filters shall be measured as specified in the schedule of work.

4. TECHNICAL SPECIFICATION FOR AIR HANDLING SYSTEM

1.0 **Scope**

1.1 The scope of work covers supply, installation and testing of the Air Handling Systems. The units shall meet the requirements of the data sheets and specifications.

1.2 Equipment document shall be submitted comprising but not limiting to the following:

- i) Manufacture, Model No.
- ii) Catalogues showing unit selected, physical data & weights iii)
Performance data covering
 - a) Air side b) Coil side

Equipment data shall be submitted as required under Annexure 2.1-5

2.0 **Air Handling Units (Double - Skinned)**

2.1 **Casing**

2.1.1 Air Handling Units shall be of sectionalised constructions with an underframe of extruded heavy aluminum profiles anodized for extra protection against corrosion. The

ANNEXURE-E1 TECHNICAL SPECIFICATION

aluminum profiles shall be connected through die-cast connectors which shall render the unit capable of being easily dismantled. Based on the capacity and data sheets, AH units could be horizontal floor mounted, horizontal ceiling suspended, vertical floor mounted or as mentioned in the data sheet.

- 2.1.2 The underframe shall be mechanically strong and shall take double skinned insulated panels. The panels shall consist of 0.6mm galvanised outer skin and 0.6mm galvanised inner skin with 25mm polyurethane foamed in place for indoor units and 50mm for outdoor units. The thermal conductance of the panel shall be not more than $1.2 \text{ W/m}^2 \cdot \text{C}$ and the noise reduction of 20 dB @ 250 Hz mid frequency. Thermal break profiles shall be used wherever specified.
- 2.1.3 Air tight access panels shall be provided in the fan section and coil sections. The access panel of the fan section shall be provided with a vision panel and limit switch to turn off the fan when the panel is opened and turn on the inbuilt bulkhead light. The Entire unit shall be mounted on a 100mm galvanized steel subbase.
- 2.1.4 Units meant for outdoor exposed locations shall be specially designed to meet the arduous and corrosive atmosphere and **thermal profiles**. All hardware shall be hot dip galvanized.
- 2.2 **Fan Section**
- 2.2.1 The fans shall be generally backward curved centrifugal double-inlet double – width with optimized selection for low noise and high efficiency unless specified different in data sheets. Fans shall be statically and dynamically balanced for vibration free operation.
- 2.2.2 Fans shall be enclosed in galvanized steel scroll cases with variable inlet vane section wherever specified. Fans shall be driven by a permanent magnet motor wherever mentioned in data sheets or else induction motor may be used. Fan and motor assembly shall be mounted on specified vibration isolators eliminating the need for external vibration isolators. Provision shall be made for belt tensioning.
- 2.2.3 Motors shall be rated 10% over the maximum possible power absorbed by the fan operating at a maximum face velocity of 3.25 mps (650 fpm). The natural frequency of the fan assembly shall not fall within 30% of the operating speed. There shall be an extended shaft with two drive systems and two motors for 24 hours operation. All motors shall have ‘high’ efficiency as per IS 12615-2004 (IE2 compliant) unless otherwise specified.
- 2.2.4 The fan outlet and inlets shall be as shown on drgs. and shall be isolated from the casing by means of factory made flexible connectors as specified in section “Sheet Metal Ducting”.
- 2.3 **Coil Section**
- 2.3.1 Coils shall be made of 10mm or larger copper tube with finned extended surface. Fins shall be of aluminum spaced with integral collars as specified and mechanically expanded for proper bonding. Coils shall be tested after assembly with compressed air at 30 bar under warm water. Finned coils meant for outdoor use (air cooled condenser) shall be suitably protected against corrosion. All coils to be AHRI certified to AHRI std. 410.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.3.2 Air velocity across the coil shall not exceed 2.5mps. Inlet and outlet coil nipples shall be sealed against unit casing by means of neoprene gaskets. Each coil shall have a double skin drain pan with 20mm polyurethane foamed in.
- 2.3.3 Coils more than 6 row deep, shall be in two halves with 150mm space in between for easy cleaning.
- 2.4 Filter Section
- 2.4.1 The filter frame shall accommodate the filters in a manner that no air bypass takes place. Filters shall be easily inserted in slide-in guides.
- 2.4.2 Filters shall be cleanable dry type "Pre filters" as specified under section "Air Filters" and shall be 50mm in thickness. Filter area shall be selected for 1.5m/s velocity with an initial pressure drop of 50Pa and with full dust load pressure of 150Pa.
- 2.5 Selection & Installation
- 2.5.1 All air handling units shall be selected to meet the performance criteria set out in the appropriate data sheets. Wherever the ceiling heights are low, unit selection shall be such that the unit could be accommodated in the space assigned.
- 2.5.2 Where it is not possible to take-in an assembled unit, it shall be dismantled and reassembled. All air handling units shall be installed with appropriate vibration isolation systems.
- 3.0 Ventilation AH Units with Heat Recovery Systems
- 3.1 The ventilation AH units are essentially same as double skinned AH units specified above but characterized by the following:
- i) Outdoor weather resistant construction and installation including thermal profile.
 - ii) Units incorporate
 - a) Intake section with filters & dampers
 - b) Coil section
 - c) Supply fan section
 - d) Heat pipe with connections
 - e) Heat recovery wheel or Z-duct
 - f) Return fan section
 - g) Exhaust intake & damper
- 3.2 The unit shall have demountable sections, if necessary, for easy handling and shall be installed in the places shown. Unit shall be complete with drive motors, single control panel with necessary incomer & outgoing breakers, starters for each drive motor, temp. & humidity sensors, power and control cabling
- 3.3 Heat recovery wheel

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.3.1 Heat recovery wheel should be complete with aluminum wheel, seals, purge section frame and housing for the wheel, wheel drive, motor, starter etc. The wheel assembly should be tested and assembled at the factory and should be ready for start up when installed at site. The wheel performance shall meet the requirements of the data sheet.
- 3.3.2 Wheel should be manufactured of aluminum with a coating of appropriate absorbent for the transfer of water vapour to meet the capacities specified in the data sheet. At no point there should be any mixture between the supply and exhaust sides of the wheel and the wheel should be designed to pass particles upto 800 microns. Absorbent coating on the wheel should be capable of being washed with steam, hot water, or detergent without any effect on the heat transfer capacities.
- 3.3.3 Wheel frame should be of structural framework designed to limit deflection of wheel due to differential pressure to no more than 2mm. All the metal components should be of galvanized steel or should be epoxy painted for corrosion protection. Bearings supporting the wheel should be capable of replacement without removal of wheel. The wheel should be supplied with four pass labyrinth seals which shall not make contact with any rotating surface of the wheel. The seals should be adjusted for the desired performance to limit the cross contamination due to carry over and an adjustable purge section should be provided. Seal and purge system should be properly adjusted to limit the cross contamination to less than 0.04% of that of the exhaust airstream concentration.
- 4.0 **Fan Coil Units**
- 4.1 Fan coil units shall be horizontal/vertical type as shown on data sheets with return air plenum and filter as shown on drawings. Unit capacities shall be as required in the data sheets. Filter shall be single pane cleanable type.
- 4.2 Unit shall consist of coil section, fan deck, motor and blower assembly, insulated drain pan. Entire unit shall be capable of being supported from four points. All sheets used for casing panels shall be hot dip galvanised before assembly and phosphate coated before being painted. Sheet metal shall not be less than 1.6mm.
- 4.3 Coils shall be made of 10mm or larger copper tube with plain aluminum fins expanded on to the tube. Number of fins shall not be less than 320 nor more than 400 per meter. Coils shall be tested to 20 bar working pressure. Supply and return connections shall be 16mm O.D copper arranged either right or left handed as required. Automatic air vents shall be provided on the return headers with a flexible pipe discharging into the drain pan. End connections shall have supply, return and control solenoid valves (on the return side). Coil design shall be such that the coil (alone) could be disconnected and removed from the unit for cleaning and maintenance.
- 4.4 Fans shall be slow-speed direct driven centrifugal forward curve type, statically and dynamically balanced. Fans shall have three speeds (100%, 70% & 50%) and quiet in operation. The maximum sound power level of the unit shall not exceed NC 35. A length of acoustically treated duct shall be provided as shown on drawings and as specified under section 'NOISE & VIBRATION'.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.5 Ductable fan coil units shall be capable of rated air discharge against specified external static resistance which shall be 200Pa by default.
- 4.6 Fan motors shall be single phase 220V 50Hz or 3 phase 400V with built in thermal overload protection and shall be capable of reliable starting and vibration free operation upto 90% of the rated voltage. Motor shall be mounted on a 3mm thick motor board and capable of being removed easily.
- 4.7 A full size double skin drain pan shall be fabricated of 1.25mm galvanised sheet. 25mm polystyrene or polyurethane shall be sandwiched or foamed-in. The two skins shall not be interconnected at any point. Pan shall be large enough to contain the unit and the coil connection shut-off valves, control valves etc. Units shall be mounted on the pan with rubber bushes. Inside of pan shall be finished smooth and pitched towards a 25mm drain connection located on the same side as the coil connections. Drain shall be connected to the drain pipe with flexible connection and a PVC trap of 40mm water seal and with inbuilt cleaning plug.
- 4.8 Unit control package shall consist of two way or three way solenoid or motorized water valve and two shut-off valves. A wall mounted control panel shall consist of:
- a) ON-OFF room thermostat having digital display with adjustable set point.
 - b) Control switch with ON-OFF and High, Medium & Low Fan speeds. (upto 1000cfm)
 - c) On-line starter with a 3PN mcb/ mccb.
- A sample of the entire unit and control panel shall be got approved by the project manager.
- 4.9 Fan coil units shall be installed with necessary galvanised steel frame to support the fan coil units.

5.0 **Variable Air Volume Terminals**

- 5.1 The VAV unit assembly shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume. At an inlet velocity of 10mps, the differential static pressure for any unit shall not exceed 2.5mm WG. Sound rating of air distribution assemblies shall not exceed NC 35 at 50mm WG pressure.
- 5.2 The air flow sensor shall be of cross configuration located at the inlet of assembly and shall have multiple pick up points, designed to average the flow across the inlet of assembly. The air flow sensor shall amplify the sensed air flow signal.
- 5.3 The assembly shall be constructed of 0.8mm thick zinc coated steel, internally lined with 20mm thick, fibre glass insulation. Any cut edges of fibre glass exposed to the air stream shall be coated with sealant. The primary air valve damper shall be heavy gun metal with peripheral gasket, pivoted in self lubricating bearings. In the full closed position air leakage past the closed damper shall not exceed 2% of the nominal catalogue rating at 80mm static pressure.
- 5.4 The terminal unit controller shall be a dedicated, microprocessor based, pressure independent VAV controller complete with electronic flow transducer. The controller shall be capable of stand alone operation and have the capability to network with a building automation system, personal computer or portable operator interface device.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.5 The actuator shall be bi-directional and direct coupled to the damper shaft. The actuator must be capable of operating in the stalled position without overheating or mechanical damage.

5.6 Terminal controller, flow transducers and electric actuator shall be factory wired, calibrated and pretested to ensure full functional unit. The zone sensor shall be furnished by the terminal unit manufacturer and shall include temperature set point adjustment and access for connection of a hand held operator terminal. The DDC control package shall be calibrated and factory set for maximum and minimum flow rates as shown on the drawings.

5.7 The air terminal unit shall be installed and field adjusted to maintain controlled pressure independent airflow. The units shall be provided with a minimum of four duct diameters of straight inlet duct, same size as the inlet, between the inlet and any takeoff, transition or fitting. To facilitate field measurements terminal unit manufacturer shall furnish a portable hand held operator interface. The operator interface shall have capability of changing all inputs, set points and operating parameters of the VAV controllers by connection to the zone sensor.

All control components should be mounted inside a protective metal shroud. All VAV terminals shall be connected to the grille or diffuser through an insulated flexible duct and grille/diffuser.

6.0 **Testing**

6.1 The air handling and fan coil and VAV units shall be tested for establishing:

- | | | |
|------|-------------|--|
| i) | Air side | <ul style="list-style-type: none">• Fresh air quantity (cmh)• Dehumidified air quantity (cmh)• Total static pressure (WG) & external static pressure (WG)• Leaving & entering conditions (DB & WB)• Coil capacity<ul style="list-style-type: none">- Sensible heat (Kcal/hr)- Total heat (Kcal/hr)• Fan speed (rpm)• Power consumption of fan (watts) |
| ii) | Water Side | : Water flow (lpm)
Temp. IN & OUT (deg C)
Pressure IN & OUT (mWG) |
| iii) | Noise level | : NC level @ 1m from the unit and at the four corners of the room. |

ANNEXURE-E1 TECHNICAL SPECIFICATION

- iv) Ventilation AH Units for supplying treated fresh air shall be tested for all the parameters of the Air Handling Units above but also register the performance of the heat recovery wheel / heat pipe for the actual flow conditions.

7.0 **Air Distribution**

- 7.1 Air distribution shall be by means of sheet metal ducting grilles and diffusers as described under 'SHEET METAL DUCTING'.

8.0 **Mode of measurement**

- 8.1
 - i) The air handling unit complete with fan, filters, cooling coil, dampers, flexible connections and vibration mounts, motor and drive and starter, power and control cabling as shown on data sheets etc. shall form one unit (two motors, drives & starters on all 24 hour units).

- 8.2
 - i) The fan coil unit complete with filter, cooling coil, poleflex insulated pipe connections, shut off valves, full drain pan, motorised valve, room thermostat with fan speed control, wiring from unit to thermostat and fan speed controller or starter, duct with acoustic insulation and supply & return grills, support etc. shall form one unit of measurement.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 8.3 Automatic controls for AH units complete with damper actuator, transformer, RA thermostat, damper linkage, control wiring, relays etc. shall form part of the BMS or as shown in the schedule of work.
- 8.4 VAV units shall be treated as one unit complete with:
- i) Temp. sensor.
 - ii) Control wiring from unit to temp. sensor.
 - iii) 200 dia flexible ducting not more than 1.2m iv) Plenum of approximately 1.2 x 0.15 x 0.3m
- 8.5 Ventilation AH Unit complete with supply and return fan sections, cooling coil, heat recovery wheel, heat pipe etc. and control panel & all internal power and control cabling shall be regarded as one unit of measurement.

5. TECHNICAL SPECIFICATION FOR AIR MOVING APPARATUS

1.0 **Scope**

- 1.1 The scope of work covers supply, erection, testing and commissioning of various Air Moving Apparatus as described herein.
- 1.2 All manufacturers catalogues and performance data physical dimensions & weight shall be submitted and get approved before procurement.
- 1.3 **Fan performance ratings shall conform to AMCA (Air Movement and Control) standard 211 and 311 and tested in accordance with ANSI/AMCA std 210-99 and AMCA std 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA seal for air and sound performance.**

2.0 **Centrifugal fans**

- 2.1 Centrifugal fans shall have backward curved preferably with hollow heavy section aerofoil blades, with non-over loading characteristic unless stated otherwise. Blades in fans for class III and above applications shall be internally reinforced. Wheel hubs shall be machined cast iron or fabricated for heavy duty operation mounted on liberally sized shaft assembly. Fan assembly including shafts shall be statically and dynamically balanced with critical speeds atleast 30% away from the operating range of speeds of the fan. Fans shall be selected for the specified outlet velocities, default maximum velocity 12m/s.
- 1.2 Fan bearings shall be unless otherwise specified heavy duty self-aligning, regreasable roller bearings capable of absorbing radial and/or thrust loads. All bearings shall be selected for quiet operation and long life.
- 1.3 Fans shall have manually operated inlet vanes and quick opening access door. Fan housing shall be constructed of heavy gauge steel completely seam welded and shall have heavy angle or channel side and fixed discharge and inlet flanges conforming to AMCA recommendations.

ANNEXURE-E1 TECHNICAL SPECIFICATION

1.4 Fan drives shall be through multiple vee-belts using multi-vee-grooved pullies. **An OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).** . Fan and drive motor shall be mounted on a common fabricated base frame which in turn shall be isolated from the floor through specified vibration mounts. Motor rating shall exceed maximum power the fan absorbs at all operating conditions. **Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service..**

2.0 **Fan Sections**

2.1 Fan sections shall be similar to single skin Air Handling Units fabricated out of mild steel angles and galvanised sheet steel with bracing or beading for structural rigidity.

2.2 Fans shall be backward curve centrifugal double inlet multiple blade type, enclosed inside the unit casing as specified above and together with the drive/s, unless stated otherwise.

2.3 Drive motor shall be mounted on adjustable motor base capable of a minimum adjustment of 100mm. Wherever 24 hours operation with two drive motors are specified the fan shaft shall be extended on both sides with the drive pulleys. Motor ratings shall exceed the maximum power absorbed by the fan at all operating conditions.

3.0 **Axial Flow Fans**

3.1 Axial flow fans may be tube or vane axial type for in-line installation. Fans shall be selected for low noise levels and meet the flow and pressure requirements specified in the data sheets.

3.2 Drives for all axial flow fans shall be with multiple V belts unless specified otherwise there shall be minimum 2 belts. All motors shall be sized at more than the maximum brake power of the fan in its operating range.

4.0 **Propeller fans**

4.1 Propeller fans shall be direct driven as specified with square frame and heavy deep drawn steel panel construction. Fans shall be capable of being mounted in horizontal or vertical or any angular position. Drive motor shall be single phase/3 phase with necessary starter specified. All fans shall have discharge gravity louvers and bird screen with 1.0mm dia 20 mesh galvanised steel mesh with diaphragm plate & frame, grouted into the wall.

5.0 **Mixed Flow Tubular Inline fans**

5.1 Mixed flow fans shall have a mixed flow designed wheel in a tubular housing for in-line installation. Fan Housing should be aerodynamically designed to reduce incoming air turbulence. The Housing shall include welded steel vanes to straighten air flow prior to exiting the fan discharge. Units shall incorporate a universal mounting system which shall allow the fan to be mounted in either vertical or horizontal configurations and field rotation of motor position in 90 degree increments. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.2 An Access Door shall be provided for impeller inspection and service. For belt driven fans belt guard and motor cover shall be included to completely cover the motor pulley and belt(s). For kitchen grease exhaust application motor pulley and belt assembly shall be securely isolated from the air stream to prevent grease accumulation. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.

5.0 **Sheet Metal Ducting**

5.1 All sheet metal ducting associated with ventilation and exhaust systems shall follow the specifications "SHEET METAL DUCTING".

6.0 **Installation**

6.1 Installation of all fans shall be done with necessary vibration isolation fittings and the minimum static deflection as specified in the data sheets.

7.0 **Testing**

7.1 All fans shall be tested to establish the following ratings: Air quantity

	✂s
Static pressure	Pa Fan speed
	rpm Outlet
velocity	(m/s)
Noise (On Octave wave band)	(SPL) dB
Full load current	(amps)

8.0 **Mode of measurement**

8.1 Each fan with motor, drive & guard, mounting frame, vibration mounts starter panels, cabling, earthing as per data sheet shall form one unit. In case of propeller exhaust fans, the mounting frame with bird screen and gravity louvres (back draft dampers) should also be included in the unit cost or as defined in the schedule of work.

6. TECHNICAL SPECIFICATION FOR NOISE & VIBRATION

1.0 **Scope**

1.1 The scope of work cover :

ANNEXURE-E1 TECHNICAL SPECIFICATION

i) Selection of equipment for optimized noise levels. ii) Selection of vibration elimination systems

as specified in the various equipment data sheets.

2.0 Equipment

2.1 All equipment shall be selected for low noise and minimum vibration levels. Selection of bearings, operating speeds and enclosures shall be such as to meet the above objections. Bearings shall be selected for an average life of 100,000 hours. Maximum operating speed should not exceed 75% of the first critical speed. Equipment submittals shall clearly show the critical speed and the operating speed. Fans and AH Units shall be selected for highest efficiency at the operating point.

2.2 Upon installation, all equipment shall be checked for misalignment which shall be less than 2°. All readings shall be recorded. Also the belt-tightness and bearing fixture and lubrication are to be ensured and confirmed. Every equipment shall be tested for vibration and following acceptable limits are ensured and recorded:

RPM	Maximum vibration verticals, horizontal, axial (mm)
0-300	0.13
301-500	0.10
501-1000	0.08
1001 and up	0.05

3.0 Noise Ratings

3.1 Certified noise power levels of each equipment on an octave band spectrum shall be furnished together with values for the discharge and suction sides. Equipment with low noise power levels would have added weightage in the assessment of equipment.

4.0 Vibration Isolation

4.1 All rotating equipment shall be totally balanced for smooth dynamic performance and at any rate should not exceed maximum limits set above. In addition, each equipment shall be mounted on suitable vibration isolation mounts specially selected for the equipment and its drive assembly. For all equipment installed on concrete slabs or structural steel lofts, the vibration isolation shall take into account the natural frequency of the slab or loft as the case may be. At any rate, a minimum static deflection of 25mm shall be achieved in all such cases. Isolators for higher deflection shall have suitable snubbers. Metallic vibration mounts shall have neoprene isolators.

5.0 Piping & Ducting

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.1 All rigid piping and ducting connected to any equipment mounted on vibration mounts, shall have flexible connectors of approved type. The flexibles shall absorb the equipment movement without causing vibrations in the rigid sections.

6.0 **Mode of measurements**

6.1 All vibration isolators, flexibles etc. shall form part of the equipment and shall not be paid separately.

7. TECHNICAL SPECIFICATION FOR PIPING INSTALLATION

1.0 **Scope**

1.1 The scope of work covers supply, installation, testing & commissioning of all piping for

- i) Chilled water / Hot water distribution
- ii) Condenser water distribution
- iii) Refrigerant piping

1.2 This specification shall be applicable to pipes covering the following fluids:

- i) Cooling water not exceeding 50^o C
- ii) Chilled water not less than 6^o C
- iii) Refrigerant piping – 20^oC

2.0 **Pipes & Fittings**

2.1 Pipes shall conform to the following schedule:

NB	Pipe (mm)		Material
	Min.OD	Thickness	
25	33.3	4.05	ERW Heavy class carbon steel tube to IS-1239-79 Part I
40	47.9	4.05	
50	59.7	4.50	
65	75.3	4.50	
80	88.0	4.85	
100	113.1	5.40	
150	163.9	5.40	ERW carbon steel pipes to IS 3589-1981
200	219.1	6.00	
250	273.0	6.00	
300	323.9	6.00	
350	355.6	7.00	
450	406.4	7.00	

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.2 All pipes shall be new and factory fabricated from standard manufacturers. All pipes shall be black steel and be prepared for butt or socket welding as specified herein.
- 2.3 All bends upto 65 mm NB shall be hydraulically formed with a minimum R/D of three unless space restrictions inhibit, in which case long radius elbows may be used with the approval of the Engineer-in- charge. For sizes upto 50 mm NB, socket weld fittings shall be used. For larger sizes butt welding wrought steel fittings to BS 1965 and matching with the straight pipe wall thickness shall be used. All bends shall be ready made only.
- 2.4 Flanges shall be carbon steel raised face conforming to IS : 6392 – 1971. Pressure rating shall be :

Minimum : PN10 (BS.EN:1092) Maximum :
PN16,20,25,40

According to the system pressure. System pressure shall be reckoned as 1.25 times the maximum pressure recorded on a pressure gauge mounted immediately after the pump discharge. (Pump no-delivery head + the static head of the standing column of water). All components like flanges, fittings, valves, vents, strainers etc. shall be rated for the system pressure.

- 2.5 Flange gaskets shall be as follows :

Upto PN10 3mm reinforced teflon flat ring
Over PN10 3 to 6mm serrated or laminated gasket

Pressure on the gaskets shall be applied uniformly through a torque – wrench for achieving uniform pressure and a leak-tight joint.

3.0 **Valves and Strainers**

- 3.1 All valves and flange joints shall be suitable for system pressures as defined above.
- 3.2 Valves upto 50mm NB can be ball valves Carbon – steel single piece with flanges. Ball and stem shall be of AISI304 with PTFE seat and seals.
- 3.3 Higher size valves shall be butterfly type. Butterfly valves shall have a fine grain cast iron body with mirror smooth finished cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer-type and should be fitted between two flanges. The valve shall have an easily replaceable molded EPDM sleeve which shall bring about 100 % tight shut off at the design working pressure. Shaft bottom shall have an axial bearing Where valves are to be insulated they should have on extended neck. All valves upto 200dia may be lever operated and larger sizes shall be with a gear box and wheel.
- 3.4 Non-return valves upto 50 mm NB shall be swing-type of gun metal construction with flanged ends. Larger sizes shall be lift / swing type of cast steel construction with gun mental internals and flanged ends.
- 3.5 Water strainers shall be either ‘Y’ or pot type with cast iron bodies.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Strainers shall be complete with S.S. Perforated 12 mesh (1.5mm ϕ) basket a dirt blowout plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe and shall have flanged end connections.

- 3.6 Manual/Auto air vents shall be provided at all high points in the piping systems for air purging. Vent sizes shall be as follows and suitable for specified test pressure.

Up to 152 mm : 12 mm size ball type gun metal valves with hose connections.

Over 152 mm : 20 mm size globe type gun metal valves
With hose connections.

Air vents associated with equipment or cooling coils shall be 12mm automatic venting type with a shut off ball cock and a plastic pipe discharging into the condensate drain. Such air vents should form part of the coil or equipment.

- 3.7 Drains shall be provided at all low points and all drain valves shall be ball valve with hose connectivity. Drain sizes shall be 25 dia or as shown on drawings.

- 3.8 Pressure gauges shall be "Bourdon" type with minimum 100 mm dial and required range. All gauges shall be provided with gun metal plug type gauge cocks and copper or S.S capillary connection with an insulating sleeve to prevent system fluctuations affecting the gauge. Gauges shall be provided wherever shown.

- 3.9 Thermometers shall be industrial direct reading stem type of the required range. Thermometers shall be provided in separable wells.

4.0 **Pressure Independent Balancing and Control Valve (PIBCV)**

- 4.1 Each Air handling unit / Fan Coil unit shall be provided with a 2-way pressure independent balancing and control valves. The control shall be modulating type for AHUs and On/OFF type for FCUs. The PIBCV should be a self balancing, pressure independent, 2-way control valve with 100% authority on the control valve.

- 4.2 The pressure drop across the PIBCV should not exceed 20kPa for FCUs and 30kPa for the AHUs.

- 4.3 The differential pressure controller should maintain a constant differential pressure across the control valve, irrespective of fluctuations in the system pressure. Each valve should have a precisely adjustable maximum flow limitation as per designed flow rate of coils which is capable of being field adjusted. All valves should have testing ports for verifying the flow by measuring the differential pressure.

- 4.4 The valve and actuator must be capable for both Logarithmic control characteristics and linear control characteristics to ensure compatibility for both water/air and water/water exchanger.

- 4.5 Flow setting of the valves should be simple and capable of being reset on site.

5.0 **Pipe Installation**

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.1 Pipe installation shall be carried out in a workman-like manner in accordance with approved drawings. Pipes shall be aligned parallel to walls and ceiling and not across a room. Change of direction shall be through hydraulically formed or wrought iron weldable fittings as specified. Alignment shall follow the approved drawings and wherever necessary pipe shall be rerouted under the instructions of the Engineer- in-charge in order to meet the site conditions and or interference from other services. Wherever dissimilar metals are required to be connected it should be through bimetallic connectors to prevent galvanic corrosion

5.2 Pipes passing through walls & floors shall be provided with sleeves as follows:

Space	Sleeve dia (mm)	Sleeve Projection (mm)	Sleeve Material	Sleeve packing and Closure
<u>Floors</u>	D + 50	50 AFF	1.25 mm GSS OR Light duty galvanised tube	32 Kg/cum Resin bonded fibre glass with 8 mm thick polysulphide or Silicon sealant
<u>Walls</u>				
i) Internal	D + 50	Flush with Finish	- do -	32 Kg/cum Resin bonded fibre glass closed on both sides with 1.0 mm GSS split flange
ii) External	D + 50	- do -	- do -	Caulked with lead wool and oakum & closed on both sides with 1.25mm GSS split flanges with brass screws

ANNEXURE-E1 TECHNICAL SPECIFICATION

- D = Outside diameter of pipe with insulation
GSS = Galvanised sheet steel
AFF = Above finished floor

5.3 Pipe supports shall be standard factory made galvanised systems or fabricated from steel structurals galvanised after fabrication. Supports shall be spaced as follows:

Size	Horizontal	Vertical
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150 & over	3.00 m	3.0 m

Where pipes connect to rotating equipment, an appropriate vibration isolation fittings shall be incorporated in the piping and the suspension systems.

5.4 Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by the Engineer-in-charge. Pipe hangers shall be from galvanised structural steel, steel inserts in concrete or anchor fasteners, wall brackets or floor supports as decided by the Engineer-in-charge depending upon the location of the support. Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50mm. All supports suspenders and hangers shall be galvanized before assembly.

5.5 Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanized mild steel. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamping arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60% of its compression strength. No support shall transfer the temperature to the support.

5.6 Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support at the lowest point.

5.7 All pipe joints shall be welded except where flange joints are specified. Pipes upto 50 mm NB shall use socket-weld fittings with fillet welding and larger sizes use butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:

- i) Pair of flanges for isolation of equipment
- ii) Mating flanges for equipment flange connections

ANNEXURE-E1 TECHNICAL SPECIFICATION

iii) Mating flanges for valves, strainers as the case may be iv) Pair of flanges at every 30 m continuous run of piping

- 5.8 Entire piping shall be self-draining, using only eccentric reducers at all change of sections. 25mm NB drain points with a dirt leg and a shut off valve (ball Valve) shall be provided at all low points of the piping and the piping system shall be pitched 1% towards such low points. All air handling unit drains shall be pitched 2% with a 75-mm water seal trap. Fan coil unit drains also shall be pitched likewise but the water seal could be 40 mm. All traps shall be built-up or prefabricated. In the case of the multiple risers of supply and return water lines, isolating valves with a strainer and drain valve shall be provided wherever required. All isolating valves shall be gate/ball/ butterfly valves rendering a tight shut-off. Valves shall not have their spindles downwards or upwards on a horizontal pipe run but should be side ways
- 5.9 Where pipes are directly buried in ground, the pipes shall have "Pypcote" wrapping or as specified in IS10221.
- 5.10 Where pipes are buried at a length less than 1.5m below ground, they shall be enclosed with RCC in such a way that pipe will not get damaged in heavy loaded conditions. No piping shall be left open during laying and construction.
- 5.11 All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer as to the alignment and height, the piping shall be full welded. Piping may be presented to the Engineer for approval in sections. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.
- 6.0 **Refrigerant Piping**
- 6.1 Refrigerant piping shall be heavy duty seamless mild steel tubes with weld-able socket type fittings. All tubes shall conform to IS 1239-1979.
- 6.2 All fittings shall be forged steel socket type fittings suitable for welding.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.3 Pipe sizes shall be as shown on the drawings or should follow the following criteria :
- | | | |
|-----------------|---|---|
| Suction lines | : | Pressure drop not exceeding equivalent to 1.1 deg.C |
| Liquid lines | : | - Do – 0.5 deg. C |
| Discharge lines | : | - Do – 0.5 deg. C |
- 6.4 All suction and liquid lines shall be lapped and together insulated as specified under "THERMAL INSULATION".
- 7.0 **Testing**
- 7.1 Hydraulic testing of piping shall be carried out before equipment connections are made. **No insulation shall be carried out unless and until the piping, is tested and tests approved.** Piping may be tested in sections, with the approval of the Engineer and in such cases all open ends shall be blanked off with necessary flanges.
- 7.2 All piping shall be tested for pressure equivalent to the following:
1.25 x No - delivery head of the pump plus the gravity head due to expansion tank or cooling tower.

In such a pressure test, the system shall hold for a minimum period of 3 hours. All pipe testing shall be witnessed and certified by the Engineer- in- charge and leaks or defects found in the joints shall be rectified.
- 7.3 The contractor shall make all arrangements for testing & removal after testing of all water connections, if any, without causing any damage to the property of the employer or any other contractor. The damages if any during testing to owner's or others property shall be made good by the contractor and the contractor will be responsible for all the consequential damages.
- 7.4 After the entire piping has been tested and equipment connected, the system of water piping shall be filled and drained till all the dirt, milscale and any other foreign matter including chemical cleaning and addition of rust inhibitors(process methodology shall be approved before commencing the work) is flushed out to the satisfaction of the Engineer-in- charge **At any rate, the system shall be flushed atleast 3 times before commissioning.** All strainers shall be cleaned of all accumulated dirt before the system is finally charged.
- 8.0 **Mode of measurement**
- 8.1 All pipes shall be in unit length rounded off to the nearest centimeter and measured along the center line of the pipe and all fittings, flanges etc. excluding the flange to flange distance of valves, strainers or any other equipment. The rate shall include all clamps, bolts etc. cutting holes in ceiling, floor or wall and making good the same including scaffolding, staging supports, flexible etc. and painting of piping as per the painting specifications.
- 8.2 All valves, strainers etc. shall be measured per unit in each size and paid for.
- 8.3 All pressure gauges complete with socket, gauge cock and pressure gauge and CP brass capillary shall be measured per unit.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 8.4 Thermometers together with thermowell, conducting fluid etc. shall be measured as one unit.
- 8.5 Air vents and drains shall each be measured per unit and paid for. Auto air vents with cooling coils / equipment shall form part of the coil or equipment.

8. TECHNICAL SPECIFICATION FOR MOTOR & ELECTRICAL INSTALLATION

1.0 **Scope of work**

- 1.1 The scope of work covers, selection, supply, installation, testing and commissioning all electrical items of work comprising:
- i) Drive motors & starters ii) Cable laying
& iii) Protective Earthing (PE)

2.0 **Ratings**

- 2.1 All motor, switchgear, cable and PE ratings shall comply with the data sheets and the specification. Where higher ratings are required to match equipment offered, the tenderer may provide accordingly and bring out the fact specifically.
- 2.2 Ratings shall be at the ambient conditions specified. Motors shall comply with IS:325 or equivalent BSS revised upto date. All motors shall be statically and dynamically balanced and shall be selected for low noise levels. Ratings shall be suitable for the complete operating range of the equipment concerned and should not cause overloading
- 2.3 Switchgear and starters shall be rated for the equipment and system fault levels. Protective Earthing shall be consistent with the over current tripping devices.

3.0 **Squirrel Cage Induction Motors**

- 3.1 Stator cores shall be made up of low loss high permeability sheet steel laminations. Stator windings shall be made of electrolytic copper with class B/E insulation and inserted as formed coils baked in position. Rotors shall be of die cast aluminium or copper cage construction.
- 3.2 Roller bearings at the drive and ball bearings at the free end shall be provided.
- 3.3 Motor windings shall be air cooled by means of shaft-mounted fan, designed for quiet operation. Enclosures shall be as shown on the data sheets or as required.
- 3.4 Motors, specially for air handling unit and fan drives shall be selected for low sound power level. Efficiency shall be standard (IS – 8789-1996) or High efficiency (IS 12615 – 2004) as stated in the data sheets.

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4.0 **Starters**

4.1 The starter selections shown in the relevant data sheets shall be used as a general guide. Where the load torque demands higher starting torque, motor and starter shall be accordingly selected.

4.2 Direct to line or Wye Delta or autotransformer starters shall be air insulated totally enclosed metal clad. Wye Delta starters shall be automatic change over type.

4.3 All starters shall have:

- i) Adjustable thermal over load trips on all phases. ii) Single phase preventing device
- iii) Under voltage protection (80%)
- iv) Latch-on contacts with trip mechanism to indicate fault tripping

4.4 Solid state soft starters, wherever specified, shall be of tested and approved makes.

5.0 **Variable Frequency Drives**

5.1 **Standards**

5.1.1 Equipment must comply with recognised, international standards, and the manufacture must be carried out in accordance with ISO 9001 and BS 5750, parts 1 and 2. The VFD must comply with EMC and RFI requirements according to EN 55011 (VDE 0875), and the supplier must be willing to issue a certificate of such compliance.

5.2 **Mechanical Protection**

5.2.1 The VFD must have a metal enclosure which will meet the requirements of IP54 unless specified otherwise in the schedule of work to ensure that an extra enclosure is not necessary and have integrated fans as required. The supplier must provide information on heat dissipation.

5.3 **Operating parameters**

5.3.1 The VFD must be able to operate under the following conditions:

- a) Rated input voltage 400V +/- 10%, 3 phase, 50 Hz +/- 2 Hz b) Ambient temperature as specified.

The VFD must be suitable for manual as well as remote control.

5.4 **Technical features**

5.4.1 The VFD must be able to supply the motor with a sine shaped supply and fully circular magnetic flux to obtain full motor torque at rated frequency, without the motor becoming warmer than in normal mains operations.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.4.2 The VFD must be able to vary the output frequency from 0 to 100 Hz and output voltage from 10% to full mains voltage even at -10% of full mains voltage. The VFD must regulate the output to continuously adapt as the case may be to the current load on the pump or the fan so as to minimise energy consumption.
- 5.4.3 The VFD must be able to work as a Stand-Alone unit, where all safety requirements have been fulfilled, or as part of a larger BMS system (Building Management System), where the control is centralised and operated via serial communication using the integrated RS 485 ports.
- 5.4.4 The control panel must be detachable and be able to function in a central control panel, if used.
- 5.4.5 The VFD must be able to regulate all types of motors without load reduction and without the motor temperature becoming higher than under normal mains operation.
- 5.4.6 The VFD must be able to control motors of different sizes connected in parallel, and it must be possible to stop a machine during operation without the risk of tripping. The VFD must be able to run without the motor being connected, for the purpose of servicing. Servicing must not require access from the back of the VFD.
- 5.4.6.1 The following features should be incorporated in the VFD.
- a. Alphanumeric display (alphanumeric code)
 - b. Light diodes indicating "ON." and "ALARM"
 - c. Choice of 12 different displays, eg. of output current, voltage, frequency, speed, output, torque, motor temp., energy kwh.
- 5.5 **Design features of the VFD**
- 5.5.1 The VFD must be able to avoid at least 4 bypass frequencies with adjustable bandwidth to avoid mechanical resonance.
- 5.5.2 The VFD must have filters in the intermediate circuit to ensure that the 5th harmonic transmitted to the mains supply is limited to approx. 30%.
- 5.5.3 The current limiting function must be quick enough for the VFD to resist short-term earthing and short circuiting on the output terminals without any damage to the components.
- 5.5.4 The VFD must have integrated protection against the mains transients in accordance with VDE 0160, single phasing, in the mains or motor, or short-circuiting of motor phases. If the speed reference is lost, it must be a programming option to either maintain the motor speed or regulate to stop.
- 5.5.5 The VFD must be able to give off a warning or stop the motor if the motor is overheated. This function must form an integral part of the VFD. Consequently, a thermistor in the motor must not be required.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.5.6 The output circuit is to ensure the possibility of unlimited switching between VFD and motor regardless of load and speed, without any damage to the VFD, and without extra equipment being required.
- 5.5.7 The VFD must have an override function which in the case of overloads during operation and starting reduces the motor current to prevent damage.
- 5.5.8 The VFD must have a power factor of 1 on the supply side (AC) at all loads and speeds; extra AC coils for stable operation must not be required.

5.6 **Protection features**

5.6.1 The following protection shall be provided:

- a) Inverter trip at 75 C on the heat sink.
- b) Protection against undervoltage
- c) Protection against overvoltage
- d) A lock to prevent unintended programming of the VFD.

5.7 **Product Support**

- 5.7.1 The supplier must be able to provide technical documentation, covering both catalogues and statements of dimensions and weight.
- 5.7.2 The local dealer must be able to provide full technical and maintenance assistance with full complements of spares.

6.0 **Motor Installation**

- 6.1 Motors and driven equipment shall be mounts on a common base and coupled through flexible couplings or multiple V-belt drive. Coupling and belt drives shall be provided with suitable safety guard.
- 6.2 Final wiring connections to motors shall be flexible.
- 6.3 Where motors are installed away from the starter.

7.0 **Motor Control Centres & Power Panels**

- 7.1 All motor control centres and power panels shall be cubicle type fabricated from a combination of 14 & 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and modular construction suitable for 3 phase 415V 4 wire 50 Hz system. All boards shall be accessible from the front for the maintenance of switch fuses, bus bars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meters etc. All sheet shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with two coats of synthetic enamel of approved colour applied over one coat of

ANNEXURE-E1 TECHNICAL SPECIFICATION

red oxide primer. Engraved plastic labels shall be provided indicating the feeder details, and capacity and danger signs.

- 7.2 The boards shall accommodate air-insulated bus bars, air circuit breakers, switch fuse units with HRS fuses, starters, necessary meters, relays contactors etc. As required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.
- 7.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an interlocked door with facility for pad-locking. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 2147/1962. Feeder connections shall be made out of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required. Internal wiring, bus bar markings etc. Shall conform to IS: 375/1963. Internal wiring shall have terminal ferrules. Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75m from floor level. Cable glands need not form part of the switch board as the cost of glands will form part of the cable termination.
- 7.4 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy as specified and shown on drawings and rated for a temperature rise of 30 °C over the ambient temperature specified, based on insulated conductor rating (IS:8084-1976). Neutral bars may be of one half the size of the phase bars. The main horizontal bus bars shall be of uniform cross section and rated in accord with the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to-bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hygroscopic insulated blocks to withstand thermal and dynamic overloads during system short circuits. An earth bus of size 50% of the phase bar subject to a minimum of 15 x 3 Cu or 25 x 3 Al. shall be provided. Individual switch components shall be connected with the earth bus through copper or aluminium or galvanised steel strip size as shown. All wire connections to bars shall be through lugs, bolts and nuts and spring washers.
- 7.5 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.
- 7.6 Panels shall be installed on a base channel frame and on a concrete pad to be provided by others. All panels shall be meggar-tested and shall not be commissioned till the

ANNEXURE-E1 TECHNICAL SPECIFICATION

valves are more than 2.5 megohms phase to phase and 1.5 megohm phase to neutral. All meters on the panel shall be calibrated before commissioning.

7.7 The general arrangement and fabrications drawings shall be got approved before taking up for fabrication.

8.0 **Cabling**

8.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards. All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm centres

8.2 Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

8.3 Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be fixed directly to walls or ceiling and supported at not more than 500 mm. Where number of cables are run, necessary perforated cable trays shall be provided wherever shown. Perforated cable trays shall be mild steel or Aluminium as specified in the schedule of work. Perforated trays shall not be directly suspended but supported on mild steel frame work as shown on drgs. or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic identification tags shall be provided at every 20m. Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

8.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid in an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles. Width of excavated trenches shall be as required. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cables markers at every 30 meters and at all loop points.

8.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

ANNEXURE-E1 TECHNICAL SPECIFICATION

8.6 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

9.0 **Equipment earthing**

9.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<i>Size of phase conductor</i>	<i>Copper</i>	<i>Aluminium</i>	<i>Galvanised steel</i>
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs. > Minimum (base)	
	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

The earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

9.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

9.3 Armoured cables shall be earthed by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 P h. D B's a single earth connection is adequate. Similarly for 3 Ph and 1

ANNEXURE-E1 TECHNICAL SPECIFICATION

Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

- 9.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

10.0 **Electrical Installation**

10.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

10.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

11.0 **Mode of measurement**

11.1 Each electric panel or motor control centre shall be separately quoted and paid for. The cost of panel shall include earthing as specified and include for mounting of starters wherever required and shown or as shown in the schedule of work.

11.2 Cables will be measured on the basis of a common rate per unit length and shall include the following items.

Laid in doors i) cables and clamps ii) cable markers

Laid out doors i) cables and protective bricks & tiles

11.3 Cable trays/racks/ladders shall be measured per unit length and width as specified in the schedule of work.

11.4 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

- i) Cable glands, lugs, bolts, nuts ii) All jointing materials
- iii) Installations, testing and commissioning iv) Earthing the glands

11.5 For cables burried under ground excavation shall be paid for additionally for the following per unit volume:

- i) Excavation and back filling
- ii) 6" Soft Earth Cushioning below and above cable

ANNEXURE-E1 TECHNICAL SPECIFICATION

The cost of laying protective tiles shall be part of cable cost.

11.6 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

- a) Motors - earthing forming part of the cabling/wiring for the motors.
- b) Isolating switches and starters should form part of mounting frame, switch starter etc.

9. TECHNICAL SPECIFICATION FOR THERMAL INSULATION

1.0 **Scope**

1.1 The scope of work covers thermal insulation for:

- a) Cold Insulation
 - i) pipes
 - ii) ducts
- b) Hot Insulation
 - i) pipes
 - ii) ducts

2.0 **Material**

2.1 Following materials shall be used:

- a) Cold Insulation
 - Closed Cell Elastomeric Nitrile Rubber with a thermal conductivity of not more than 0.03 w/m°C at 24°C and suitable for a service temperature of -40°C to 105°C and moisture diffusion resistance factor or 'μ' value shall be minimum 10000.
 - Material to be anti-microbial which is EPA (Environmental Protection Agency) approved and as an integral part of insulation which cannot be washed or worn off. Protection against microbes such as bacteria, mold, mildew and fungi shall conform to following standards :
Fungi Resistance- ASTM G21 and Bacterial Resistance – ASTM G22/ASTM 2180.
 - The insulation shall have fire performance such that it passes Class 1 as per BS 476 Part 7 for surface spread of flame and also pass fire propagation requirement as per BS476 part 6 to meet Class 'O' Fire category.
 - Material shall be FM/UL approved.
- b) Hot Insulation
 - Same as cold insulation
- c) Coatings
 - i) Indoor Application :- Treated Woven Glass Cloth

ANNEXURE-E1 TECHNICAL SPECIFICATION

(supplied by Insulation Manufacturer) suitable for temperature range of 50°C to 105°C

Outdoor Application :- For protection against mechanical impact and UV attack non-metallic flexible polymeric barrier with a high resistance to oil and chemicals suitable for temperature range 0°C to 130°C , moisture resistance factor μ ;50000 and density of 1.6kg/ltr (+/-50g).

Alternatively UV paint coupled with chop strand mat and finished with UV paint may also be used.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- | | |
|---------------------------|--|
| d) Adhesive | i) Duct Application: It shall be rubber based, solvent proofcontact adhesive free from benzene and having low VOC. It shall be quick drying characteristics for tropical conditions and shall have service temperature of 0°C to 85°C.It shall be supplied by insulation manufacturer.
ii) Pipe Application: It shall be modified rubber adhesive in a blend of solvents, free from benzene having low VOC and viscosity. Adhesive to have water vapour resistance and service temperature same as of insulation. |
| e) Vapour barrier coating | Not Applicable |

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3.0 Air Duct Insulation

3.1 Duct located INDOOR spaces shall be insulated to the following thickness:

	Location	Layer	Thickness	Material
a)	Non-air conditioned spaces			
i)	Cold supply duct with air at 12 ⁰ C		25mm	Class O Nitrile Rubber
ii)	Cold return duct with air at 24 ⁰ C	One	25mm	Same as above
b)	Air conditioned spaces			
i)	Cold Supply duct with air at 12 ⁰ C	One	19mm	Class O Nitrile Rubber
ii)		One	13mm	Same as above

3.2 Nitrile Rubber for duct insulation shall have aluminium foil reinforced with glass cloth and applied as follows:

- Clean the duct surface & apply thin film of adhesive on the back of the insulating material sheet and then on to the metal surface.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
- Treated woven glass cloth shall be cut to size as per duct perimeter with an additional 50mm for the overlap of the covering material.
- Spread thin film of adhesive on the 50mm overlap and close the seam

3.3 Duct insulation for OUTDOOR spaces shall be as follows:

	Material	Thickness (mm)	Layers
	Supply & Return ducts (at 12 – 24 ⁰ C)		
	Extruded polystyrene / Phenolyc foam	50	One
	Polyurethane	25	One
	Nitrile Rubber	25	Two

3.4 Outdoor insulation consisting of expanded polystyrene, phenolyc foam & polyurethane shall be applied as follows:

- Clean the duct surface and apply two coats of hot bitumen at 1.5kg/sqm for two coats.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- b) Stick self adhesive insulation holding pins to all ducts.
 - c) Stick insulation slabs & hold at 1000 mm centre with 1.0 mm dia galvanised steel wire or PVC strapping & blind the surface with hot bitumen at 1.5 kg/sqm. Seal the joints with sealant.
 - d) Wrap 500g polythene faced hessian & seal with hot bitumen.
 - e) The finish shall consist of 12mm sand cement plaster (1:3) with a mixture of water proof compound finished smooth over 20 mesh 0.63mm thick galvanized chicken wire mesh.
- 3.5 Outdoor duct insulation consisting of nitrile rubber shall be applied as follows:
- a) Clean the duct surface & apply thin film of adhesive on the back of the insulating material sheet and then on to the metal surface.
 - b) When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
 - c) Flexible polymeric covering cut to size with additional 50mm for overlap shall be wrapped around the insulation and overlap securely fixed using manufacturer's recommended adhesive.
 - d) Spread thin film of adhesive on the 50mm overlap and close the seam
 - e) Alternately instead of polymeric covering UV resistant paint shall be applied on the insulation which is then covered with chopstrand mat and finally finished with a top layer UV resistant paint.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.0 **Pipe Insulation**

4.1 **Cold Insulation**

4.1.1 Cold pipe insulation shall be selected as follows for INDOOR spaces:

Application	Thickness (mm)	Layer (No.)	Pipe (mm dia)	Material	
i) Chilled water supply & return	13	One	12-25	Nitrile rubber tube	
	19	One	32-65	Nitrile rubber tube or sheet	
	32	Two	80-100	Nitrile rubber sheet	
	50	Two	150 & above	Nitrile rubber sheet	
	OR				
	50	One	32 to 250	Expanded polystyrene pipe sections	
	75	50 + 25	Over 250	- do -	
ii) Refrigerant suction (a) 3 to 5 ^o C suction	13	2 x 25	Upto 25	Nitrile Rubber tube	
	25	One	Over 25	- do -	
	25	One	All sizes	- do -	
iii) Coil drains					
	(a) 10 ^o C	One	"	- do -	
	(b) 3/5 ^o C	One	"	- do -	
	(c) -20 ^o C	One	"	- do -	

4.1.2 Extruded polystyrene insulation shall be carried out with preformed pipe sections. The surface of the pipe shall be rendered dry and clean. Hot bitumen shall be applied uniformly at the rate of 1.5 kg/sqm. A similar layer of bitumen is applied on the inside surface and on the edge of the pipe section. All joints shall be staggered and sealed with sealant. Polythene faced hessian shall be wrapped and fixed in hot bitumen with an over lap of 75mm. The finish shall consist of treated woven glass cloth and 12mm sand cement plaster (1:3) with a mixture of water proof compound finished smooth over 20 mesh 0.63mm thick galvanized chicken wire mesh.

4.1.3 Elastomeric insulation like nitrile rubber shall be in tube form and applied as follows:

- i) Clean the pipe surface thoroughly
- ii) Slip the tubing or slit the tube and snap on the pipe.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- iii) Seal the joints with insulation manufacturer's recommended adhesive and applied as recommended by manufacturer.
 - iv) Adhesive must be allowed to tack dry and then press firmly together starting from butt ends and working towards centre.
 - v) Wherever flat sheets are used it shall be cut out to correct dimension. All longitudinal and transverse joints shall be sealed with sealant as recommended by manufacturer.
 - vi) The insulation shall be continuous over the entire run of piping, fitting and valves.
 - vii) All valves ,fittings, joints, strainers, etc in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced. Alternatively, valves may have a galvanized sheet steel box with foamed in polyurethane foam to the required thickness.
 - viii) Treated woven glass cloth (supplied by Insulation manufacturer) shall be cut to size according to the circumference of the insulated pipe with an additional 50mm for the overlap of the covering material. Spread thin film of adhesive and close the seam.
 - ix) Fittings shall be covered as per manufacturer's recommendation but to the same standards as the covering of insulated pipe.
 - x) The manufacturer's trained installer shall only be used for installation.
- 4.1.4 OUTDOOR piping insulation procedure for polystyrene foam shall generally follow the procedure for the INDOOR piping but the finish shall be in cement sand plaster with Aluminium cladding.
- 4.1.5 OUTDOOR piping insulation procedure for nitrile rubber shall be same as INDOOR piping but the finish shall be non-metallic flexible polymeric covering system for protection against UV and mechanical damage. All seam and transverse joints shall be covered with manufacturer recommended mastic.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.1.6 Cold pipe insulation shall be selected as follows for UNDERGROUND application:

	Application	Thickness (mm)	Layer (No.)	Pipe (mm dia)	Material
i)	Chilled water supply & return	50	25 + 25	12-250	Extruded Polystyrene - do -
		75	50 + 25	Over 250	
		50	50	32 to 250	Polyurethane foam - do -
		75	75	Over 250	

4.1.6 UNDERGROUND piping insulation shall follow the same procedure as for indoor pipes with the final finish being sand cement plaster.

4.2 Hot Insulation

4.2.1 Hot pipe insulation shall be selected as follows:

	Application	Thickness (mm)	Pipe (mm dia)	Material
a)	Hot water pipe not exceeding 80 deg C	9	12- 20	Nitrile Rubber
		13	25	
		25	50 & above	Nitrile rubber
b)	Steam piping for saturated steam at less than 1 kg/scm (100 deg. C)	25	12 – 40	- do -
		38	50 – 150	
c)	Steam piping for saturated Steam at 3 kg/scm (145 deg C)	50	12 – 75	Unbonded Fibre glass
		75	100 & over	
d)	Steam piping for saturated steam at 10kg / scm (185 deg C)	75	All sizes	Unbonded Fibre glass
e)	Thermic fluid at 250 deg C	75	All sizes	Unbonded Fibre glass
f)	Condensate piping	25	12 – 40	EPS 'or' Phenolyc foam
		38	50 – 150	

ANNEXURE-E1 TECHNICAL SPECIFICATION

All insulation to be in one layer

- 4.2.2 Insulation shall be in pipe sections with reinforced aluminium foil face. The pipe shall be thoroughly cleaned with wire brush and the surface rendered free from rust. The cleaned surface shall be painted with one coat of bitumastic paint and the insulation applied with staggered joints. The insulation joints shall be sealed with adhesive tape and held in position with 1.0 mm wire at 600 centres and finished with aluminum cladding as specified below.
- 4.2.3 Phenolyc foam insulation shall be applied over the cleaned pipe surface and finished with aluminium cladding as specified below.
- 4.2.4 Unbonded fibreglass shall have backing of galvanised wire netting. The pipe shall be thoroughly cleaned before the fibre glass blanket is wrapped round and held in position by 1.0 mm galvanised steel wire laced through the wire netting. The insulation shall be finished in aluminium cladding
- 4.2.5 Pipe insulation shall be clad with 0.5mm aluminium sheet with 50 mm overlapping joints. Cladding shall be tightly bonded to the insulated pipes with necessary grooves and held in position with 12 mm No.8 sheet metal screws.

5.0 **Equipment, Vessels & Tanks**

- 5.1.1 Insulation of Pumps for cold applications shall be the same as for the connected pipes. The pump surface shall be thoroughly cleaned and painted with one coat of bituminous paint. Hot bitumen is applied at 1.5 kg/sqm and the insulation slabs are cut and stuck to covered the entire surface. All joints shall be sealed and the insulation covered with 20 mm x 0.63 mm galvanised steel wire mesh and covered with a thick layer of hot bitumen and then clad with 0.8 mm aluminium sheet using sheet metal screws. Pump insulation and the cladding shall be carried out in such a manner that pump split sections (Wherever applicable) or pipe connections could be disconnected without disturbing the pump insulation. Alternatively, pumps may have a galvanized sheet steel box with foamed –in polyurethane foam to the required thickness.
- 5.2 Insulation of pumps for hot application shall be the same as for connected pipes and application similar to cold application. The insulation shall be held in position with wire netting as above but shall not be covered with hot bitumen. Aluminium cladding shall be done over the insulation.
- 5.3 All vessels and tanks shall be insulated according to the connected pipe. All vessels & tanks shall be thoroughly cleaned with wire brush and rendered free of milscale. Apply the surface with hot bitumen at 1.5 kg/sqm and stick the rigid insulation (in segments for cold insulation) holding it in position with 20mm x 0.63 mm galvanised wire mesh. Apply hot bitumen at 2.5 kg/sqm over the finished surface and wrap it with 6mm tar felt with 50mm over lapping. Retain the tar felt with 1 mm galvanised steel wire and finish with 0.63 thick aluminum cladding. For nitrile rubber the insulation shall be similar to pipe installation with minimum 50mm thick and detailed procedure of application shall be got approved by Consultant before execution.

6.0 **Under deck roof insulation (N.A)**

- 6.1 Under-deck insulation shall be carried out using Phenotherm 35kg / m³–or

ANNEXURE-E1 TECHNICAL SPECIFICATION

48 Kg/m³ resin bonded fibre glass rigid boards so that the R-value of the insulation should be not less than R3.5m².C/w for 24 hours occupied building & R2.1m².C/w for 12 hour occupied buildings. This is generally equivalent to 75mm and 50mm extruded polystyrene respectively.

6.2 The surface shall be thoroughly cleaned with wire brush. 75x 75 x 0.8 mm channel runners shall be provided at 600 mm centre to centre spacing. Apply hot bitument at 1.5 kg/sqm and stick the slabs between the runners blinding both sides of the slab with bitumen at 2kg/sqm. hold the slabs in position with 20 x 0.63mm galvanised wire netting. Finish the insulation in the manner specified below.

6.2 Under deck roof insulations finished neatly with 10mm gypsum board and fixed with sheet screws or as specified in schedule of work.

7.0 **Over deck roof insulation with extruded polystyrene shall be applied as follows:**

- i) The U-factor of the insulation shall be the same as for under deck insulation and applied as specified below.
- ii) Clean the surface of the roof slab thoroughly.
- iii) Spread industrial air blown bitumen 85/25 conforming to IS 702-1961 uniformly on the concrete surface at the rate of 2.5 kg/sqm.
- iv) Press heavy density (20kg/m³) extruded polystyrene slabs of following thickness.
 - i) 75mm for 24 hours occupied premises
 - ii) 50mm for 12hour occupied premisesExtruded polystyrene should have a conductivity of not more than 0.03 w/m°C at 10 deg.C mean temperature.
- v) Seal all the joints between adjacent slabs with bitumen and cover the surface with "Sealfas" 2 coats with MAST-A-FAB to build up to 3mm thickness.
- vi) Lay 20 mm thick sand cement plaster (ratio 1:4) over 22 gauge 20 mm galvanised chicken wire mesh.
- vii) Build cement mortar fillet all round at the junction of the roof slab and the parapet walls. This is done by constructing a fillet of cement plaster at the junction of roof slab and parapet walls.

8.0 **Insulation under raised false floor shall be carried out as follows:**

- i) Clean the surface thoroughly and make it free from dust and other particles.
- ii) Place 25mm thick nitrile rubber, with specified rubber – based specified adhesive. Entire assembly shall have class O fire rating.
- iii) Give two coats of suitable polyurethane paint to render the surface dust proof.

ANNEXURE-E1 TECHNICAL SPECIFICATION

9.0 **Mode of Measurement**

- 9.1 All duct insulation shall be measured on the basis of the duct prime surface area and excluding all openings for grilles, diffusers but including all flanges, dampers etc.
- 9.2 In case of bends, tapers etc. the duct prime surface shall be determined on the basis of average dimensions.
- 9.3 All pipe insulation shall be in linear measure along the centre line of the pipe, over all fittings, excluding flanges and valves.
- 9.4 Each independent flange insulation shall be measured as 300 mm equivalent length of piping. Insulation of flanges associated with equipment (equipment and mating flange) and valves (flanged or screw-ended valves with flanged tail pipes) shall form part of the valve or equipment.
- 9.5 Insulation of valves together with the flanges as above shall be measured as 600 mm long equivalent length of piping.
- 9.6 All pump insulation shall be measured as 1500 mm long piping of diameter equal to the suction size of the pump and this shall include the cost of insulation of the suction and discharge flanges.
- 9.7 All equipment and roof and floor insulation shall be measured on the prime surface of the area to be insulated.

10. TECHNICAL SPECIFICATION FOR SHEET METAL DUCTING

1.0 **Scope**

1.0 **Scope**

- 1.1 The scope of work covers supply, installation, testing, balancing and commissioning of:

- i) Sheet metal ducting
- ii) Volume, Smoke and Fire dampers
- iii) Outside intakes & exhausts louvers
- iv) Grilles and diffusers
- v) All other accessories

associated with air-conditioning ventilation and exhaust systems meeting the intents of specifications & drawings

- 1.2 Kitchen Exhaust systems are covered under a separate section.

2.0 **Standards**

ANNEXURE-E1 TECHNICAL SPECIFICATION

2.1 All duct work shall conform generally to the following standards & codes.

IS:277	Galvanised sheet steel
IS:655	Metal Air Ducts
IS:1079	Hot rolled carbon steel sheets
IS:513	Cold rolled low carbon steel sheet
SMACNA	duct construction standards as modified herein

3.0 **Submittals**

3.1 The contractors should submit shop drawings of all duct systems after a thorough survey of the space, obstructions and other services elements. The shop drawings should indicate the following information:

- i) Source of manufacture and place ii) Pressure class of ducting
- iii) Bills of materials showing the duct areas in sq. meters for each system under each category of sheet thickness.
- iv) Schedule of grilles and diffusers, dampers, Intakes and exhausts.

3.2 Catalogue cuts of all grilles and diffusers, dampers proposed to be used shall be submitted and got approved.

4.0 **Material**

4.1 The material for various applications of air ducting shall be as follows:

Application	Material
1) Ducting for <u>Air-conditioning</u>	Cold rolled sheets continuous galvanised with a zinc coating of minimum 275g/m ² both sides inclusive to IS 277-1977 in the form of sheets or rolls of lock forming quality.
2) Duct for ventilation & Exhaust	- Do -
3) Gasket	Foamed PVC 6 mm
4) Supports & duct flanges	Galvanised steel structural steel sections

4.2 All galvanised plain sheets or rolls shall be reasonably flat and free from twist. The zinc coating shall be clean, even and free from galvanised spots. Sheets shall not crack

ANNEXURE-E1 TECHNICAL SPECIFICATION

or peel during bending or fabrication. All sheets or rolls shall be procured from approved manufacturers.

5.0 **Duct Fabrication and Erection**

5.1 All ducts for air-conditioning and ventilation shall be rectangular in cross-section and fabricated for a pressure class of 500Pa positive and negative. **Preference will be given to ducts fabricated in a factory with CNC controlled machinery. These ducts must be brought to site in full duct form and not L shape and assembled at site.**

5.2 Ducts shall be rectangular with dimensional tolerance of 1.5%. Insulated ducts are shown clear sizes after insulation and during fabrication the bare duct sizes shall be accordingly enhanced.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.3 The following are guidelines for the fabrication from galvanized sheets with transverse joints at 2500mm.

Maximum side (mm)	Minimum thickness (mm)	Transverse Joints	Reinforcement
Upto 250	0.63	25mm S – Slip	-
Over 250 to 400	0.63	25 mm standing	- S – Slip
425 to 600	0.63(24 G)	40mm X 1.00mm Standing S	Same as transverse joint.
625 to 800	0.80(22 G)	40mm X 1.25mm Standing S	Same as transverse joint.
825 to 1000	0.80(22 G)	40 x 40 x 4 mm Companion flanges	25x25x3.2 mm Girth angles @ 1200 mm
1025 to 1500	1.00(20 G)	40 x 40 x 4mm Companion flanges	40 x 40 x 4 mm Girth angles @ 1200 mm
1525 to 2250	1.00(20 G)	50 x 50 x 6 mm Companion flanges	40 x 40 x 4 mm Girth angles @ 600 mm
2275 & above	1.25 (18 G)	50 x 50 x 6 mm Companion flanges	50 x 50 x 4 mm Girth angles @ 600 mm

Longitudinal joints shall be Pittsburgh lock or button punch snap lock. All joints shall withstand 1.5 times the pressure class specified. Duct deflection shall not exceed 6mm for ducts upto 1200mm width.

5.4 For ducts fabricated from coil stock (Transverse Joints every 1000mm approx)

ANNEXURE-E1 TECHNICAL SPECIFICATION

Maximum side (mm)	Minimum thickness (mm)	Transverse Joints	Reinforcement
Upto 450	0.63	C & S or C & SS cleats at 1200mm spacing	Beading
475 to 600	0.63	4 Bolt slip on flanges E class at 1200mm spacing	Beading
625 to 1000	0.80	4 Bolt slip on flanges E class at 1200mm spacing.	Beading
1025 to 1800	1.00	4 Bolt slip – on flanges H class at 1200mm spacing	Beading
1825 to 2250	1.00	4 Bolt slip –on flanges J class at 1200mm spacing	Beading

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.5 In odd positions, the ducts shall be fabricated to suit the site conditions, with the specific approval of the Engineer-in-charge. The aspect ratio shall not exceed for any fabrication.

5.6 Where specified and shown on drawings, round ducts may be used conforming to the following specifications.

Max diameter	Minimum Gauge		Reinforcement	
	Spiral Seam	Long Seam	Spiral Seam	Long Seam
Upto 200 dia	0.55 (26G)	--	0.70 (24 G)	--
Above 200 upto 600 dia	0.70 (24G)	--	0.70 (24 G)	--
Above 600 dia upto 900 dia	0.85(22G)	--	0.85(22G)	Girth angle
Above 900 dia upto 1500 dia	0.85(22G)	--	1.00(20G)	Girth angle
Above 1500 dia	1.00(22G)	Girth angle	N.A	Companion Flanges

5.7 Ducting shall be seam locked, spiral or longitudinal as indicated in the layout / construction drawings. Spiral ducts shall have four ply lock seam only. Snap lock seam will require specific approval of consultant / engineers in charge longitudinal seam ducts shall have groove seam only.

All transverse joints for longitudinal and spiral ducts shall be with beaded sleeves of equivalent gauge thickness.

Joints must be screwed or pop riveted at uniform intervals of 300mm along the circumference.

5.8 Flexible ducts shall be used only as connectors and should not be more than 1200mm in one length. Duct attachment collars should be minimum 50mm in length and attached with minimum of 3# M8 screws for lower than 300 dia and 5# for 300 and higher sizes. Insulation shall be factory applied and held in position through a draw band.

5.9 Girth angles and companion flanges shall be mitered and welded at corners and riveted to duct sheets at 75 mm centres. Flanged joints shall be made with 9.5 mm GI bolts spaced at 100 mm centres and provided with 6mm foamed PVC gasket. All joints and seams shall be rendered air tight with sealant. Duct panels are not to be cross-broken, if insulated. Longitudinal seams shall be inside groove or pittsburgh type.

5.10 Standard elbows with a R/D ratio of not less than 1.25 shall be used as far as possible. Where space restrictions do not permit use of standard radius, elbow with lesser R/D

ANNEXURE-E1 TECHNICAL SPECIFICATION

ratio and square elbow with equally spaced double thickness vanes may be used. Length of taper ducts shall be at least four times the maximum size difference between the ends.

- 5.11 All duct fabrication and installation shall conform to the extent modified herein, to the SMACNA standard for Low Pressure Duct Construction upto 75mm pressure. All transverse joints shall be sealed with non-hardening mastic sealant.
- 5.12 All duct lining for acoustic insulation shall be carried out as specified under section "NOISE & VIBRATION" before the duct is installed in position.
- 5.13 All ducts shall be sealed to SMACNA class C 24 and 10% of ducting of at least two fan systems shall be proof – tested in the presence of the Project Engineer / Manager and leakage readings recorded and attested.

6.0 **Sheet Metal Duct Accessories**

6.1 Turning vanes

- 6.1.1 Air turning devices shall be provided at least for first four outlet collars after every elbow and at all non-split branch take offs. Turning blades shall be fabricated out of 0.8 mm (22G) thick G.S sheets and equally spaced on side runner to be riveted/bolted to duct sheets. All vanes shall be of double thickness.

6.2 Splitter dampers

- 6.2.1 Splitter dampers shall be installed in branches wherever split takes place. Splitter dampers shall consist of double thickness air foil blades hinged at the downstreams edge. The operation rod shall terminate outside of the duct and insulation, and an air tight hub and locking set screw shall be provided. Damper blade thickness shall be the same as the duct in which it is installed but not less than 1.5 mm. Entire splitter damper shall be enclosed in a sheet steel ducting with flanges at both ends aligning with main run of ducting. The enclosure shall be made of sheets one size larger than the upstream duct.

6.3 Louvre dampers

- 6.3.1 Louvres dampers shall be provided in all branches. Any duct feeding more than four outlets shall be regarded as a branch and louver dampers provided whether shown or not.
- 6.3.2 Louvre dampers shall be multi-blade type with opposed blades or parallel blades of air foil construction rotating in permanently lubricated ball/ roller bearings. Blades shall be 1200 x 250 maximum mounted in a channel frame. Blades shall be connected with suitable linkage for gang operation by an operating rod extending beyond the frame and insulation if any and terminating in a locking quadrant with damper position indicator. Damper larger than 1200 mm in width shall be furnished in multiple sections. Dampers shall be enclosed in a sheet steel box with flanges at both ends. Thickness shall be one size larger than the upstream duct.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.3.3 Dampers shall be manual or motorised as shown on drawings & schedule of work. All actuators shall be Belimo or equal rated for operation against static pressure of 650 Pa unless stated otherwise.

6.4 Fire dampers

6.4.1 Fire dampers shall be dynamic rated against minimum static pressure of 100mm WG and fire rated for 1 1/2 hours if installed in a 3 hr rated wall (225 brick wall) and 3 hour rated in higher rated walls. Dampers shall conform to UL 555 and shall be tested and certified by an appropriate authority. A test certificate shall be attached with each damper assembly.

6.4.2 Dampers shall be actuated through Belimo or equal. An access door shall be provided for accessing the damper & its mechanism. Damper open & closed positions shall be indicated.

6.4.3 Damper shall be installed such that the fire integrity of the partition is maintained. Sleeves, if any, used for mounting the damper shall be designed for the rated fire resistance and the opening in the partition fire sealed with an appropriate and approved sealant. Typical arrangement is shown in the drawing construction standards.

6.5 Smoke dampers

6.5.1 Smoke dampers are same as fire dampers but the leakage through the closed damper shall meet class II requirements under UL 555S while maintaining the fire rating.

6.5.2 Damper actuator and installation shall be similar to that of fire damper. Damper open and closed positions shall be indicated.

6.6 Duct supports

6.6.1 Duct supports and suspenders shall be galvanized steel and meet the following requirements:

Duct Width (mm)	Support	Hangar Rod (mm)	Location
Upto 1200	40 x 40 x 3 mm angle	8mm	At Transverse Joints OR Support length not exceeding 2500mm
Over 1200 - 1800	- Do -	10mm	- Do -

ANNEXURE-E1 TECHNICAL SPECIFICATION

Duct Width (mm)	Support	Hangar Rod (mm)	Location
Over 1800 to 2500	40 x 40 x 6 mm steel MS	12mm	At Transverse Joints OR Limiting Support length not exceeding 2500m
Over 2500	50 x 50 x 6 mm MS angle	12mm	At Transverse Joints OR Limiting support length not exceeding 1200m

ANNEXURE-E1 TECHNICAL SPECIFICATION

As an alternative slotted galvanized brackets attached to the top two bolts of the four bolt duct jointing system may be used.

6.6.2 Additional supports wherever considered necessary by the Engineer-in-charge shall be provided.

6.6.3 All duct supports, flanges, hangers shall be hot-dip galvanised after fabrication.

6.7 Duct connectors

6.7.1 Ducts connected to air-moving apparatus shall have flexible connectors. Flexible connectors shall be preassembled factory made units with minimum 150mm in width with 50mm galvanized steel rims on both sides. Connectors shall be mildew resistant and shall have fire retardant materials.

6.8 Duct penetrations

6.8.1 Ducts penetrations through walls, slabs or any other partitions shall be sealed as shown on drawings or as required.

6.9 Test Probes

6.9.1 Test probes shall be standard products. Probes shall be of Heavy duty Zinc alloy casting. Expansion plugs shall be of neoprene and capable of withstanding 80°C & 300 kPa.

6.9.2 Probes shall be installed at every fan discharge and suction duct.

7.0 **Air Intakes & Exhaust**

7.1 i) Unless shown otherwise, louvers shall be made of 3mm thick 100mm wide extruded aluminium sections fixed in an extruded aluminum frame. Louvers shall be fixed at 45⁰ to vertical and provide 60% minimum net opening.

ii) 15 x 15 x 1.0 mm galvanized steel bird screen shall form part of the intake or exhaust.

7.2 The entire assembly shall be fitted into the wall clear opening and the edges sealed with a polysulphide or silicone sealant. All frames and clamps used shall be hot dip galvanized or extruded aluminium.

8.0 **Air Diffusing Equipment**

8.1 Supply air grilles shall be double deflection type with horizontal face bars and vertical rear bars placed in a rigid marginal frame. Bars shall be shaped and spaced at 18mm centres with swaged pivot pins positively holding the deflection setting under

ANNEXURE-E1 TECHNICAL SPECIFICATION

all conditions of velocity and pressure. All grilles shall be provided with integral opposed blade, grille-face key operated dampers.

- 8.2 Return grilles shall have fixed face bars shaped and set at 18 mm (3/4) centres. Bars shall be set at 40 deg deflection for vision-proof installation. The grilles shall be complete with rigid marginal frames and shall be matching with the supply grilles.
- 8.3 Ceiling diffusers shall be round/square/rectangular face flush type horizontal air diffusion pattern. Diffusers shall have ample margins to minimize ceiling smudge. All diffusers shall be provided with face operated volume control dampers. Half diffusers shall be similar to full diffusers.
- 8.4 Linear diffusers/grilles shall be die formed, flush mounted type with single or double directional air flow. The diffuser /grille shall be in an extruded aluminum frame with minimum 20 mm margin. All linear air diffusing equipment shall be fitted with a distribution sheet metal plenum as shown on drawings.
- 8.5 Grille types are indicated in the drawings and equivalent types of any other standard manufacturer are acceptable. Mild steel grilles and diffusers shall be fabricated out of 1.0 mm mild steel and painted with two coats of red oxide. All duct collars terminating on to a grille or diffuser shall be given two coats of black paint for a length of 300 mm. Grilles & diffusers shall be selected for an aero-dynamic noise power not in excess of NC 30.
- 8.6 Aluminium grilles and diffusers wherever specified shall be of extruded aluminium with margins & GSS butterfly dampers. Grilles shall have horizontal face bars and vertical rear bars.
- 9.0 **Testing & Balancing**
- 9.1 Capped air-flow connections shall be provided as necessary for testing and balancing of air distribution.
- 9.2 The entire air distribution shall be adjusted and balanced for delivery of design air quantities or as required for achieving design space conditions. Tests shall be carried out for each fan or AHU section. After all adjustments are made, the air readings shall be recorded on the drawings vis-à-vis the space conditions. All dampers after adjustment shall be set and locked in position. All air and static pressure measurements shall be done through probe type meters. Vane type meter readings are not considered reliable.
- 9.3 After balancing the fan speed shall be suitably adjusted. Test readings should display static pressures before and after speed change.
- 9.4 10% of ducting from at least 2 –fan systems shall be tested to validate leakage.

ANNEXURE-E1 TECHNICAL SPECIFICATION

10.0 **Mode of measurement**

- 10.1 All sheet metal ducting complete with duct supports, turning vanes, canvas connections, erected in position shall be measured externally and paid per unit area. All dampers shall be excluded in the duct area.
- 10.2 All manual control / splitter damper sections with operations linkages locking quadrant, sheet steel enclosure, frame, erection, supporting etc. shall be measured on the basis of damper cross sectional area and paid per unit area.
- 10.3 Motorized control dampers with actuator are to be paid per unit of upto 0.3, 0.3 to 0.6, over 0.6 to 0.9, over 0.9 to 1.2 and over 1.2 sqm damper area.
- 10.4 Intake and exhaust louvers with bird screen, louvers and frame, erection & sealing shall be measured on the basis or cross sectional area and paid per unit area.
- 10.5 Side wall grilles shall be measured on the basis of the core area excluding the margins and shall include necessary dampers. Minimum payable unit is 0.1 sqm.
- 10.6 In line diffusers and grilles shall be measured per unit length. The back up plenum shall be measured as additional sheet metal ducting or part of the grille as defined in the schedule or work.
- 10.7 All fire and smoke dampers with operating linkage actuator, locking quadrant sheet steel enclosure, frame, fusible links, access door etc. shall be measured as one unit for upto 0.3, 0.3 to 0.6, over 0.6 to 0.9, over 0.9 to 1.2 and over 1.2 sqm damper area.
- 10.8 All duct liners for acoustic insulation shall be measured and paid as specified under 'NOISE & VIBRATION.'
- 10.9 Flexible ducts shall be paid per unit length of each diameter.

11. TECHNICAL SPECIFICATION FOR KITCHEN EXHAUST SYSTEMS

1.0 **Scope**

1.1 The kitchen exhaust systems consist of :

- 1) Kitchen range hoods (in Kitchen Consultants scope)
- 2) Exhaust round/rectangular ducting
- 3) Exhaust fans

2.0 **Kitchen Hoods**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.1 All kitchen hoods shall be fabricated from 1.0mm thick S.S 304 supported on galvanised steel frame work.. The type, size and height of hood and general construction shall conform to the details shown on the drawings or as approved.
- 2.2 The entire hood casing shall be welded and rendered air tight. An all- round grease gutter shall be provided with necessary slope towards valved drains as shown on drawings.
- 2.3 Grease filters shall be impingement, preferably change-of direction type made of 1mm thick Stainless Steel 304 with non-clogging continuous draining baffles. Filter shall be light in weight and easily removable for cleaning. Filter surface shall exhibit low flammability from licks of flame and the depth of filter shall be a minimum of 50 mm. A continuous filter frame of Stainless Steel 304 shall hold the bank of filters and the velocity across the grease filters shall not exceed 1.25 m/s. Filters shall be placed according to the equipment under the hood. Blanks shall be placed over work tables and spreaders.
- 2.4 Hoods must house one light fitting for every 1.2m length or part thereof. The fittings shall use 2 x 11 watt compact fluorescent tubes in vapour tight fitting with Lexon cover. All wiring inside shall be through 90 deg. C rated wires in galvanised steel conduit brought out in galvanised steel junction box over the hood with a suitably rated EL MCB.
- 2.5 Each exhaust hood should be protected by a 2 hours rated fire damper set for not more than 80 deg. C.
- 2.6 Sprinklers shall be provided inside the hood over the equipment. Sprinklers shall be water mist type 163°C rated. Sprinkler header shall be brought out of the hood and terminated in a ball type brass valve.

3.0 **Exhaust Ducting**

- 3.1 Kitchen exhaust ducting shall be rectangular/round fabricated out of CRCA sheets conforming to IS 4030 - 1973. **The fabricated duct shall be degreased and applied with one coat of primer and 2 coat of fire retardant painting.**

- 3.2 Ducts shall be fabricated as follows:

Maximum size or dia of straight duct	Minimum thickness	Transverse Joints	Reinforcement
Upto 750 mm	1.20 mm	50 x 50 x 6 Flanges	50 x 50 x 6 @750 cc

ANNEXURE-E1 TECHNICAL SPECIFICATION

Over 750 mm 1.50 mm - Do - - Do -

3.3 Longitudinal joints shall be lapped and revitted or spot welded at 75mm centre to centre. All joints shall be rendered leak tight by welding or high temperature tape or any other medium to SMACNA C12 and validated by testing 10% of duct length.

3.4 Round elbows shall be of five sections upto 200 dia and seven sections over 200 dia and the centre line radius shall be minimum two pipe diameters. Transformation shall be concentrically tapered and all branches shall enter at an angle not exceeding 15 degree. Cleaning gutters and trapped drains shall be provided as shown on drawings and as required.

3.5 Upright sprinklers shall be provided inside the duct at every 3.2m till the vertical riser. All sprinklers shall be water mist 260°C rated.

4.0 **Fans**

4.1 Fans shall be centrifugal type conforming to the specifications “AIR MOVING APPARATUS” and the data sheets.

5.0 **Testing and balancing**

5.1 The fans shall be tested for the total static pressure and the discharge air quantity and compared with the design. Hood exhaust quantities shall be set to conform to design values and the system are balance accomplished. After balancing, the fan speed shall be regulated by changing the motor pulleys.

6.0 **Mode of measurement**

6.1 Each kitchen range hood complete with:

- a) Grease filters
- b) Light fittings and wiring shall form one unit of measurement. c) Sprinklers

6.2 All exhaust ducting shall be measured and paid for per unit area and this should include:

- a) cost of ducting & supports b) flanges, bends etc.
- c) supports

ANNEXURE-E1 TECHNICAL SPECIFICATION

- d) joint sealing
 - e) sprinklers in horizontal runs
 - f) Degreasing, one coat of primer and 2 coat of fire retardant painting.
- 6.3 All fire dampers shall be measured and paid per unit cross sectional area and the rate shall include:
- a) cost of damper
 - b) fusible element/actuator

12. TECHNICAL SPECIFICATION FOR NOISE & VIBRATION

1.0 **Scope**

1.1 The scope of work cover :

- i) Selection of equipment for optimized noise levels. ii) Selection of vibration elimination systems

as specified in the various equipment data sheets.

2.0 **Equipment**

2.1 All equipment shall be selected for low noise and minimum vibration levels. Selection of bearings, operating speeds and enclosures shall be such as to meet the above objections. Bearings shall be selected for an average life of 400,000 hours. Maximum operating speed should not exceed 75% of the first critical speed. Equipment submittals shall clearly show the critical speed and the operating speed. Fans and AH Units shall be selected for highest efficiency at the operating point.

2.2 Upon installation, all equipment shall be checked for misalignment which shall be less than 2^0 . All readings shall be recorded. Also the belt-tightness and bearing fixture and lubrication are to be ensured and confirmed. Every equipment shall be tested for vibration and following acceptable limits are ensured and recorded:

RPM	Maximum vibration verticals, horizontal, axial
	(mm)
0-300	0.13
301-500	0.10

ANNEXURE-E1 TECHNICAL SPECIFICATION

501-1000	0.08
1001 and up	0.05

3.0 **Noise Ratings**

3.1 Certified noise power levels of each equipment on an octave band spectrum shall be furnished together with values for the discharge and suction sides. Equipment with low noise power levels would have added weightage in the assessment of equipment.

4.0 **Vibration Isolation**

4.1 All rotating equipment shall be totally balanced for smooth dynamic performance and at any rate should not exceed maximum limits set above. In addition, each equipment shall be mounted on suitable vibration isolation mounts specially selected for the equipment and its drive assembly. For all equipment installed on concrete slabs or structural steel lofts, the vibration isolation shall take into account the natural frequency of the slab or loft as the case may be. At any rate, a minimum static deflection of 25mm shall be achieved in all such cases. Isolators for higher deflection shall have suitable snubbers. Metallic vibration mounts shall have neoprene isolators.

5.0 The contractor shall get approval from the acoustic consultant for the material and method before execution.

6.0 **Piping & Ducting**

6.1 All rigid piping and ducting connected to any equipment mounted on vibration mounts shall have flexible connectors of approved type. The flexible shall absorb the equipment movement without causing vibrations in the rigid sections. **Piping and Ducting shall be supported as shown in the construction details.**

7.0 **Mode of measurements**

7.1 All vibration isolators, flexible etc. shall form part of the equipment and shall not be paid separately.

ANNEXURE-E1 TECHNICAL SPECIFICATION

13. TECHNICAL SPECIFICATION FOR ACOUSTIC INSULATION

1.0 Scope

1.1 The scope of work covers Acoustic insulation of

- i) sheet metal ducting
- ii) return air boxes
- iii) equipment rooms

1.2 The work also covers acoustic doors for equipment rooms.

2.0 Material

2.1 The materials for acoustic insulation shall be as follows:

Application	Material	Sound Absorption Coefficient at Octave Mid band frequency HZ				
		250	500	1000	2000	4000
Ducts	Open Cell Nitrile Rubber 150 Kg/Cum 25mm thick	0.25	0.86	1.14	0.88	0.99
Walls & Ceiling.	Open Cell Fibre Glass 150Kg/Cum 30mm thick	0.32	0.99	1.16	0.93	1.08
	Open Cell Fibre Glass 150Kg/Cum 50mm thick	0.73	1.29	0.99	1.09	1.11

2.2 All nitrile rubber shall be fibre free and shall have antimicrobial protection and shall pass Fungi Resistance as per ASTM G 21 and bacterial resistance as per ASTM G 22 from an independent testing agency. A certificate to that effect shall be submitted with each consignment.

2.3 The material shall have thermal conductivity not exceeding 0.047 W/m.K at 20 Deg C and withstand temperatures from 0 deg C to 50 deg C.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 2.4 The material shall conform to Class 1 rating for surface spread of flame in accordance to BS 476 part 7 & UL 94.
- 2.5 The insulation shall pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 from an independent testing agency.
- 3.0 **Duct Liners**
- 3.1 All discharge and return ducts connected to Air handling units and fan coil units shall be acoustically insulated for distance as shown:
- | | |
|----------------|---|
| AH Units | 4.5 m or as shown on drawings or as directed by the Engineer-in-charge. |
| Fan coil units | Entire discharge duct |
- 3.2 The inside duct surface shall be cleaned and covered with adhesive recommended by manufacturer. Cut foamed sheets into required sizes , apply adhesive on the foam and stick to the duct surface.
- 4.0 **Wall & Ceiling Acoustics**
- 4.1 Walls and ceilings shall be acoustically insulated wherever shown on drawings or as required by the Engineer-in-charge. The wall/ceiling surface shall be cleaned and required surface preparation shall be done for applying adhesive. Rubber based contact adhesive as recommended by manufacturer shall be used .The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the wall and the insulation material. When it is tack dry ,it shall be applied to the wall/ ceiling with sufficient pressure. Minimum five fasteners with washer , four at corners & one at center shall be put immediately after sticking with the help of adhesive .The length of fastener shall be minimum 75 mm.
- 5.0 **Return Air Acoustic Boxes**
- 5.1 The return air acoustic boxes wherever required shall be generally as shown on drawings and the acoustic insulation shall be applied as for duct lining.
- 6.0 **Air tight doors**
- 6.1 Air tight doors for AHU rooms shall be double leaf hollow steel doors of 2” (50 mm) thick filled with honey comb fill. The doors shall be fixed with 3 point heavy duty hinges, mounted on a steel frame. The door shall have double acoustic seals at the hinges and a single seal at the centre point. Doors shall have positive pressure latch with adjustable strike and push rod release. The door and frame shall be fabricated from combination of 14/16 SWG mild steel sheets and given two coats of grey oil paint over two coats of primer. The door performance shall be such that the leakage is not more than 10 cfm/100 sqft face area.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 Mode of measurement

- 7.1 Acoustic insulation shall be calculated on the basis of the prime duct size and paid for per unit area.
- 7.2 Room acoustic insulation shall be calculated on the basis of the prime unfinished area and paid for per unit area.
- 7.3 Air tight doors shall be measured per unit including the door, frame etc. as specified. (The doors are normally outside the scope of the HVAC contractor).

14. TECHNICAL SPECIFICATION FOR PAINTING

1.0 Scope

1.1 The scope of work covers painting of:

- i) All equipment
- ii) Piping & pipe supports
- iii) Duct & duct supports
- iv) Electric Panels & cable trays

1.0 All equipment and piping shall be painted in accordance with the following colour code (or other colours if specifically requested for by the Project Manager.)

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		<u>Colour</u>
		<u>Width</u> (mm)	<u>Spacing</u> (mm)	
COLD WATER				
Municipal Domestic	Sea green	-	-	- White Brown
Flush	- do -	25	1500	Red Red
Hot water supply	- do -	25	1500	(chain dotted)
Hot water Ret	- do -	25	1500	
	- do -	25	1500	
DRAINAGE				
	Black			
Soil	- do -	-	-	- White White
Waste	- do -	25	1500	(Chain dotted)
Vent.	- do -	25	1500	
Rain water	- do -	-	-	

ANNEXURE-E1 TECHNICAL SPECIFICATION

FIRE

Hydrant line	Fire Red	-	-	- White
Sprinklers	- do -	25	1500	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		<u>Colour</u>
		Width (mm)	Spacing (mm)	
STEAM	Silver grey			
Over 3 kg Upto 3 kg Condensate	- do - - do - - do -	- 25 25	- 1500 1500	- Red Red (Chain dotted)
AIR				
Compressed Air	Sky blue	-	-	- OILS
HSD LDO	Light Brown - do -	- 25	- 1500	- White
NATURAL GAS	Light Brown	25	1500	White & Blue
WATER CHILLING UNIT				
a) Compressor b) Motor	Dark Adm. Blue	- -	- -	- Grey - " - Steel
c) Condenser				
REFRIGERANT PIPING				
a) Hot gas	Signal Red	25	1500	- White
b) Liquid lines c) Suction	Signal Red Riveira Blue	25 -	600 -	-

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
PUMPS & MOTORS	Canary Yellow	-	-	-
CHILLED WATER				
a) Supply	Fiesta Blue	-	-	-
b) Return	Fiesta Blue	25	600	White
CONDENSER WATER				
a) Supply	Steel Blue	-	-	-
b) Return	Steel Blue	25	600	White
COOLING TOWERS	Steel Blue	-	-	-
DUCTS & DUCT SUPPORTS	Black or as directed	-	-	-
a) Exposed ducts b) Support	Approved colour			
UNIT COLOUR & AH	Fiesta Blue (28-9104)	-	-	-

ANNEXURE-E1 TECHNICAL SPECIFICATION

ELECTRIC PANELS

Steel grey

Notes: 1) All colours and codes refer to Asian paint Synthetic Enamel colours. Nearest equivalent acceptable.

2.0 All surfaces to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat zinc chromate primer shall be applied completely covering the exposed surfaces. Out finish coat of painting shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Project Manager. Black steel ducts shall be painted with a prime coat and above and galvanized steel duct need to be painted without the need of a prime coat. The DFT of the coating should minimum 250.

3.0 **Mode of measurement**

3.1 All painting shall form part of the cost (item rate) of equipment, piping etc. No separate payment shall be admissible.

15. TECHNICAL SPECIFICATION FOR MOTOR & ELECTRICAL INSTALLATION

1.0 **Scope of work**

1.1 The scope of work covers, selection, supply, installation, testing and commissioning all electrical items of work comprising:

i) Drive motors & starters ii) Cable laying
& iii) Protective Earthing (PE)

2.0 **Ratings**

2.1 All motor, switchgear, cable and PE ratings shall comply with the data sheets and the specification. Where higher ratings are required to match equipment offered, the tenderer may provide accordingly and bring out the fact specifically.

2.2 Ratings shall be at the ambient conditions specified. Motors shall comply with IS: 325 or equivalent BSS revised upto date. All motors shall be statically and dynamically balanced and shall be selected for low noise levels. Ratings shall be suitable for the complete operating range of the equipment concerned and should not cause overloading

2.3 Switchgear and starters shall be rated for the equipment and system fault levels. Protective Earthing shall be consistent with the over current tripping devices.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.0 Squirrel Cage Induction Motors

- 3.1 Stator cores shall be made up of low loss high permeability sheet steel laminations. Stator windings shall be made of electrolytic copper with class B/E insulation and inserted as formed coils baked in position. Rotors shall be of die cast aluminium or copper cage construction.
- 3.2 Roller bearings at the drive and ball bearings at the free end shall be provided.
- 3.3 Motor windings shall be air cooled by means of shaft-mounted fan, designed for quiet operation. Enclosures shall be as shown on the data sheets or as required.
- 3.4 Motors, especially for air handling unit and fan drives shall be selected for low sound power level. Efficiency shall be standard (IS – 8789-1996) or High efficiency (IS 12615 – 2004) as stated in the data sheets.

4.0 Starters

- 4.1 The starter selections shown in the relevant data sheets shall be used as a general guide. Where the load torque demands higher starting torque, motor and starter shall be accordingly selected.
- 4.2 Direct to line or Star Delta or autotransformer starters shall be air insulated totally enclosed metal clad. Star Delta starters shall be automatic change over type.
- 4.3 All starters shall have:
- i) Adjustable thermal over load trips on all phases. ii) Single phase preventing device
 - iii) Under voltage protection (80%)
 - iv) Latch-on contacts with trip mechanism to indicate fault tripping
- 4.4 Solid state soft starters, wherever specified, shall be of tested and approved makes.

5.0 Variable Frequency Drives

5.1 Standards

- 5.1.1 Equipment must comply with recognized, international standards, and the manufacture must be carried out in accordance with ISO 9001 and BS 5750, parts 1 and 2. The VFD must comply with EMC and RFI requirements according to EN 55011 (VDE 0875), and the supplier must be willing to issue a certificate of such compliance.

5.2 Mechanical Protection

- 5.2.1 The VFD must have a separate metal enclosure which will meet the requirements of IP54 unless specified otherwise in the schedule of work to ensure that an extra enclosure is not necessary and have integrated fans as required. The supplier must provide information on heat dissipation. All VFDs to be with factory supplied back plate to facilitate air flow across the heat sink so as to enable free standing installation of VFD.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.3 **Operating parameters**

5.3.1 The VFD must be able to operate under the following conditions:

- a) Rated input voltage 400V +/- 10%, 3 phase, 50 Hz +/- 2 Hz b) Ambient temperature as specified.

The VFD must be suitable for manual as well as remote control.

5.4 **Technical features**

5.4.1 The VFD must be able to supply the motor with a sine shaped supply and fully circular magnetic flux to obtain full motor torque at rated frequency, without the motor becoming warmer than in normal mains operations.

5.4.2 The VFD must be able to vary the output frequency from 0 to 100 Hz and output voltage from 10% to full mains voltage even at -10% of full mains voltage. The VFD must regulate the output to continuously adapt as the case may be to the current load on the pump or the fan so as to minimize energy consumption.

5.4.3 The VFD must be able to work as a Stand-Alone unit, where all safety requirements have been fulfilled, or as part of a larger BMS system (Building Management System), where the control is centralised and operated via serial communication using the integrated RS 485 ports.

5.4.4 The control panel must be detachable and be able to function in a central control panel, if used.

5.4.5 The VFD must be able to regulate all types of motors without load reduction and without the motor temperature becoming higher than under normal mains operation.

5.4.6 The VFD must be able to control motors of different sizes connected in parallel, and it must be possible to stop a machine during operation without the risk of tripping. The VFD must be able to run without the motor being connected, for the purpose of servicing. Servicing must not require access from the back of the VFD.

5.4.6.1 The following features should be incorporated in the VFD. a.

Alphanumeric display (alphanumeric code)

b. Light diodes indicating "ON." and "ALARM"

c. Choice of 12 different displays, eg. of output current, voltage, frequency, speed, output, torque, motor temp., energy kwh.

5.5 **Design features of the VFD**

5.5.1 The VFD must be able to avoid at least 4 bypass frequencies with adjustable bandwidth to avoid mechanical resonance.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.5.2 The VFD must have filters in the intermediate circuit to ensure that the 5th harmonic transmitted to the mains supply is limited to approx. 30%.
- 5.5.3 The current limiting function must be quick enough for the VFD to resist short-term earthing and short circuiting on the output terminals without any damage to the components.
- 5.5.4 The VFD must have integrated protection against the mains transients in accordance with VDE 0160, single phasing, in the mains or motor, or short-circuiting of motor phases. If the speed reference is lost, it must be a programming option to either maintain the motor speed or regulate to stop.
- 5.5.5 The VFD must be able to give off a warning or stop the motor if the motor is overheated. This function must form an integral part of the VFD. Consequently, a thermistor in the motor must not be required.
- 5.5.6 The output circuit is to ensure the possibility of unlimited switching between VFD and motor regardless of load and speed, without any damage to the VFD, and without extra equipment being required.
- 5.5.7 The VFD must have an override function which in the case of overloads during operation and starting reduces the motor current to prevent damage.
- 5.5.8 The VFD must have a power factor of 1 on the supply side (AC) at all loads and speeds; extra AC coils for stable operation must not be required.
- 5.6 **Protection features**
- 5.6.1 The following protection shall be provided:
- a) Inverter trip at 75 C on the heat sink.
 - b) Protection against under voltage
 - c) Protection against overvoltage
 - d) A lock to prevent unintended programming of the VFD.
- 5.7 **Product Support**
- 5.7.1 The supplier must be able to provide technical documentation, covering both catalogues and statements of dimensions and weight.
- 5.7.2 The local dealer must be able to provide full technical and maintenance assistance with full complements of spares.
- 6.0 **Motor Installation**

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.1 Motors and driven equipment shall be mounted on a common base and coupled through flexible couplings or multiple V-belt drive. Coupling and belt drives shall be provided with suitable safety guard.
- 6.2 Final wiring connections to motors shall be flexible.
- 6.3 Where motors are installed away from the starter.

7.0 **Motor Control Centres & Power Panels**

- 7.1 All motor control centres and power panels shall be cubicle type fabricated from a combination of 14 & 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and modular construction suitable for 3 phase 415V 4 wire 50 Hz system. All boards shall be accessible from the front for the maintenance of switch fuses, bus bars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meters etc. All sheet shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with two coats of synthetic enamel of approved colour applied over one coat of red oxide primer. Engraved plastic labels shall be provided indicating the feeder details, and capacity and danger signs.
- 7.2 The boards shall accommodate air-insulated bus bars, air circuit breakers, switch fuse units with HRS fuses, starters, necessary meters, relays contactors etc. As required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.
- 7.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an interlocked door with facility for pad-locking. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 2147/1962. Feeder connections shall be made out of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required. Internal wiring, bus bar markings etc. Shall conform to IS: 375/1963. Internal wiring shall have terminal ferrules. Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75m from floor level. Cable glands need not form part of the switch board as the cost of glands will form part of the cable termination.
- 7.4 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy as specified and shown on drawings and rated for a temperature rise of 30 °C over the ambient temperature specified, based on insulated conductor rating (IS:8084-1976).

ANNEXURE-E1 TECHNICAL SPECIFICATION

Neutral bars may be of one half the size of the phase bars. The main horizontal bus bars shall be of uniform cross section and rated in accord with the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to-bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hygroscopic insulated blocks to withstand thermal and dynamic overloads during system short circuits. An earth bus of size 50% of the phase bar subject to a minimum of 15 x 3 Cu or 25 x 3 Al. shall be provided. Individual switch components shall be connected with the earth bus through copper or aluminium or galvanised steel strip size as shown. All wire connections to bars shall be through lugs, bolts and nuts and spring washers.

- 7.5 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.
- 7.6 Panels shall be installed on a base channel frame and on a concrete pad to be provided by others. All panels shall be meggar-tested and shall not be commissioned till the values are more than 2.5 megohms phase to phase and 1.5 megohm phase to neutral. All meters on the panel shall be calibrated before commissioning.
- 7.7 The general arrangement and fabrications drawings shall be got approved before taking up for fabrication.

8.0 **Cabling**

- 8.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards. All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm centres
- 8.2 Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.
- 8.3 Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be fixed directly to walls or ceiling and supported at not more than 500 mm. Where number of cables are run, necessary perforated cable trays shall be provided wherever shown. Perforated cable trays shall be mild steel or Aluminium as specified in the schedule of work. Perforated trays shall not be directly suspended but supported on mild steel frame work as shown on drgs. or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic identification tags shall be provided at every 20m. Cables shall be bent to a radius not less than 12 (twelve) times the

ANNEXURE-E1 TECHNICAL SPECIFICATION

overall diameter of the cable or in accordance with the manufacturer’s recommendations whichever is higher.

8.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid in an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles. Width of excavated trenches shall be as required. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cables markers at every 30 meters and at all loop points.

8.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

8.6 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

9.0 **Equipment earthing**

9.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<i>Size of phase conductor</i>	<i>Copper</i>	<i>Aluminium</i>	<i>Galvanised steel</i>
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs. > Minimum (base)	
	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

ANNEXURE-E1 TECHNICAL SPECIFICATION

The earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

- 9.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.
- 9.3 Armoured cables shall be earthed by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. D B's a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.
- 9.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

10.0 **Electrical Installation**

- 10.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.
- 10.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

11.0 **Mode of measurement**

- 11.1 Each electric panel or motor control centre shall be separately quoted and paid for. The cost of panel shall include earthing as specified and include for mounting of starters wherever required and shown or as shown in the schedule of work.
- 11.2 Cables will be measured on the basis of a common rate per unit length and shall include the following items.

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- Laid in doors i) cables and clamps ii) cable markers
- Laid out doors i) cables and protective bricks & tiles
- 11.3 Cable trays/racks/ladders shall be measured per unit length and width as specified in the schedule of work.
- 11.4 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:
- i) Cable glands, lugs, bolts, nuts ii) All jointing materials
 - iii) Installations, testing and commissioning iv) Earthing the glands
- 11.5 For cables burried under ground excavation shall be paid for additionally for the following per unit volume:
- i) Excavation and back filling
 - ii) 6" Soft Earth Cushioning below and above cable
- The cost of laying protective tiles shall be part of cable cost.
- 11.6 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.
- a) Motors - earthing forming part of the cabling/wiring for the motors.
 - b) Isolating switches and starters should form part of mounting frame, switch starter etc.

16. TECHNICAL SPECIFICATION FOR MEDIUM VOLTAGE CABLING

1.0 **Scope**

1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- 1) IS: 1554 Parts I & II PVC Insulated Heavy duty cable
- 2) IS: 3961 Recommended current Rating of cable

ANNEXURE-E1 TECHNICAL SPECIFICATION

or not. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

5.0 **Testing**

5.1 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

6.0 **Mode of measurement**

6.1 Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:

For cables laid indoors:

- i) Cables and clamps
- ii) Installation, commissioning and testing
- iii) Cable marking

OR

For cable buried underground:

- i) Cables and protective bricks & tiles
- ii) Installation, commissioning & testing
- iii) Cable markers

6.2 Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include

- i) Galvanised steel perforated tray with necessary suspenders and frame supporting the tray.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- ii) Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.

6.3 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

- i) Lugs, glands, bolts, nuts ii) All

jointing materials

- iii) Installations, testing and commissioning iv) Earthing

the glands

6.4 For cables buried under ground excavation shall be paid for additionally for the following per unit volume:

- i) Excavation and back filling

- ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost as stated above.

17. TECHNICAL SPECIFICATION FOR MV SWITCHWEAR

1.0 **Scope**

1.1 The scope of work shall cover the supply, installation, testing and commissioning of all power panels, incorporating circuit breakers, switch fuses, busbars, interconnections, earthing etc., meeting the requirements shown in the data sheets & drawings and specifications.

2.0 **Standards**

2.1 The following standards and rules shall be applicable:

- 1) IS: 13947:1993 Switchgear & Control gear specification

- 2) IS:8623:1993 Low Voltage Switchgear and Control gear assemblies.
Parts 1 & 3

ANNEXURE-E1 TECHNICAL SPECIFICATION

3) Indian Electricity Act and Rules

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

3.0 **Air Circuit Breakers**

3.1 Air circuit breakers shall be air break horizontal draw out or fixed type fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 600V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits specified.

3.2 Breakers shall be, motorized or manually operated as specified, complete with front-of-the-panel operating handle, isolating plugs with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes and trip free operation. Breakers shall be capable of being racked out into 'Testing', 'Isolator' and 'Maintenance' position and kept locked in any position. Breakers for remote and automatic operation shall be motor operated spring charged with closing and trip coils.

4.0 **MCCB 's**

4.1 Moulded case circuit breakers shall be standard products of established manufacturers. Breakers shall be rated for system short circuit levels and if unavoidable, backed up by HRC fuses. Breakers shall incorporate thermal and magnetic trips, unless shown otherwise. Thermal trips shall be fixed according to the feeder rating and magnetic trips shall be adjustable.

5.0 **Switch Fuse Units & Disconnects**

5.1 Switch fuse units shall have quick-make, quick-break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting.

All switches shall be rated according to the equipment schedule or drawings and shall withstand the system prospective fault current let through. Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type.

5.2 Fuses shall be HRC cartridge type conforming to IS:2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type diazed fuses are not acceptable for any ratings.

5.3 All disconnecting isolators shall consist of switch units quick-make, quick-break type with silver plated contacts. The switches shall preferably have double breaks. The switches shall preferably have sheet steel enclosure, which in turn is mounted on suitable angle iron frame work. In wet locations switches shall have cast iron enclosures. Disconnects shall have a minimum breaking capacity of 5KA at 415 Volts.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.0 Isolators

- 6.1 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.
- 6.2 Painting, earthing and labels shall be provided as generally indicating for MV Switchgear and shown on drawings.

7.0 Instrument Transformers, Meters & Relays.

- 7.1 Ammeters and voltmeters shall be electronic digital type. Meters shall conform to BS:89 and have grade 'a' accuracy. Scale ranges shall meet with the requirements or as indicated on the drawing or in the Data Sheets.
- 7.2 Energy meters shall be electronic two element switch board mounting type suitable for unbalanced loads. In case of two incoming feeders, a summating C.T shall be provided with the meter. Meters shall conform to BS: 37.
- 7.3 The energy meters for DG Set & Transformers shall be calibrated and got certified by the respective Electricity Authority wherever required.
- 7.4 CTS shall be cast raisin type and conform to meter IS:2705 in all respects. Rated secondary current shall be 5A unless otherwise stated. Accuracy class of metering CT's shall be 1.0 & for protection 5P10.

Test links to be provided in secondary connection to facilitate testing of instruments, meters & protection device. CT burden shall be minimum of 10VA but appropriate to the instruments connected.

- 7.5 Relays and trip devices shall be any one of the following as specified and shown on drawings and data sheets:
- i) Thermal – Magnetic trips – direct acting ii) Solid state trips for O/L, SC & E/F.
 - iii) Microprocessor controlled relays.

All trips shall be 400/230V AC series type unless shunt tripping is specified for.

- 7.6 LED indicating lamps to be provided for phase indication & breaker position as required.
- 7.7 All wiring for relays shall be of CU with colour coding and labelled with appropriate plastic tags for identification.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Minimum size of control wiring shall be 2.5 sqmm. All control circuits to be provided with protective MCB's.

8.0 Cubicle Boards

- 8.1 All boards shall be combination of 14 & 16 SWG sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle, flush dead front and of modular construction suitable for 3 phase 415V 4 wire 50 Hertz system TN-S neutrals grounding. All boards shall be accessible from the front or as shown on Drgs and specified in the equipment data sheet, for the maintenance of switch fuses, busbars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom. All panels shall be machine pressed with punched openings for meters etc. mounted on a 75mm high base channel frame. All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with powder coating of approved colour applied over a primer. Engraved plastic labels shall be provided indicating the feeder details, and capacity and danger signs.
- 8.2 The boards shall accommodate air insulated bus bars, air circuit breakers, mccb's switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.
- 8.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an inter-locked door with facility for padlocking. Each switch or MCCB or ACB shall have provision for locking in the OFF position for life safety. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 2147/1962. Feeder connections shall be of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required and if insulated, the insulation shall be able to withstand the high temp at the terminals. Internal wiring, bus bar markings etc. shall conform to IS:375/1963. Internal wiring shall have terminal ferrules.

Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75M from floor level. Cable glands shall form part of the switch board.

- 9.0 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy as specified and shown on drawings and rated for a temperature rise of 30 deg C over the ambient temperature specified, (IS:8084-1976). Neutral bars may be of one half the size of the phase bars or as shown on drawings. The main horizontal bus bars shall be of uniform cross section and rated for the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hydroscopic insulator blocks to withstand thermal and dynamic overloads during system short circuits.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Feeder connections shall be solid CU bus bars duly insulated with bimetallic dampers where required. Bus bars shall be designed for easy extension in future on either side. All feeder connections shall be rated for 25°C temperature rise over the ambient.

10.0 **Earthing**

10.1 Protective earthing shall be provided as shown on drawings or as follows:

-----	Phase
	Protective conductor
	conductor
-----	upto 16 sqmm
	equal size
16 to 35 sqmm	16 sqmm
over 35 sqmm	50% of phase conductor

In case of dissimilar materials the Protective Earth Conductor shall be suitably sized for equal conductance.

10.2 Protective earthing of each switch shall be connected to the earth bar.

11.0 **Installation**

11.1 All panels shall be supported on MS channels incorporated in the panel during the fabrication. All such supports shall have two finish coats over a prime coat after completion of the work. All panels shall be touched up for damaged painting.

11.2 All panels shall be meggered phase to phase and phase to neutral using a 1000V megger with all outgoing feeders in closed position. The megger value should not be less than 2.5 megohms between phases and 1.5 megohms between phases and neutral.

11.3 Fabrication drawings of all panels shall be approved by the Consulting Engineers before fabrication.

12.0 **Testing & Inspection**

12.1 All switchboards shall be factory inspected before finishing and dispatch unless waived.

12.2 Certificate for all routine and type tests for circuit breakers in accordance with the IS:2516-1963 shall be furnished. In addition, all panels shall be meggered phase to phase and phase to phase neutral, using a 1000V megger with all switchgear in closed position. The megger value should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

ANNEXURE-E1 TECHNICAL SPECIFICATION

12.3 All meters shall be calibrated and tested through secondary injection tests.

12.4 All field tests shall be witnessed by Consultants and recorded unless waived.

13.0 **Mode of measurement**

13.1 Each panel will be considered as one unit for the purpose of measurement and shall include the following:

- i) Incoming and Outgoing feeders.
- ii) Interconnections and controls and instrument wiring with necessary protective fuses.
- iii) Meters, Relays, Indicating lamps, CT's control fuses etc.
- iv) Supporting structure, sheet steel enclosure v) Installation and testing

13.2 Isolators shall each be measured as one unit complete with:

- i) mounting frame ii) switch/fuse

13.3 Protective earthing of the panel/Isolator from the equipment earthing system will be measured separately and paid at unit rates.

13.4 Outgoing and incoming feeder terminations will be paid at the unit rates separately as specified under cabling.

18. TECHNICAL SPECIFICATION FOR VARIABLE REFRIGERENT VOLUME SYSTEM

1.0 **Scope**

1.1 The scope of work covers supply, installation, commissioning and testing of Variable Refrigerant Volume air conditioning systems. The units shall meet the requirements of the data sheets and specifications.

2.0 **Submittals**

2.1 Equipment documentation shall be submitted comprising but not limited to the following.

- 1) Manufacturer, Model No.
- 2) Catalogues showing unit selected, physical data and weights
- 3) Performance data covering :- Power supply characteristics Cooling capacity Compressor output KW Airflow rate (Condenser) Sound level (Outdoor unit) Airflow rate (Indoor unit) Sound level

ANNEXURE-E1 TECHNICAL SPECIFICATION

(Indoor unit) Cooling capacity (Indoor unit)

2.2 The supply of the system shall comprise

- 1) Outdoor unit
- 2) Indoor units
- 3) Refrigerant piping including all joints and connections
- 4) Drain pump and drain piping
- 5) Electrical wiring from socket outlet to the indoor units
- 6) Control panel
- 7) Fresh air intake system (As specified and as required)

3.0 **Out door unit**

- 3.1. The out door condensing unit shall comprise single/multiple compressor, condensor coil, condenser fan, refrigerant connections and a casing. The compressor shall be hermetically sealed scroll type. The compressor drive shall be a refrigerant cooled motor and shall have an inbuilt over load protector. The unit shall be capable of frequent starting and stopping without causing any over load.
- 3.2. The condenser coil shall have copper tube with aluminium fins. The tube shall be not less than 10 mm with a wall thickness of 0.4 mm copper. Tube shall have aluminium fins adequately bonded through a process of mechanical expansion. The number of fins shall not exceed 520 per meter (13 per inch) and the number of rows in each case shall be for the specified output. The condensor fan shall be a multiblade propeller type designed for low noise and directly driven by a totally enclosed fan motor. The refrigerant connections shall be brought out into plain stub ends.
- 3.3 All the components shall be enclosed in a casing formed from heavy gauge 1.6 mm galvanised sheet steel totally rust inhibited.
- 3.4 The speed of the compressor shall be capacity controlled through frequency modulation.
 - 3.4.1 The frequency modulation system must comply with recognised international standards. The drive must comply with EMC and RFI requirements according to EN 55011 (VDE 0875).
 - 3.4.2 The drive should be able to operate with a ±10% of supply voltage variation.
- 3.5 The refrigerant used shall be non CFC with low global warming potential.
- 3.6 To yield the required system capacity number of outdoor units of equal or varying capacities can be put together as specified. In such case the system should balance the usage of each outdoor unit through a duty cycling function. The system should also provide for switching the starting sequence of multiple outdoor units.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.0 Indoor unit

4.1 The indoor units shall be any or a mixture of the following types.

Ceiling mounted cassette – Four way or two way
Ceiling mounted cassette – Corner type
Ceiling mounted ducted type
Ceiling suspended Wall
mounted Floor standing
Concealed floor standing

4.2 The system can comprise of a number of indoor units of single or different types as listed in 4.1 and the type and number of indoor units will be as specified in the drawings and data sheets.

4.3 The indoor units shall consist of an evaporator fan and motor, evaporator coil, drain tray, drain pump air filter, outlet for duct connection (for ducted units) and all required controls.

4.4 The evaporator fan shall be double inlet, double width with centrifugal forward curved impellers statically and dynamically balanced. The impellers shall be mounted on either side of a double shafted 2 speed motor directly driving the fans. The fans shall be housed in a sheet steel a high impact ABS plastic enclosure which is acoustically treated. The evaporator coils shall be similar to the condenser coil and made of copper tube with aluminium fins and the refrigerant lines brought out to plain stub ends within the unit casing.

5.0 Interconnecting piping

5.1 Refrigerant lines shall be run inconspicuously and generally as shown in the drawings and as directed on site. The suction and liquid lines shall be bonded together and insulated with 6 mm thick elastomeric tubing. All insulation exposed to direct sunlight shall be treated for damage from UV radiation. All power wiring shall be drawn from the nearest socket outlet and shall include the control wiring, power wiring, on-off switch with speed controller.

5.2 All pipe sizing shall be done taking into account the length and rise.

5.3 System should be capable of supporting total piping length of 150 running meters (Actual length) with a permitted height difference of 50 meters between the indoor and outdoor units and a maximum level difference of 15m between indoor units of the same system.

5.4 It should be possible to connect refrigerant piping to the outdoor unit from front, both sides or the bottom of the unit.

6.0 Control Cabling

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.1 It should be possible to connect multiple indoor units to the outdoor units with one 2 core control cable.

6.2 Cabling to the outdoor unit should be possible from front panel, both side panels or the bottom panel.

7.0 Drain pump and piping

7.1 When specified in the data sheets the indoor unit should be equipped with a drain pump with minimum 750mm lift.

7.2 A drain pipe 32mm OD / 25mm ID with 6mm thick elastomeric insulation shall be provided from the indoor unit drain point to the nearest floor drain indicated in the drawing.

8.0 Central Control System

8.1 The central control system shall be equipped with a wired or wireless remote controller (as specified) with the following minimum features

Large LCD screen display for complete operating status
Temperature settable in steps of 1°C
Programmable timer
Thermostat sensor
Self diagnostic function
On / off control Fan speed
setting Password protection
BMS access (3rd party Compatible) Energy
consumption of individual units

8.2 Each indoor unit shall have a local wired controller with an 1R remote hand hold unit whether specified, shown or not.

9.0 Heat Reclaim Ventilation (Optional)

9.1 When specified in data sheets, heat reclaim ventilation units which exchanges heat between supply air and exhaust air is to be provided as part of the system.

10.0 Installation

10.1 The out door unit shall be installed as decided by the Architect/Consultant.
The room unit shall be either ceiling or wall/floor mounted as shown on drawings.

11.0 Testing

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 11.1 The unit shall be tested for establishing the capacity and power consumption. Tests shall be carried out in accordance with IS 5141 - 1969 (revised up to date) computed results shall tally with specified capacity and power consumption figures furnished with the tender offer.
- 11.2 Tests shall be carried out on
- a) the compressor and drive motor side b) condenser side for heat rejection
 - c) Cooling coil for cooling capacity d) Evaporator air volume
- 11.3 Total system performance shall be documented with hourly readings of the indoor spaces, equipment readings etc.
- 12.0 **Mode of measurement**
- 12.1 The system shall be measured as one item of work consisting of
- 1) Bank of outdoor units of specified capacity.
 - 2) Multiple indoor units of one or more types as specified including electrical power cabling from the nearest socket. Wall mounted control panel with hand hold remote unit.
 - 3) Refrigerant and drain piping with all joints and connections duly insulated
 - 4) Central / control panel
 - 5) Refrigerant charge and oil charge
 - 6) Fresh air unit as specified
 - 7) Erection of the system
 - 8) Commissioning & testing

ANNEXURE-E1 TECHNICAL SPECIFICATION

SEWAGE TREATMENT PLANT

V. TECHNICAL SPECIFICATIONS FOR STP WORKS

1. TECHNICAL SPECIFICATION FOR SEWAGE TREATMENT PLANT

1.0 Scope

- 1.1 The scope of work covers supply, installation, testing and commissioning of a sewage treatment plant. The final effluent quality after the primary and tertiary treatments shall meet the quality standards specified or the requirements of the local pollution control authorities whichever is more stringent.
- 1.2 The treatment process proposed is for a contact stabilisation plant to produce and maintain the quality standards of effluent as set down in the section "DESIGN CRITERIA". If the tenderer, by virtue of his experience and process know how, considers that the specified process needs modification and/or addition to meet the specified end results, the tenderer should lay down such modifications and/or additions together with its merits and demerits and also the additional costs.
- 1.3 The tenderer may even propose any proven alternate process with all the details and costs.
- 1.4 The tenderer should also obtain the approval of the State Pollution Control Board (PCB) not only for the process but also for operation of the plant after it is commissioned.

2.0 The Process

2.1 The process plant essentially consists of the following:

- 1) A primary sedimentation and flow balancing tank with bar screens and grit chamber.
- 2) 2# sewage pumps, one working and one standby for lifting sewage from the primary tank to the aeration tank.
- 3) An aeration tank complete with distribution piping and air diffusers.
- 4) Sludge stabilisation tank with distribution piping and air diffusers.
- 5) Roots type air blowers
- 6) Clarified effluent tank.
- 7) 1# Filter press
- 8) Sludge re-circulation pumps, one working and one standby.
- 9) 2 Nos filter pumps

ANNEXURE-E1 TECHNICAL SPECIFICATION

2.2 The tertiary treatment of the effluent, consists basically of i)A

pressure sand filter to remove suspended solids

ii) An activated carbon filter for odour control. iii)

Softener

iv) Coagulant dosing and hypochlorite dosing systems. v)

2# treated water pumps.

3.0 **Equipment**

3.1 **Sewage Pumps**

3.1.1 Sewage pumps shall be standard products of one of the accepted or any other approved makes. Pumps may be vertical submersible suitable for wet pit installation or horizontal for dry installation as specified and shown on drawings. Pump impellers shall be open type capable of handling solids upto 50mm dia with an integral cutter-grinder.

3.1.2 All pumps shall be in duplicate, one working and one standby, whether so specified or not. Submersible pumps shall be installed with an automatic coupling guide rail system.

3.1.3 Pumps shall be provided with sealed level switches through which pumps shall start and stop automatically. Pumps will be alternated after every stop.

3.2 **Sludge pumps**

3.2.1 Sludge pumps shall be same as sewage pumps but capable of handling thick sludge. The pumps generally are for dry in-line installation.

3.2.2 Pump operation shall be timer controlled.

3.3 **Aeration system**

3.3.1 The aeration system consists of air blowers one working and one standby, distribution piping and air diffusing terminals. The blowers shall be twin lobe Roots type with a close grained cast iron grade 20 body and high tensile strength involute profiled impellers in dynamically balanced rotor assembly. Impellers shall rotate in amply sized anti-friction bearings suitable for trouble free continuous running.

3.3.2 The blowers shall be rated to deliver required quantity of oil-free air at the design pressure while operating at not more than 1200 rpm. The blower shall be driven by a squirrel cage induction motor selected for 125% of the power absorbed at the rated discharge and pressure. The drive shall be with multiple V-belts and protected through a suitable belt guard.

3.3.3 All air piping net work shall use UPVC piping valves for sectionalisation. Air diffusion should be through self-closing polyester or EPDM diffusers held in SS-

ANNEXURE-E1 TECHNICAL SPECIFICATION

304 nipples.

3.3.4 The primary sedimentation tank, in-let channel with bar screens, grit chamber, aeration tank, clarifiers, flocculator clarified effluent tank and treated effluent tank shall be of concrete or steel as specified in the schedule of work and shown on drawings. All civil works will be carried out by others to the drawings and layouts of the tenderers but all internals and pipe inserts in the concrete shall be supplied by the STP contractor.

3.3.5 Where steel tanks are required, they shall be rendered rust proof with an epoxy coating consisting of 3 coats of 100 micron DFT each of Epilux 5 or equivalent on the inside and two coats on the outside.

4.0 Tertiary treatment

4.1 Raw water pumps & back wash pumps

4.1.1 Pumps shall be vertical or horizontal back pull out, monobloc or coupled centrifugal pumps meeting the performance specified in the data sheets.

4.1.2 Pumps shall be complete with drive motor, flexible coupling with guard & base plate. The base plate shall be cast iron or fabricated steel epoxy painted complete with fixing arrangement for back pull out as required. Pump material of construction, shaft seals shall be as specified in the data sheets. The motor shall be squirrel cage induction with specified enclosure. The motor rating shall be as specified or the maximum bhp absorbed in the operating range of the selected pump.

4.1.3 Pumps shall be installed on a concrete pad and aligned on site, if coupled type. Pump shall be isolated from the floor with suitable vibration isolators and flexible connectors on the suction and discharge connections. The installation shall be neat and workman like. The power cable shall be PVC insulated FRLS sheathed armoured cables terminating in a starter or isolator or galvanised junction box with heavy duty mechanical connector from where the LAPP type steel braided copper flexible cable shall be laid. No cable shall be laid on floor nor the flexible cable should be longer than 1.0m.

4.1.4 Pumps starting and stopping shall be manual or automatic as specified in the data sheets and drgs. In automated systems the following operation sequence are suggested:

- 1) Raw water pump No. 1 should start and stop through Hi/Lo level switches in the Raw Water and Treated Water tanks. Pumps should alternate after every stoppage. There shall be dry-run protection as part of the control scheme.
- 2) The differential pressure switch across the pressure sand filter shall put the system in back wash mode. In back wash mode the raw water pump should stop and the back wash pump shall start and stop through a timer control. The flow diversion should be through motorised multiport valve(s). Where a backwash pump is not envisaged, the main pumps should function for bachwash as well.
- 3) The regeneration of the softener shall be started manually by observation of the soft water flow meter or automatically as specified. In automatic regeneration, the tenderer should propose necessary automatic monitoring and control regime for approval.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.2 Pressure sand filters

4.2.1 The filter shall be vertical free standing or horizontal type with dished ends as shown in the data sheets. The filter shall be provided with a suitable manhole, bolted type at a suitable location for inspection/replacement of filter media small horizontal filters should have a hand hole in lieu of a manhole. The filter shall be provided with legs so that filter bottom is about 300mm above floor level. Suitable nozzles with relief valve and gauges shall be provided. The vessel shall be hydraulically tested to pressure as shown in the data sheet.

4.2.2 The vessel shall be of mild steel with epoxy coating from inside and polyurethane paint from outside. The vessel shall be tested for 1.5 times the system pressures indicated in the data sheets. The frontal piping shall be of a PVC rated for 10 bar system pressure.

4.2.3 All shut-off valves shall be flanged butterfly valves with appropriate seating and the multiport control valves shall be manual or motorised as specified and be of approved make. Back wash shall take place at 0.75 bar pressure drop across the filter or every 24 hours whichever is earlier.

4.2.4 Each filter shall be provided with the following:

- i) Frontal piping with all shut off & multiport valves as shown ii) Supporting frame
- iii) Pressure relief valve
- iv) Pressure gauges 100mm dia with brass syphone pipe & gauge cock v) Inspection manhole 450mm dia or hand hole 200 dia.
- vi) Graded filter media

5.0 Activated Carbon Filter

5.1 The activated carbon filter shall be same as the pressure sand filter but the media shall be activated carbon. Filters shall be provided with necessary steam/ hot water connection for the sterilisation of the media.

6.0 Softener

6.1 An exchange softener shall be provided for supplying soft water to the cooling tower.

7.0 Chemical Dosing System

7.1 Chemical dosing systems could be differential pressure type or positive displacement pumps as specified in the data sheets complete with chemical container, piping and valves to make a complete dosing system. Systems shall be compatible with the dosing of following chemicals:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) Alum solution for coagulation
- ii) Lime soda solution for PH correction and Co₂ neutralisation
- iii) Disinfection using bleaching powder solution or sodium hypochlorite solution

OR

- iv) Ozonisation as specified in the schedule of work.

7.2 Differential pressure type dosing systems shall incorporate a calibrated orifice plate with pressure probes in the main water line and the dosing rate shall be adjustable. The system shall incorporate a flow indicator. Pumped system shall have an electric driven positive displacement gear pump with a starter. The pump construction shall be as follows:

Chemical

Head

Piston

ANNEXURE-E1 TECHNICAL SPECIFICATION

- | | | | |
|----|--|--|---------------------|
| 1) | Lime, soda, alum etc. | Zinc-free acid resisting phosphor bronze | Stainless steel 316 |
| 2) | Bleaching solution, sodium hypchlorite, acids upto 10% concentration | Ebonite | Glass |

ANNEXURE-E1 TECHNICAL SPECIFICATION

The capacity of each pump shall be capable of being adjusted form 0 to 100 % of its rating. Each pump shall have a pressure relief valve set to operate at 110 % of system maximum working pressure.

- 7.3 The system shall have a chemical mixing tank of FRP with a capacity specified. An agitator shall be provided wherever asked for. The tank shall be closed type with openable top and inlet/outlet connections, drain and air vents with valves.
- 7.4 All piping from and to the dosing system shall be flexible white transparent polypropelene with PVC control valves.
- 7.5 Dosing systems shall be activated when the raw water pumps start.

8.0 Installation, testing and commissioning

- 8.1 The drawings show the suggested flow diagram and a feasible layout of various tanks and equipment. The tenderer shall make the following submittals along with the tender.
- i) A detailed process narrative and a flow diagram
 - ii) Suggested plant layout conforming to the space provisions made.
 - iii) Deviations from specifications stating necessity and financial implications. iv) Confirmation of plant conformance to the state pollusion control standards as well the specified quality standards.
- 8.2 On award of the contract, final detailed layouts and shop drawings of equipment and piping shall be submitted for approval. The process flow diagrams and plant layout drawings shall be submitted simultaneously to the state P.C.B and approvals obtained. These approvals will enable the contractor to proceed with the procurement and fabrication.
- 8.3 All civil works will be constructed by others in accordance with the approved drawings but all internals and inserts for ingress into the civil elements shall be provided by the contractor.
- 8.4 All piping within the battery limits shall be the responsibility of the contractor. Piping handling sewage shall be of cast iron M.S and water piping shall be of heavy duty galvanised steel.
- 8.5 The installation shall be carried out in a workman like manner and to approved drawings. All equipment shall automatically start and stop to a programme. Twin equipment, one working and one standby, shall operate alternately in a manner to have equal run time over one week.
- 8.6 Before starting up the plant, the contractor should have it inspected and approved by PCB and the Project Managers. Contractor should arrange for necessary seeding microbial mass for the start up of the plant. The plant shall be operated for 2 days of 24 hours each

ANNEXURE-E1 TECHNICAL SPECIFICATION

before test readings and taken in accordance with Annexure 2.3-1. The plant shall be operated for at least 2 weeks after stabilized system performance or 6 weeks whichever is later. All consumables, operating personnel for the above duration shall be borne by the contractor.

9.0 Mode of Measurement

9.1 Supply, installation, testing and commissioning of the entire sewage treatment plant shall be treated as one unit for purpose of measurement and payment. The work embraces.

1. Supply of detailed drawings of the process, the plant and all appurtenant civil works.

2. Supply installation and testing of all plant viz i) Sewage

pumps

ii) Sludge pumps

iii) Blowers, piping network with valves and diffusers iv) Dosers

3. All interconnected piping, tank internal and inserts.

4. Obtaining approvals from PCB and any other statutory bodies.

9.2 Tertiary equipment shall be measured as described in the schedule of work.

9.3 Variable speed pumping shall be measured as described in the schedule of work.

9.4 All electrical work shall be measured as described in the schedule of work.

ANNEXURE-E1 TECHNICAL SPECIFICATION

WATER TREATMENT PLANT WORK

VI. TECHNICAL SPECIFICATIONS FOR WTP WORKS

1. TECHNICAL SPECIFICATION FOR WTP SYSTEM

1.0 Scope

1.1 The scope of work shall cover supply, installation, testing and commissioning of the entire water treatment plant meeting the intents of these specifications. The plant shall generally comprise, but not limited to, the following:

- i) Raw water pumps
- ii) Pressure quartz filter
- iii) Base exchange softener & Activated Carbon Filter iv) Dosing systems for coagulation and disinfection
- v) All piping and valves from pumps to vessels to tanks

Treated water is stored in the Treated Water Tank and pumped through the building with variable speed pumping systems.

2.0 Raw water pumps & back wash pumps

2.1 Pumps shall be vertical or horizontal back pull out, monobloc or coupled centrifugal pumps meeting the performance specified in the data sheets.

2.2 Pumps shall be complete with drive motor, flexible coupling with guard & base plate. The base plate shall be cast iron or fabricated steel epoxy painted complete with fixing arrangement for back pull out as required. Pump material of construction, shaft seals shall be as specified in the data sheets. The motor shall be squirrel cage induction with specified enclosure. The motor rating shall be as specified or the maximum bhp absorbed in the operating range of the selected pump.

2.3 Pumps shall be installed on a concrete pad and aligned on site, if coupled type. Pump shall be isolated from the floor with suitable vibration isolators and flexible connectors on the suction and discharge connections. The installation shall be neat and workman like. The power cable shall be PVC insulated FRLS sheathed armoured cables terminating in a starter or isolator or galvanised junction box with heavy duty mechanical connector from where the LAPP type steel braided copper flexible cable shall be laid. No cable shall be laid on floor nor should the flexible cable be longer than 1.0m.

2.4 Pumps starting and stopping shall be manual or automatic as specified in the data sheets and drgs. In automated systems the following operation sequence are suggested:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 1) Raw water pump No. 1 should start and stop through Hi/Lo level switches in the Raw Water and Treated Water tanks. Pumps should alternate after every stoppage. There shall be dry-run protection as part of the control scheme.
- 2) The differential pressure switch across the pressure quartz filter shall put the system in back wash mode. In back wash mode the raw water pump should stop and the back wash pump shall start and stop through a timer control. The flow diversion should be through motorised multiport valve(s). Where a backwash pump is not envisaged, the main pumps should function for back wash as well.
- 3) The regeneration of the softener shall be started manually by observation of the soft water flow meter or automatically as specified. In automatic regeneration, the tenderer should propose necessary automatic monitoring and control regime for approval.

3.0 Pressure quartz filters

- 3.1 The filter shall be vertical free standing or horizontal type with dished ends as shown in the data sheets. The filter shall be provided with a suitable manhole, bolted type at a suitable location for inspection/replacement of filter media small horizontal filters should have a hand hole in lieu of a manhole. The filter shall be provided with legs so that filter bottom is about 300mm above floor level. Suitable nozzles with relief valve and gauges shall be provided. The vessel shall be hydraulically tested to pressure as shown in the data sheet.
- 3.2 The vessel shall be of fibreglass with an inner layer of polyester suitable for edible and potable contents or m.s with food grade epoxy quoted from inside and normal epoxy quoting from outside. The vessel shall be tested for 1.5 times the system pressures indicated in the data sheets. The frontal piping shall be of CPVC or polybutylene rated for 10 bar system pressure.
- 3.3 All shut-off valves shall be flanged butterfly valves or ball valves with appropriate seating and the multiport control valves shall be manual or motorised as specified and be of approved make. Backwash shall take place at 0.4 bar pressure drop across the filter or every 24 hours whichever is earlier.
- 3.4 Each filter shall be provided with the following:
 - i) Frontal piping with all shut off & multiport valves as shown and as required.
 - ii) Supporting frame
 - iii) Pressure relief valve
 - iv) Pressure gauges 100mm dia with brass syphone pipe & gauge cock v) Inspection manhole 450mm dia or hand hole 200 dia.
 - vi) Graded filter media
 - vii) Differential pressure switch

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.0 Softener

- 4.1 The softener shall be vertical type with dished ends meeting the requirements under the data sheets. The softener shall have a manhole, bolted type at a suitable location to facilitate replacement of exchange resin. It shall be mounted on supporting frame so that the softener bottom will be about 300 mm above floor level. Suitable nozzles shall be provided for pressure relief valve, pressure gauge etc.
- 4.2 The vessel shall be of fibreglass with an inner layer of polyester suitable for edible and potable contents or m.s with food grade epoxy quoted from inside and normal epoxy quoting from outside. The vessel shall be tested for 1.5 times the system pressures indicated in the data sheets. The frontal piping shall be of C- PVC or polybutylene rated for 10 bar system pressure.
- 4.3 Regeneration shall take place after the design quantum of soft water is produced. This may be semiautomatic or fully automatic. The semiautomatic process consists of :
- i) Manual observation of recording of quantity of soft water production ii)
Initiate regeneration through a toggle switch which
 - a) Diverts the incoming flow through the ejected and shut-off flow through the softener.
 - b) After preset time, the flow is diverted to the rinse circuit
 - c) After preset time or manual check of rinse water, the main system flow is restored manually by switching off the toggle switch.
- 4.4 In the fully automated system, the quantum of soft water production is computed by the microprocessor and the regeneration process is initiated. Stopping may be time and rinse quality based, through timer and water quality sensor.
- 4.5 Softener shall be provided with the following:
- i) Frontal piping with valves on inlet, outlet, rinse inlets and outlets, sampling cock, brine ejector, brine suction blending bypass etc. as shown. All valves shall be butterfly with flanges.
 - ii) Supporting frame. iii)
Pressure relief valve
 - iv) Pressure gauge 100 mm dia with brass pipe and gauge cock. v)
Inspection manhole 450 mm dia

ANNEXURE-E1 TECHNICAL SPECIFICATION

- vi) Requisite charge of exchange resin
- vii) An FRP brine tank similar to the pressure vessel to hold brine sufficient for two regenerations.
- viii) Integrating water meter on the discharge side or flow measuring transducer.

5.0 Activated Carbon Filter

5.1 The activated carbon filter shall be same as the pressure sand filter but the media shall be activated carbon. Filters shall be provided with necessary steam/ hot water connection for the regeneration of the media.

6.0 Chemical Dosing System

6.1 Chemical dosing systems could be differential pressure type or positive displacement pumps as specified in the data sheets complete with chemical container, piping and valves to make a complete dosing system. Systems shall be compatible with the dosing of following chemicals:

- i) Alum solution for coagulation
- ii) Lime soda solution for PH correction and Co₂ neutralisation
- iii) Ozone dosing system as specified and shown on drawings.
- iv) Any other chemical solution needed in the treatment process

6.2 Differential pressure type dosing systems shall incorporate a calibrated orifice plate with pressure probes in the main water line and the dosing rate shall be adjustable. The system shall incorporate a flow indicator. Pumped system shall have an electric driven positive displacement gear pump with a starter. The pump construction shall be as follows:

Chemical	Head	Piston
----------	------	--------

ANNEXURE-E1 TECHNICAL SPECIFICATION

- | | | | |
|----|--|--|---------------------|
| 1) | Lime, soda, alum etc. | Zinc-free acid resisting phosphor bronze | Stainless steel 316 |
| 2) | Bleaching solution, sodium hypchlorite, acids upto 10% concentration | Ebonite | Glass |

ANNEXURE-E1 TECHNICAL SPECIFICATION

The capacity of each pump shall be capable of being adjusted from 0 to 100 % of its rating. Each pump shall have a pressure relief valve set to operate at 110 % of system maximum working pressure.

- 6.3 The system shall have a chemical mixing tank of FRP/HDPE with a capacity specified. An agitator shall be provided wherever asked for. The tank shall be closed type with openable top and inlet/outlet connections, drain and air vents with valves.
- 6.4 All piping from and to the dosing system shall be flexible white transparent polypropylene with PVC control valves.
- 6.5 Dosing systems shall be activated when the raw water pumps start.

7.0 Piping

- 7.1 All interconnected piping in the plant room shall be galvanised steel conforming to the specifications of international standards.

8.0 Installation, testing & commissioning

- 8.1 All plant shall be laid out generally in accordance with approved layout drgs. The tender drawings show the suggested layout with selected equipment and the contractor should make equipment and material submittals for approvals. All such submittals shall give all the technical and dimensional data and ensure compliance with the specifications and accommodation in the assigned space. Procurement or ordering of equipment shall be done only after such approvals.
- 8.2 Shop drgs. shall be made for plant layouts and piping and got approved before proceeding with the installation.
- 8.3 After installation, all the piping shall be pressure tested to 1.5 times the working pressure or 10 bar whichever is higher. All such tests shall be witnessed and attested by the engineer in-charge without which the system shall not be accepted.
- 8.4 The water treatment plant shall be subject to the following proving tests:
- 1) Capacity testing of all components like pumps, pressure filters, softeners, dosing systems shall be conducted to establish the contracted ratings of each component.
 - 2) Performance testing of the system shall be conducted to validate the system as meeting the intents of the specifications. Design quality of the effluent shall be established through several readings spread over a period of 7 working days.
 - 3) All electrical components like motors, cables etc. shall be meggar tested for Insulation Resistance.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4) All tests shall be witnessed and attested by the engineer-in-charge.

8.5 The plant shall be run for a period of 7 days (24 hours a day if the plant is meant for 24 hour operation) for testing and validation and during the period the contractor shall train the assigned engineers/operators of the client in all aspects of operation, trouble shooting and maintenance.

9.0 **Mode of measurement**

9.1 Raw water pumps & back wash pump with pressure gauge on delivery side, foundation bolts, nuts etc. shall be measured as one unit and paid.

9.2 Pressure filter and activated carbon filter with frontal piping, valves and pressure gauge shall be measured as one unit for payment. The filter media shall form part of filter.

9.3 Softener with frontal piping and valves, pressure gauges, requisite charge of exchange resin, brine tank with interconnected piping etc. generally as specified shall be measured as one unit.

9.4 Dosing Systems complete with chemical container, pumps, piping, valves etc. shall be treated as one unit.

9.5 All plant room piping and shut-off valves shall be measured per unit as defined in the schedule of work.

9.6 Electrical Panel shall be measured per unit with all components as specified and shown on drgs.

9.7 All cabling including end connections shall be measured per unit length. Starters or isolators or junction boxes with connector, supporting frame shall be paid per unit and the braided flexible cable shall be per piece not exceeding 1.0m.

2. TECHNICAL SPECIFICATION FOR REVERSE OSMOSIS PLANT

1.0 **Scope**

1.1 The scope of work covers supply, installation, testing and commissioning of a total Reverse Osmosis plant meeting the intents of specifications, data sheets and drawings.

2.0 **Design Criteria**

ANNEXURE-E1 TECHNICAL SPECIFICATION

2.1 The plant design shall be based on the feed water quality shown in Data Sheet WT – RO. The permeate quality and quantity shall be better than that specified in the data sheet.

3.0 **Equipment & Installation**

3.1 High pressure pump shall be multistage centrifugal type with duty rating specified in the data sheets. Pump impellers and shaft shall be of SS 316.

3.2 Cartridge filters shall be polypropylene 5micron type in a SS 304 housing. The housing shall accommodate the no. of cartridges as required for the flow conditions.

3.3 R.O unit shall consist of spiral wound membrane of spirally wound composite polyamide of ultra low pressure. Membrane elements and Pressure tubes (SS 316) shall be selected for an output specified in the data sheets. The R.O tubes shall be neatly mounted on a powder coated structural steel skid.

3.4 Degasser tower shall be of M.S Construction with polypropylene pall rings. Degasser blower shall be Roots type of adequate capacity.

3.5 All dosing systems shall comprise a HDPE solution tanks and metering pump as shown in the data sheets and drawings.

3.6 All high pressure piping shall be S.S and low pressure piping of CPVC of appropriate pressure rating. Valves shall be S. S. ball type.

3.7 A control panel shall be provided with necessary pressure gauges, hi/lo pressure cut offs, pump starter etc.

3.8 A membrane cleaning system with solution tank, circulating pump etc. shall be provided.

4.0 **Performance Guarantee**

4.1 The tenderer should submit a performance guarantee on the following parameters.

1. Quality and quantity of the permeate.
2. Energy cost per m³ of permeate
3. Chemical cost per m³ of permeate
4. Estimated cost of replacement of cartridge filters, membrane elements etc. per m³ of permeate.

5.0 **Testing and Commissioning**

5.1 The R.O system shall be tested with the raw water as specified. Test samples of Raw water & permeate shall be taken every 4 hours for 3 days consecutively to establish

- 1) Treated water quality, and compliance with the specifications.
- 2) Permeate recovery percent.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.2 In addition, the working parameters of the high pressure pump and the system safety features shall be tested and validated.

6.0 **Mode of Measurement**

6.1 The mode of measurement shall follow the schedule of work.

3. TECHNICAL SPECIFICATION FOR WATER CIRCULATION SYSTEM

1.0 **Scope**

1.0 Scope

1.1 The scope of work covers supply, installation, testing and commissioning of Water Circulation Systems meeting the intents of the data sheets and drawings.

1.2 The Systems shall meet the design parameters set in the data sheet VSP & VSPP.

2.0 VSP System

2.1 The VSP System shall be a standard tested product of approved manufacture and shall consist of :

- 1) Pumps
- 2) Suction and discharge headers with valved pump connections
- 3) Bladder type pressure vessel
- 4) Microprocessor based control panel with variable speed drive, line starters, power distribution with incomer and outgoing breakers.
- 5) All prewired power and control wiring with a suitable interface with third party building management system.
- 6) Skid mounting

2.2 The pumps shall be vertical multistage all stainless steel with mechanical shaft seals operating at not more than 3000 rpm synchronous speed. The no. of pumps, 2 or 3, shall be as shown in the data sheets. All pumps shall be driven by a 3 Ph induction motor to IP 54 protection enclosure.

2.3 There shall be amply designed (max. 2.0 mps) suction and discharge headers with flanged connections on both sides of the headers. One side on each header shall be blank flanged and the other side shall have a flexible connector suitable for the system piping. Headers shall be connected to each pump on the suction side with a butterfly valve and on the discharge side with a non-return

ANNEXURE-E1 TECHNICAL SPECIFICATION

and a butterfly shut-off valve. Entire assembly shall be pre-fabricated and mounted on a galvanised steel skid.

- 2.4 A bladder type booster vessel, steel or FRP, with moulded one-piece Butyl bladder shall form part of the system. The boosting capacity shall meet the requirements shown in the data sheet. The vessel may be mounted on the skid and connected or mounted separately and connected to the header.
- 2.5 A microprocessor based control panel shall house an incoming circuit breaker, outgoing circuit breakers, one variable speed drive one or two line starters, a control transformer and all control elements like pressure switches, timers, sequence relays, over current, earth leak and dry running protection. The panel shall incorporate a voltmeter with selector, discharge water pressure indicator (digital) and dry running protection. Pump motors shall be prewired with copper conductor steel braided LAPP flexibles. Control cabling from the pressure sensors to the control panel shall be made on site using multicore PVC insulated and armoured cables with FRLS sheath. The panel shall meet with IP 52 enclosure standard with a safety OFF provision and shall be mounted on the skid.
- 2.6 The pump operation shall follow a sequence as suggested below:
- i) On loss of pressure in the supply header one pump shall start, followed by the 2nd pump through a time delay.
 - ii) One pump will be through the variable speed drive in two pump configuration and two pumps in 3 pump configuration.
 - iii) After every stoppage, the pump starting sequence should be modified so that there is equal running of pumps during a day.
 - iv) All pumps shall be protected against dry running.
 - v) Total pump failure or breakdown of the system shall setoff an alarm with signal to the third party Building Management System.

3.0 **Installation, testing and commissioning**

- 3.1 The system shall be pre-assembled and factory tested before being installed. The site installation procedure shall be the minimum by way of levelling, external control wiring, checks on electrical connections, meggar testing.
- 3.2 After installation, the system shall be tested and validated for:
- i) Start/stop functions ii) Sequencing
 - iii) Dry running protection

ANNEXURE-E1 TECHNICAL SPECIFICATION

- iv) System failure/switch off alarm and interface with BMS
- v) Emergency stop function

3.3 The clients operating staff shall be trained in the operation of the system for a period of 3 days and all the above tests shall be carried out on all the three days to familiarise the staff. All tests shall be jointly signed by the contractor and the clients representative.

4.0 Mode of Measurement

4.1 The variable speed pumping shall be measured as one unit and shall comprise :

- 1) Pumps
- 2) Pressure vessel
- 3) Supporting system
- 4) All piping, valves gauges covering
 - i) Pump suction header & individual valves, gauges etc.
 - ii) Pump discharge header with valves, gauges etc. upto and including pressure vessel.
 - iii) All control piping, air/water for pressure or level monitoring and control components.
- 5) The control panel for the VSP System & the power and control cabling
- 6) Level/Pressure sensors
- 7) Any other materials required for the system.

4. TECHNICAL SPECIFICATION FOR PAINTING

1.0 **Scope**

1.1 The scope of work covers painting of:

- i) All equipment
- ii) Piping & pipe supports
- iii) Duct & duct supports
- iv) Electric Panels & cable trays

1.2 All equipment and piping shall be painted in accordance with the following colour code (or other colours if specifically requested for by the Project Manager.

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
COLD WATER				
Municipal	Sea green	-	-	- White Brown
Domestic	- do -	25	1500	Red Red
Flush	- do -	25	1500	(chain dotted)
Hot water supply	- do -	25	1500	
Hot water Ret	- do -	25	1500	
DRAINAGE				
	Black			
Soil	- do -	-	-	- White White
Waste	- do -	25	1500	(Chain dotted)
Vent.	- do -	25	1500	
Rain water	- do -	-	-	
FIRE				
Hydrant line	Fire Red	-	-	- White
Sprinklers	- do -	25	1500	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>Width</u> (mm)	<u>BAND</u> Spacing (mm)	<u>Colour</u>
STEAM	Silver grey			
Over 3 kg	- do -	-	-	- Red
Upto 3 kg	- do -	25	1500	Red
Condensate	- do -	25	1500	(Chain dotted)
AIR				
Compressed Air	Sky blue	-	-	- OILS
HSD	Light Brown	-	-	- White
LDO	- do -	25	1500	
NATURAL GAS	Light Brown	25	1500	White & Blue
WATER CHILLING UNIT				
a) Compressor b)	Dark Adm. Grey	-	-	-
Motor		-	-	- "
c) Condenser	Steel Blue			
REFRIGERANT PIPING				
a) Hot gas	Signal Red	25	1500	- White
b) Liquid lines c)	Signal Red	25	600	-
Suction	Riveira Blue	-	-	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		<u>Colour</u>
		<u>Width</u> (mm)	<u>Spacing</u> (mm)	
PUMPS & MOTORS	Canary Yellow	-	-	-
CHILLED WATER				
a) Supply	Fiesta Blue	-	-	-
b) Return	Fiesta Blue	25	600	White
CONDENSER WATER				
a) Supply	Steel Blue	-	-	-
b) Return	Steel Blue	25	600	White
COOLING TOWERS	Steel Blue	-	-	-
DUCTS & DUCT SUPPORTS	Black or as directed	-	-	-
a) Exposed ducts b) Support	Approved colour			

ANNEXURE-E1 TECHNICAL SPECIFICATION

UNIT COLOUR & AH Fiesta Blue

(28-9104

ELECTRIC PANELS Steel grey

Notes: 1) All colours and codes refer to ICI DULUX Synthetic Enamel colours. Nearest equivalent acceptable.

2) The painting shall be with synthetic enamel paint unless otherwise specified.

2.0 All surface to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat of red oxide primer shall be applied completely covering the exposed surfaces. Out finish coat of painting shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Project Manager. Black steel ducts shall be painted with a prime coat and above and galvanised steel duct need to be painted without the need of a prime coat.

3.0 **Mode of measurement**

3.1 All painting shall form part of the cost (item rate) of equipment, piping etc. No separate payment shall be admissible.

5. TECHNICAL SPECIFICATION FOR PIPING INSTALLATION

1.0 **Scope**

1.0 **Scope**

1.1 The scope of work covers supply, installation, testing & commissioning of all piping.

2.0 **Standards**

2.1 Following codes and standards shall be applicable.

IS . 1239 – 2004 (Parts1 & 2) - Mild steel tubes and tubulars & wrought steel fittings.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- IS . 3589 – 2001 - Steel pipes for water & sewage. IS .
6392 – 71 - Steel pipe flanges

2.2 All standards mean the latest

3.0 **Application**

3.1 This specification shall be applicable to pipes covering the following fluids:

- i) cooling water not exceeding 50° C
- ii) chilled water not less than 6° C
- iii) hot water not exceeding 60° C

4.0 **Pipes & Fittings**

4.1 Pipes shall conform to the following schedule:

NB	Pipe (mm)		Material
	Min.OD	Thickness	
25	33.3	4.05	ERW Heavy class mild steel tube to IS-1239-90 Part I
40	47.9	4.05	
50	59.7	4.50	
65	75.3	4.50	
80	88.0	4.85	
100	113.1	5.40	
150	163.9	5.40	
200	219.1	6.00	ERW pipes to IS 3589-1991
250	273.0	6.00	
300	323.9	6.00	
350	355.6	7.00	
450	406.4	7.00	

All pipes shall be factory fabricated.

4.2 All pipes shall be new and from standard manufacturers.

4.3 All bends upto 65 mm NB shall be hydraulically formed with a minimum R/D of three unless space restrictions inhibit, in which case long radius elbows may be used with the approval of the Engineer-in-charge. For sizes upto 40 mm NB, socket weld fittings shall be used. For larger sizes upto 150-mm dia butt welding wrought steel fittings to BS 1965 and matching with the straight pipe wall thickness shall be used. In the case of larger sizes, the bends shall be fabricated from the same stock of pipe and in at least 4 sections with a radius equal to + / -

ANNEXURE-E1 TECHNICAL SPECIFICATION

1.5 times the diameter.

- 4.4 Flanges shall be slip-on carbon steel with plain faces conforming to IS 6392-1971. Flange shall be rated for 1000 kPa or twice the system working pressure whichever is higher and drilled to suit the equipment or valve flange if already drilled. All bolts & nuts shall be carbon steel and gasket 3-mm fiber reinforced PTFE.

5.0 **Valves**

- 5.1 All valves and the flanges shall be suitable for 1000 kPa cold non-shock working pressures or twice system pressure whichever is high.

- 5.2 Valves upto 50 mm NB shall be full bore ball valves with forged body and polished hard chrome plated ball with PTFE seal.

- 5.3 Higher size valves shall be butterfly type. Butterfly valves shall have a fine grain cast iron body with mirror smooth finished cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer-type and should be fitted with two slip on type pipe flanges. The valve shall have an easily replaceable molded EPDM sleeve which shall bring about 100 % tight shut off at the design working pressure. Shaft bottom shall have an axial bearing Where valves are to be insulated they should have on extended neck.

- 5.4 Non-return valves upto 50 mm NB shall be swing-type of gun metal construction with flanged ends. Larger sizes shall be of cast iron construction with gun metal internals and flanged ends.

- 5.5 Water strainers shall be either 'Y' or pot type with cast iron bodies for specified test pressure. Strainers shall be complete with brass basket with 3 mm perforations, a dirt blowout plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe and shall have flanged end connections.

- 5.6 Manual air vents shall be provided at all high points in the piping systems for air purging. Vent sizes shall be as follows and suitable for specified test pressure.

Up to 152 mm : 12 mm size ball type gun metal valves with hose connections.

Over 152 mm : 20 mm size globe type gun metal valves with hose connections.

Air vents associated with equipment or cooling coils shall be 12mm automatic venting type with a shut off ball cock and a plastic pipe discharging into the condensate drain. Such air vents should form part of the coil or equipment.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.7 Drains shall be provided at all low points and all drain valves shall be gunmetal globe type with hose connectivity. Drain sizes shall be 25 dia or as shown on drawings.
- 5.8 Pressure gauges shall be “Bourdon’ type with minimum 100 mm dial and required range. All gauges shall be provided with gun metal plug type gauge cocks and copper or S.S capillary connection to prevent system fluctuations affecting the gauge. Gauges shall be provided wherever shown.
- 5.9 Thermometers shall be industrial direct reading stem type of the required range. Thermometers shall be provided in separable wells.

6.0 Pipe Installation

- 6.1 Pipe installation shall be carried out in a workman-like manner in accordance with approved drawings. Pipes shall be aligned parallel to walls and ceiling and not across a room. Change of direction shall be through hydraulically formed or wrought iron welding fittings as specified. Alignment shall follow the approved drawings and wherever necessary pipe shall be rerouted under the instructions of the Engineer- in-charge in order to meet the site conditions and or interference from services.
- 6.2 Pipes passing through walls & floors shall be provided with sleeves as follows:

Space	Sleeve dia (mm)	Sleeve Projection (mm)	Sleeve Material	Sleeve packing and Closure
<u>Floors</u>	D + 50	50 AFF	1.25 mm GSS OR Light duty galvanised tube	32 Kg/cum Resin bonded fibre glass with 8 mm thick polysulphide or Silicon sealant
<u>Walls</u>				
i) Internal	D + 50	Flush with Finish	- do -	32 Kg/cum Resin bonded fibre glass closed on both sides with 1.0 mm GSS split flange

ANNEXURE-E1 TECHNICAL SPECIFICATION

ii) External	D + 50	- do -	- do -	Caulked with lead wool and oakum & closed on both sides with 1.25mm GSS split flanges with brass screws
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D = Outside diameter of pipe with insulation
 GSS = Galvanised sheet steel
 AFF = Above finished floor

6.3 Pipe supports shall be standard factory made galvanised systems or fabricated from steel structurals galvanised after fabrication. Supports shall be spaced as follows:

Size	Horizontal	Vertical
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150 & over	3.00 m	3.0 m

6.4 Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by the Engineer-in-charge. Pipe hangers shall be from galvanised structural steel, steel inserts in concrete or anchor fasteners, wall brackets or floor supports as decided by the Engineer-in-charge depending upon the location of the support. Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50mm. All supports suspenders and hangers shall be galvanised after fabrication.

6.5 Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanised mild steel. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamping arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60% of its compression strength.

6.6 Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support at the lowest point.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.7 All pipe joints shall be welded except where flange joints are specified. Pipes upto 40 mm NB shall use socket-weld fittings with fillet welding and larger sizes use butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:
- i) Pair of flanges for isolation of equipment
 - ii) Mating flanges for equipment flange connections
 - iii) Mating flanges for valves, strainers as the case may be iv) Pair of flanges at every 30m continuous run of piping
- Galvanised pipes when welded, the joints shall be painted with zinc – rich paint as approved by the Engineer.
- 6.8 Where valves, strainers, NR valves adjoin, there is no need for additional mating flanges and valve flanges may be used to mate with the other valves, strainers etc.
- 6.9 Entire piping shall be self-draining, using only eccentric reducers at all change of sections. 25mm NB drain points with a dirt leg and a shut off valve shall be provided at all low points of the piping and the piping system shall be pitched 1% towards such low points. All air handling unit drains shall be pitched 2% with a 75-mm water seal trap. Fan coil unit drains also shall be pitched likewise but the water seal could be 40 mm. All traps shall be built-up or prefabricated. In the case of the multiple risers of supply and return water lines, isolating valves with a strainer and drain valve shall be provided wherever required. All isolating valves shall be gate/ball/ butterfly valves suitable for tight shut-off. Valves shall not have their spindles downwards.
- 6.10 A vent shall be provided at high points. All vents shall have a shut off ball valve with hose connectivity.
- 6.11 Where pipes are directly buried in ground, the pipes shall be coated 2.0mm “Sealfas’ or equivalent coating.
- 6.12 Pipes shall be buried at a depth of 750 mm to top of pipe. The excavated trench be filled with soft earth/sand for atleast 150 mm over the top of pipe before being refilled with the excavated soil.
- 6.13 Where pipes are buried at less than 750 mm, the pipes shall be duly protected as directed by the Engineer-in-charge.
- 6.14 All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer as to the alignment and height, the piping shall be full welded. Slip-on flanges shall be demounted for welding. Piping may be presented to the Engineer for such approval in sections. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 Testing

7.1 Hydraulic testing of piping shall be carried out before equipment connections are made. No insulation shall be carried out unless and until the piping, in section, is tested and tests approved. Piping may be tested in sections, with the approval of the Engineer and in such cases all open ends shall be blanked off with necessary flanges.

7.2 All piping shall be tested for pressure equivalent to the following:

2 x dynamic head of the pump plus the gravity head due to expansion tank or cooling tower.

In such a pressure test, the system shall hold for a minimum period of 3 hours. All pipe testing shall be witnessed and certified by the Engineer- in- charge and leaks or defects found in the joints shall be rectified.

7.3 The contractor shall make all arrangements for testing & removal after testing of all water connections, if any, without causing any damage to the property of the employer or any other contractor.

7.4 After the entire piping has been tested and equipment connected, the system of water piping shall be filled and drained till all the dirt, milscale and any other foreign matter is flushed out to the satisfaction of the Engineer-in-charge. At any rate, the system shall be flushed at least 3 times before commissioning. All strainers shall be cleaned of all accumulated dirt before the system is charged.

8.0 Mode of measurement

8.1 All pipes shall be in unit length rounded off to the nearest centimeter and measured along the center line of the pipe and all fittings, flanges etc. excluding the flange to flange distance of valves, strainers or any other equipment. The rate shall include all clamps, bolts etc. cutting holes in ceiling, floor or wall and making good the same including scaffolding, staging supports, flexible etc. and painting of piping as per the painting specifications or as directed by the Engineer – in – charge.

8.2 All valves, strainers etc. shall be measured per unit in each size and paid for.

8.3 All pressure gauges complete with socket, gauge cock and pressure gauge and CP brass capillary shall be measured per unit.

8.4 Thermometers together with thermowell, conducting fluid etc. shall be measured as one unit.

8.5 Air vents and drains shall each be measured per unit and paid for. Auto air vents with cooling coils / equipment shall form part of the coil or equipment.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6. TECHNICAL SPECIFICATION FOR MV SWITCHGEAR

1.0 Scope

1.1 The scope of work shall cover the supply, installation, testing and commissioning of all power panels, incorporating circuit breakers, switch fuses, busbars, interconnections, earthing etc.

2.0 Standards

2.1 The following standards and rules shall be applicable:

- 1) IS:13947:1993 Switchgear & Control gear specification
- 2) IS:8623:1993
Parts 1 & 3
Low Voltage Switchgear and Control gear assemblies.
- 3) Indian Electricity Act and Rules

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the applicable Codes of Practices of the Bureau of Indian Standards.

3.0 Air Circuit Breakers

3.1 Air circuit breakers shall be heavyduty air break horizontal draw out fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 600V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits specified.

3.2 Breakers shall be, motorised or manually operated as specified, complete with front-of-the-panel operating handle, isolating plugs with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes and trip free operation. Breakers shall be capable of being racked out into 'testing', 'Isolator' and 'Maintenance' position and kept locked in any position. Breakers for remote and automatic operation shall be motor operated spring charged with closing and trip coils. Breakers shall have minimum 3 NO-NC contacts. Breaker terminals shall be shrouded.

3.3 Construction:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 1) ACB should be with safety shutter, Anti-pumping and rating error preventer.
- 2) Cradle: Should be service, test, isolate & maintenance positions
Racking handle should be stored in cradle.
Electrical breaker should not close during travel from service and test position and vice versa.
- 3) Inter-phase clearance should be more than 25 mm after termination of bus bar.
- 4) Neutral pole rating should be equal to phase rating unless specified otherwise
- 5) Electrical /Mechanical life: 15000 Cycles up to 2500A and 5000 cycle above 3200A.

3.4 Release:

- 1) All releases in ACB should be communicable microprocessor Based and having over load, short circuit and earth fault protection.
- 2) Release should be operated through magnetic fluxing device direct on trip rod.
- 3) Release should be True RMS, self powered using CT.
- 4) Release should have zone selectivity facility.

3.5 Breaking:

- 1) As per SLD $ICU=100\%ICS=ICW$ for 1 sec
- 2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

4.0 MCCB's

4.1 Construction

- 1) MCCB should be current limiting type, and of trip free mechanism.
- 2) MCCB operated with rotary handle having door interlock facility.
- 3) All accessories like Shunt release, UV release, Aux & trip contacts should be site fittable.
- 4) Phase to phase barrier should be provided with MCCB.
- 5)

4.2 Breaking:

- 1) As per SLD $ICU=100\%ICS$.
- 2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.3 Release:

- 1) Ratings equal and above 200Amp. should be Microprocessor based with over load ,short circuit ,earth fault protections
- 2) Ratings less then 200A should be adjustable thermal and magnetic type.

5.0 Switch Fuse Units & Disconnectes

5.1 Switch fuse units shall have quick-make, quick-break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting.

All switches shall be rated according to the equipment schedule or drawings and shall withstand the system prospective fault current let through.

Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type. All switch fuse unit should be AC23A.

5.2 Fuses shall be HRC cartridge type conforming to IS:2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type diazed fuses are not acceptable for any ratings.

5.3 All disconnecting isolators shall consist of switch units quick-make, quick-break type with silver plated contacts. The switches shall preferably have double breaks. The switches shall have sheet steel enclosure, which in turn is mounted on suitable angle iron frame work. In wet locations switches shall have cast iron enclosures. Disconnects shall have a minimum breaking capacity of 5KA at 415 Volts.

6.0 Isolators

6.1 Isolators shall be fixed on wall on self-supported angle iron framework as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.

6.2 Painting, earthing and labels shall be provided as generally indicating for MV Switchgear and shown on drawings.

7.0 Instrument Transformers, Meters & Relays

7.1 Ammeters and voltmeters shall be electronic digital type. Meters shall conform to BS:89 and have grade 'A' accuracy.

7.2 Energy meters shall be electronic two element switch board mounting type suitable for unbalanced loads. In case of two incoming feeders, a summing C.T shall be provided with the meter. Meters shall conform to IS: 37.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 7.3 The energy meters for grid supply and DG supply shall be calibrated and got certified by the respective Electricity Authority wherever required.
- 7.4 CTS shall be cast resin type and conform to IS:2705 in all respects. Rated secondary current shall be 5A unless otherwise stated. Accuracy class of metering CT's shall be 1.0 & for protection 5P20 or as specified in the datasheets. Test links to be provided in secondary connection to facilitate testing of instruments, meters & protection device. CT burden shall be minimum of 10VA but appropriate to the instruments, relays connected or as specified in the datasheets.
- 7.5 Relays and trip devices shall be any one of the following as specified:
i) Adjustable Thermal – Magnetic trips – direct acting ii) Solid state relays with shunt tripping.
iii) Microprocessor controlled relays numerical type with shunt Tripping.
All trips shall be 400/230V AC series type unless shunt tripping is specified for.
- 7.6 LED indicating lamps to be provided for phase indication & breaker position as required.
- 7.7 All wiring for relays shall be of stranded copper with colour coding and labelled with appropriate plastic tags for identification. Minimum size of control wiring shall be 2.5 sqmm stranded copper. All control circuits to be provided with protective MCB's or fuses consistent with short circuit levels.
- 8.0 **Cubicle Boards**
- 8.1 All boards shall be combination of 14 SWG (Main Body) & 16 SWG (Doors & partitions) sheet steel, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle as per IP 52, flush dead front and of modular construction suitable for 3 phase 415V 4 wire 50 Hertz system TN-S neutrals grounding. All boards shall be accessible from the front as shown on Drgs, for the maintenance of breakers, switch fuses, busbars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom as specified in drawings. All panels shall be machine pressed with punched openings for meters etc. mounted on a 75mm high base channel frame. All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with powder coating of approved colour applied over a primer. Aluminium anodized Engraved labels having white letters on black background shall be provided indicating the feeder details and capacity. All panels shall be provided with danger boards on bus bar & cable chamber.
- 8.2 The boards shall accommodate air insulated bus bars, air circuit breakers, mccb's switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.

ANNEXURE-E1 TECHNICAL SPECIFICATION

8.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an inter-locked door with facility for padlocking. Each switch or MCCB or ACB shall have provision for locking in the OFF position for life safety. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. Glands shall be of heavy duty brass casting, machine finished & complete with check nut, washers etc. The lugs shall be tinned Cu /Al depending upon cable conductor & of solderless crimping type. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 13947. Feeder connections shall be of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required and if insulated, the insulation shall be able to withstand the high temp at the terminals. Internal wiring, bus bar markings etc. shall conform to IS:375/1963. Internal wiring shall have terminal ferrules.

Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75M from floor level. Cable glands shall form part of the switchboard.

8.4 Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, 1ph 50 Hz supply. They shall be complete with MCB or HRC fuses, isolating switches & adjustable thermostat.

8.5 Each panel shall be provided with 240V 1ph 50Hz , 5A 3pin receptacle with switch located at a convenient position.

9.0 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy (E91E) as specified and shown on drawings and rated for a temperature rise of 30 deg C over the ambient temperature specified, (IS:8084-1976). Neutral bars may be of one half the size of the phase bars or as shown on drawings. The main horizontal bus bars shall be of uniform cross section and rated for the incoming switch. The vertical bus bars for the feeder columns may be rated at 75% of aggregate feeder capacity and shall be uniform in size. Bus bars and interconnections shall be taped with PVC colour coded tape to prevent bar-to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded and supported on non-hydroscopic insulator blocks to withstand thermal and dynamic overloads during system short circuits.

Feeder connections shall be solid copper bus bars duly insulated with bimetallic clamps where we required. Bus bars shall be designed for easy extension in future on either side. All feeder connections shall be rated for 25°C temperature rise over the ambient.

ANNEXURE-E1 TECHNICAL SPECIFICATION

10.0 Earthing

10.1 An earthing bus shall be provided at the bottom & extended throughout the length of panel. It shall be bolted / welded to the frame of each unit & each breaker earthing bar.

10.2 Protective earthing shall be provided as shown on drawings or as follows:

	Phase
	Protective conductor
	conductor
	upto 16 sqmm
	equal size
16 to 35 sqmm	16 sqmm
over 35 sqmm	50% of phase conductor

In case of dissimilar materials the Protective Earth Conductor shall be suitably sized for equal conductance.

- 10.3 Protective earthing of each switch shall be connected to the earth bar.
- 10.4 All non current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

11.0 Installation

- 11.1 All panels shall be supported on MS channels incorporated in the panel during the fabrication. All such supports shall have two finish coats over a prime coat after completion of the work. All panels shall be touched up for damaged painting.
- 11.2 All panels shall be megged phase to phase and phase to neutral using a 1000V meggar with all outgoing feeders in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phases and neutral.
- 11.3 Fabrication drawings of all panels shall be approved by the Consulting Engineers before fabrication.

12.0 Testing & Inspection

- 12.1 All switchboards shall be factory inspected before finishing and dispatch unless waived. Type test reports for all switchgear shall be furnished.
- 12.2 Certificate for all routine and type tests for circuit breakers in accordance with the IS:2516-1963 shall be furnished. In addition, all panels shall be megged phase to phase and phase to phase neutral, using a 1000V

ANNEXURE-E1 TECHNICAL SPECIFICATION

meggar with all switchgear in closed position. The meggar values should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

- 12.3 All meters shall be calibrated and tested through secondary injection tests.
- 12.4 All field tests shall be witnessed by Consultants and recorded unless waived.

13.0 **Mode of measurement**

- 13.1 Each panel will be considered as one unit for the purpose of measurement and shall include the following:
 - i) Incoming and Outgoing feeders.
 - ii) Interconnections and controls and instrument wiring with necessary protective fuses.
 - iii) Meters, Relays, Indicating lamps, CT's control fuses etc.
 - iv) Supporting structure, sheet steel enclosure
 - v) Installation, commissioning and testing
- 13.2 Isolators shall each be measured as one unit complete with:
 - i) mounting frame
 - ii) switch/fuse
- 13.3 Protective earthing of the panel/Isolator from the equipment earthing system will be measured separately and paid at unit rates.
- 13.4 Outgoing and incoming feeder terminations will be paid at the unit rates separately as specified under cabling.

7. TECHNICAL SPECIFICATION FOR PROTECTIVE EARTHING

1.0 **Scope**

- 1.1 The scope of work shall cover earthing stations, laying aluminum/ copper earth strips and connecting the power panels, DBs and switch boards.

2.0 **Standards**

- 2.1 The following standards and rules shall be applicable:

- 1) IS:3043 - 1966 Code of Practice for earthing.
- 2) Indian Electricity Act and Rules

- 2.2 All codes and standards mean the latest.

3.0 **Plate Earthing Station**

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.1 The substation earthing shall be with copper plate earthing station unless otherwise specified.

3.2 The earthing station shall be as shown on the drawing. The earth electrodes shall be 600 x 600 x 3mm copper plate. The earth resistance shall be maintained with a suitable soil treatment and watering arrangement as shown on drawings. Excavated soft soil shall be thoroughly mixed with bentonite material and the earth pit is back-filled 300 x 300 earth chamber with cast iron cover shall be provided to house the earth terminal and water pipe & funnel.

3.3 The resistance of each earth station should not exceed 3 ohms.

3.4 The earth lead shall be connected to the earth plate through copper/brass bolts as shown on the drawing.

4.0 Pipe Earthing Station

4.1 The pipe earth station shall be as shown on the drawing and shall be used for equipment protective earth grid. The earth electrode shall be 2.5m long 50mm dia 5mm thick galvanised steel pipe. The earth resistance shall be maintained with a suitable soil treatment as shown on drawings and as for plate electrodes. An earth chamber shall be provided as for plate earth station.

4.2 The resistance of each earth station should not exceed 5 ohms.

4.3 The earth lead shall be fixed to the pipe with a clamp and safety set screws. The clamps shall be permanently assessable.

5.0 Earth leads and connections

5.1 Earth lead shall be bare copper or aluminium or galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 percent. Aluminium and galvanised steel buried in ground shall be protected with bitumen and Hessian wrap or polythene faced hessian and bitumen coating. At road crossings necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles on wall so that the strip is atleast 6mm away from the wall surface.

5.2 All earth strip shall be jointed as follows:

Copper : Copper riveting with 80mm fish plate and brazing

Aluminium : Riveting with 2Nos 100mm long bimetal fish plates using copper rivets

Galvanised Steel : Lap welding with 50mm minimum lap

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.3 All strips shall be run on walls/beams with 6mm thick galvanised steel earth saddles at 500mm centre to centre as shown on drawings.

6.0 Equipment earthing

6.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<i>Size of phase conductor</i>	<i>Copper</i>	<i>Aluminium</i>	<i>Galvanised steel</i>
Upto 16	<	Same	> 1.55
Over 16 to 35	<	16	> 32
Over 35	<	As shown on drgs.	> Minimum
(base)	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

The protective earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

6.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

6.3 Armoured cables shall be bonded to the earth by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. DB's a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

6.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.0 Earthing Installation

7.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

7.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

8.0 Testing

8.1 The following earth resistance values shall be measured with an approved earth meggar and recorded.

- 1) Each earthing station
- 2) System as a whole
- 3) Earth continuity

9.0 Mode of measurements

9.1 Providing earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

9.2 The following items of work shall be measured and paid per unit length covering the cost of the earth wires/strips clamps, labour etc.

- (a) Main protective earth terminal and connections to the earthing stations
- (b) Connections to the switchboard, power panels, distribution boards etc.

9.3 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

- a) Motors - earthing forming part of the cabling/wiring for the motors.
- b) Isolating switches and starters should form part of mounting frame, switch starter etc.
- c) Light fittings - form part of installation of the light fittings. d) Conduit wiring - should form part of the wiring
- e) Cable armouring - should form part of the cable termination.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- f) Street lighting - should form part of the external cable which shall incorporate a protective earth-conductor which shall be used for earthing of the pole etc.

8. TECHNICAL SPECIFICATION FOR MV CABLING

1.0 **Scope**

- 1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

2.0 **Standards**

- 2.1 The following standards and rules shall be applicable:

- | | |
|--------------------------|-------------------------------------|
| 1) IS: 1554 Parts I & II | PVC Insulated Heavy duty cable |
| 2) IS: 3961 | Recommended current Rating of cable |
| 3) IS: 7098 | XLPE Insulated cables |

All codes and standards mean the latest.

3.0 **Cables**

- 3.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. All cables shall have Flame Retardant, Low Smoke Sheath (FRLS) and meet, ASTM norms for the smoke density and Oxygen Index norms. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards.

- 3.2 XLPE cables shall be same as PVC with an FRLS outer sheath.

- 3.3 All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm spacing.

4.0 **Installation**

- 4.1 Cables shall be laid in the routes marked in the drawings. Contractor shall install all conduits/Pipes required for the cable work as per drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

- 4.2 All cables running indoor shall be supported with necessary GI cable trays.

ANNEXURE-E1 TECHNICAL SPECIFICATION

Cable trays shall be hot dip galvanized & minimum 1.8 mm thick. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance (for Rod supports every 1.0m distance) including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

Cable support dimensions shall be as per table 1.1.

Sr. no.	Size	Cable Support
1	1500MM wide	2nos x 40 x 40 x 5MM GI Angle
2	1200MM wide	2nos x 40 x 40 x 5MM GI Angle
3	1000MM wide	2nos x 40 x 40 x 5MM GI Angle
4	750MM wide	2nos x 32 x 32 x 5MM GI Angle
5	600MM wide	2nos x 32 x 32 x 5MM GI Angle
6	For 2 Tier	2nos x 32 x 32 x 5MM GI Angle
7	450MM wide	2nos 8MM DIA GI RODS
8	300MM wide	2nos 8MM DIA GI RODS
9	150MM wide	2nos 8MM DIA GI RODS

4.3 Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

4.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles as shown on drgs. Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cable markers at every 35 meters and at all loop points.

4.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid, on aluminium tag. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands and all lugs shall be double compression type whether so specified or not. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

4.6 Each cable shall be tagged with number that appears in cable schedule & Panel/Distribution board from where it is being laid., tag shall be of aluminium.

5.0 **Testing**

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.1 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

- 1) Continuity on all phases
- 2) Insulation Resistance
 - (a) between conductors
 - (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

6.0 **Mode of measurement**

6.1 Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:

For cables laid indoors:

- i) Cables and clamps
- ii) Installation, commissioning and testing
- iii) Cable marking

OR

For cable buried underground:

- i) Cables and protective bricks & tiles
- ii) Installation, commissioning & testing
- iii) Cable markers

6.2 Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include

- i) Galvanised steel tray with necessary suspenders and frame supporting the tray, anchor fastners, insert plates & necessary support arrangement for completeness of the installation.
- ii) Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.

6.3 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

ANNEXURE-E1 TECHNICAL SPECIFICATION

i) Lugs, glands, bolts, nuts ii) All

jointing materials

iii) Installations, testing and commissioning iv)

Earthing the glands

6.4 For cables buried under ground excavation shall be paid for additionally for the following per unit volume:

i) Excavation and back filling

ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost as stated above.

ANNEXURE-E1 TECHNICAL SPECIFICATION

PLUMBING WORK

VII. TECHNICAL SPECIFICATIONS FOR PLUMBING WORK

1. TECHNICAL SPECIFICATION FOR SANITARY SYSTEM

1.0 Scope

1.1 Scope of work covers supply, installation, testing and commissioning of:

- i) Sanitaryware
- ii) Chromium plated (CP) fittings

1.2 The client reserves the right to supply the sanitaryware and/or the CP fittings in which case, the scope of work shall cover all fixing devices, water and drain connections generally as defined under the mode of measurement and schedule of work.

2.0 Standards

2.1 All sanitaryware shall generally conform to IS: 2550 Part I to VIII unless stated otherwise.

3.0 Materials

3.1 General

3.1.1 All sanitaryware and CP fittings shall be new and of approved make, type and colour. All samples of materials with catalogues, performance data, shall be submitted and got approved before use on the work. Approved samples along with other approved materials shall be neatly displayed on a board and such a display board of samples shall always be in exhibition in the construction office of the Project Manager. Such display shall be used for the day-to-day checking of the materials on site.

3.1.2 In cases where the materials are supplied by the clients, all such materials shall be inspected and received in good condition and thereafter, it will be totally under the safe custody of the contractor till they are handed over satisfactorily after installation, testing and commissioning.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.1.3 Wherever multiple choices of fixtures are offered, the client shall have the final choice.
- 3.1.4 All fixtures shall be complete with all accessories as required for the working of the said fixture as specified.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.2 Indian W.C

3.2.1 Indian W.C shall be in glazed vitreous chinaware white or colour. The W.C shall be provided with a 100 mm white vitreous chinaware P or S trap with or without vents as required.

3.2.2 Each W.C shall be provided with an exposed or concealed type CP brass flush valve or flushing cistern.

3.3 European W.C

3.3.1 European W.C shall be wash down or siphonic, floor or wall mounted in white or colour glazed vitreous chinaware with integral P or S trap as required. Wall hung W.C shall be supported by C.I or G.I floor mounted chair. The W.C shall be provided with an exposed or concealed type brass flush valve or flushing cistern as specified in the schedule of work.

3.3.2 Each W.C shall be provided with a solid plastic seat. The seat shall be fixed to the W.C with acrylic pillar bar hinges. PVC / Rubber buffers shall be provided for the cover.

3.4 Urinals

3.4.1 Urinals shall be lipped type large flat back in white or colour glazed vitreous chinaware of size shown in schedule of work.

3.4.2 Urinals shall be provided with:

- i) 15 dia spreader
- ii) 32 dia CP dome waste
- iii) 32 dia CP P-trap (50 deep) with unions. iv) CP wall flange and pipe up to the wall

All exposed pipes and fittings shall be of C.P brass. The urinals shall be fixed with C.P brass screws. CP bottle traps may be used only with the approval of the Engineer-in-charge.

3.4.3 Urinal flushing shall be through one of the following methods as specified in the schedule of work:

- i) Small urinal flush valve with push button.
- ii) Auto flush valve with DC long life battery or AC supply.

Auto flush shall be concealed in wall and flush pipe shall be of copper or polybutylene or CPVC except the exposed parts which shall be C.P brass.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.4.4 Waste pipe for urinals shall be any one of the following: -

- a) G.I pipes, heavy quality as per I.S 1239
- b) Copper pipes

as specified in the schedule of work or shown on drawings.

3.4.5 Urinal partitions shall be white glazed vitreous chinaware complete with CP brass screws, anchor fasteners etc. as required. Alternatively, the partitions could be of any other material as specified by the interior designers. These shall be provided by others.

3.5 Lavatory Basin

3.5.1 Lavatory basins shall be white or colour glazed vitreous chinaware synthetic or polymarble or any other material and of size, shape and type specified in the schedule of work.

3.5.2 Each basin shall be complete with:

- i) C.I or galvanised steel supporting brackets & clips as required.
- ii) 32 dia CP waste and overflow.
- iii) Pop-up waste or rubber plug with CP chain as specified.
- iv) 32 dia CP P-trap with (50 deep) cleanout, unions, CP pipe to wall and wall flange
- v) 15 dia CP control angle valve/s with CP connections.
- vi) Mixing or CP fittings as specified in the schedule of work.

3.6 Sinks

3.6.1 The sink shall be of size specified in the schedule of work with glazed vitreous chinaware or stainless steel AISC 304 as specified.

3.6.2 Each sink shall be complete with:

- i) C.I or galvanised steel brackets & clips as required.
- ii) 40 dia waste fitting with brass/rubber plug & chain.
- iii) 40 dia P-trap (50 deep) with clean out, unions, CP pipe to wall & wall flange.
- iv) 20 dia CP control valve/s with CP connections.
- v) Mixing or CP fittings with spout as specified in the schedule of work.

3.7 Bath tub

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.7.1 Bath tub shall be polymarble/synthetic marble or reinforced acrylic or pressed steel stove enamelled as specified in the schedule of work.

3.7.2 Each bath tub shall be complete with i) 40 dia

CP waste fitting

ii) Pop-up or CP brass plug with chain. iii) 40/50

dia P or S trap

iv) Supply fittings shall consist of:

a) one or two CP brass pillar taps with hot & cold mixer diverter and spout with/without hand shower.

b) one single lever mixing fitting and spout with diverters for shower and / or hand shower.

c) a manual shower set with one or two CP brass stop cocks exposed or concealed and a high pressure shower head of approved make.

all as specified in the schedule of work.

4.0 Installation

4.1 All sanitaryware and CP fittings shall be installed in accordance with the interior requirements. Neat workmanship and maintaining exact position and level of each fixture shall be the objective of the installation. Care shall be taken to fix inlet and outlet pipes at correct positions. Faulty positioning shall be made good without any damage to the finished floor or wall tiling and any damage to the finished surfaces shall be made good at the contractor's cost.

4.2 In order to ensure quality of workmanship and compliance with interior requirements, one or two mock-up installations shall be done and got approved. Fixtures used in the mock-up may be reused with the approval of the Project Manger / Engineer – in charge.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.3 All fixing accessories like bolts, nuts, brackets etc. may be supplied along with the ware as defined in the mode of measurement and schedule of work. All such accessories shall be CP brass or galvanised or stainless steel as approved by the Project Manger. All exposed pipes, fittings, bolts & nuts shall be of CP brass.
- 4.4 The Indian W.C shall be fixed to level in a neat workmanlike manner. The W.C and trap shall be set in brick bat 1:2:4 concrete mix. Joints between W.C and flush pipe shall be made with a putty or epoxy drip seal or with approved rubber joints. The joint between W.C and trap shall be made with 1:1 cement mortar and shall be rendered leak proof.
- 4.5 The Orissa W.C shall be fixed in level in a neat workmanlike manner. The W.C & trap shall be set in brick bat concrete 1:2:4. Joint between W.C & flush pipe shall be made with approved rubber joint. Joint between W.C & trap shall be made with 1:1 cement sand mortar and shall be rendered leak proof.
- 4.6 Wall-hung European W.C shall be mounted on C.I or GI chairs which are fixed to the floor using anchor fasteners. The bolts and nuts used for fixing the chairs shall be stainless steel and the fixing bolts for the W.C and chairs could be CP brass or stainless steel. Floor-mounted W.C shall be fixed with anchor fasteners using stainless steel CP brass bolts and nuts. The gap between the WC and floor or wall shall be neatly sealed with water proof non-hardening sealant of approved type and colour. The sealant should not protrude beyond the foot print or WC outline.
- 4.7 All W.C's shall be aligned and levelled with the floor and wall tiles so as to present an integrated look. Utmost care and skill shall be exercised to achieve a good installation in keeping with the interior designs.
- 4.8 Urinals shall be fixed to the wall using CP brass bolts and nuts. The urinals shall be held in line and level according to the interior designs and tile modules. Partitions, wherever required to be provided, shall also maintain line and level as shown on drawings and as required. Supply spreader and drain piping and P-trap shall be of CP brass and installed in a neat and workman like manner. No unseemly bends or wooden support pieces shall be permitted.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.9 Wall-mounted lavatory basins and sinks shall maintain line and level as specified by the interior drawings and also with the tile modules. The supply connections shall be of CP brass from the angle stop valves to the pillar taps or single lever fixture and shall display good workmanship. Drain connections shall have a CP P-trap with unions and exposed CP drain pipe and a wall flange or escueheon. In the case of counter mounted basins and sinks extreme care shall be taken to independently and adequately support the basin and aligning with the opening in the counter slab. Supply and drain connections shall be same as for wall mounted basins. The crevices between basin and wall or counter shall be neatly sealed with a non-hardening sealant of approved.
- 4.10 Bath tubs shall be fixed true to level and firmly fixed to anchors or supports provided by the manufacturer. Bathtub flanges shall be truly aligned with the wall on all the sides so as to make a watertight joint. Sealants if any used for edge ceiling shall be non-hardening type. Bath tubs shall be sloped 1:30 towards the drain.
- 4.11 All accessories like the mirror, soap trays etc shall be neatly fixed as per interior designs. Good workmanship is the essence of all sanitary installation for achieving the interior design objectives.
- 4.12 During the construction period, the contractor shall protect all the sanitary fixtures from damage due to accidental or even intentional mechanical impact with hard objects and also misuse and vandalism.

5.0 Testing and Acceptance

- 5.1 The sanitary fixtures form the final terminal units of the water supply and drainage system and should meet the performance needs as a terminal unit. Each fixture shall be inspected for scratches or chippings and alignment before acceptance.
- 5.2 The following design flows shall be verified and validated for acceptance.

W.C	Flush valve	9 ltrs.	Provide test 32 dia valved per flush connection at the lowest floor & highest floor.
	Flushing Cistern (Dual)	6 – 3 ltrs	Fill time between two consecutive flushes. 2 minutes

ANNEXURE-E1 TECHNICAL SPECIFICATION

Lavatory Basin	(CW/HW) Pillar taps) or) Single lever) fixture)	15 lpm max. 10 lpm min	
	Full basin drain time	3 min.	To be measured & validated.
Sink	(CW/HW) Pillar taps) Single lever) fixture)	15 lpm max. 10 lpm min or)	
	Full sink drain time	3 min.	To be measured & validated.
Bath tub	Faucet (CW/HW) Shower Full tub drain time	20-30 lpm 20-30 lpm 10 min.	To be measured & validated.

All tests shall be conducted at each and every fixture except for flush valves which shall be at the lowest and highest test connections to be made on each riser/downtake. The contractor shall make the temporary valve connections which shall be plugged with a brass plug after validation.

6.0 Mode of measurement

6.1 Supply of all Sanitary ware & CP fittings shall be measured per unit and shall include the following

6.1.1 Indian WC's shall include 2# white glazed ceramic foot rests and P or S trap.

6.1.2 Orissa type WC's shall be complete with P or S trap.

6.1.3 Flush valves concealed or exposed shall be complete with operating handle or push and flange

6.1.4 Flushing cisterns shall be complete with fixing brackets, CP flush bend.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.1.5 European WC's shall be complete with

- i) Integral / separate cistern ii)
Flush bend
- iii) G.I or C.I supporting brackets iv)
Seat cover

6.1.6 Urinals shall be complete with fixing accessories.

6.1.7 Urinal flush valves shall be CP brass concealed or open, manual or automatic as defined in the schedule of work.

6.1.8 Bath tubs shall be complete with support legs.

6.1.9 Concealed shower assembly shall comprise

- i) 1 or 2 pillar taps with mixer diverter shower head, and spout with or without hand shower.
- or**
- ii) Single lever mixer diverter, shower head and spout with or without hand shower.

6.1.10 Open shower set shall be same as above but with CP brass piping connections to make it as a whole unit.

6.2 Installation of the various sanitaryware shall be as specified in the schedule of work.

6.3 In case of items which are not defined here, the description under the schedule of work shall be taken in conjunction with the specifications.

ANNEXURE-E1 TECHNICAL SPECIFICATION

2. TECHNICAL SPECIFICATION FOR WATER SUPPLY SYSTEM

1.0 Scope

1.1 The scope of work shall cover supply, installation, testing and commissioning of water piping required in but not limited to the following applications wherever they come up and shall meet the intents of these specifications.

- i) Cold, hot and Flush Water distribution piping.
- ii) Connections to sanitary ware, kitchen and laundry equipment, water treatment plant etc.
- iii) Municipal water connection including meter connection. iv) Piping from tube wells and other water tanks.
- v) Irrigation piping
- vi) Secondary storage tanks, if any.
- vii) All valves, masonry valve chambers etc. viii) Pipe inserts in walls & storage tanks.
- ix) Painting of pipes & supports generally as specified and shown on drawings.
- x) All inserts and vents for underground and overhead storage tanks.

2.0 Standard

2.1 The following standards shall be applicable as revised upto date:

- 1) IS 2026 Code of practice for water supply in buildings.
- 2) ASTM D1784 Standard Specification for Rigid Poly (Vinyl chloride) (PVC) Compounds and Chlorinated Poly (Vinyl chloride) (CPVC) Compounds
- 3) ASTM D2846 Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot & Cold Water Distribution Systems.

ANNEXURE-E1 TECHNICAL SPECIFICATION

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|----------------|---|
| 4) ASTM F493 | Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe & Fittings. |
| 5) ASTM F441 | Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, SCH 40 & 80. |
| 6) IS 7634 | Code of practice for plastic pipe work for portable water supplies. |
| 7) ASTM -1785 | Standard Specifications for Unplasticised Poly (Vinyl Chloride) (UPVC), Schedule 80. |
| 8) ASTM-D-2567 | Standard Specifications for solvent cements for Unplasticised Poly (Vinyl Chloride) (UPVC), plastic pipes & fittings. |

3.0 Materials

3.1 General

- 3.1.1 All materials shall be new of the best quality conforming to the specifications. Where different makes are specified, the choice of make shall rest with the consultants.
- 3.1.2 All samples of materials with necessary catalogues, performance data shall be submitted and got approved before use on the work. Approved samples of all materials shall be neatly displayed on a board and such a display board of samples shall always be in exhibition in the sample room of the construction office of the Project Manger / Engineer – in - charge. Such a display shall be used for the day-to-day checking of the materials on site.
- 3.1.3 In cases where the materials are supplied by the clients, all such materials shall be inspected and received in good condition and thereafter, it will be totally under the safe custody of the tendered contractor till they are handed over satisfactorily after installation, testing and commissioning.

3.2 Plastic Pipes & Fittings

- 3.2.1 All Plastic pipes shall be heavy quality chlorinated Poly Vinyl Chloride (CPVC) tubes conforming to ASTM D2846 for sizes upto 150 dia or UPVC tubes confirming to ASTM – 1785.
- 3.2.2 Fittings shall be of same material as of pipe and approved make conforming to ASTM D-2846 & ASTM-D-1785. All fittings shall have manufacturer's trade mark stamped on it. Fittings shall include couplings, bends, tees, reducers, nipples, union, bushes etc. All fittings shall be suitable for the class of pressure of the piping system.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.3 Valves

3.3.1 All valves and the flanges shall be suitable for cold non-shock working pressures specified under para "Acceptance testing & Commissioning".

3.3.2 Ball valves upto 50mm NB shall be of one piece SS and SS ball with screwed or flanged ends and PTFE seats and seals. Flanges shall be drilled to suit mating flange.

Ball valves over 50 mm NB shall be cast iron no-lubricated full-bore valves with fine grain cast iron (Gr 20) body with mirror finished AISI 410 stain-less steel ball, glass filled PTFE seats and stem seals. Valves shall be suitable for control and drop-tight shut off and shall have flanged ends drilled as required for mating.

3.3.3 Butterfly valves shall have a cast iron body with cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer-type and should be fitted with two slip on type pipe flanges. The valve shall have a molded PTFE sleeve which shall bring about 100 % tight shut off at the design working pressure. Where valves are to be insulated they should have an extended neck.

3.3.4 Non-return valves upto 50 mm NB shall be swing-type of gun metal construction with flanged ends. Larger sizes shall be of cast iron construction with gun metal internals and flanged ends.

3.3.5 Water strainers shall be either 'Y' or pot type with cast iron or fabricated steel bodies for specified test pressure. Strainers shall be complete with brass basket with perforations to mesh 40, a dirt blow-out plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe and shall have flanged end connections.

3.3.6 Manual air vents shall be provided at all high points in the piping systems for air purging. Vent sizes shall be as follows and suitable for specified test pressure.

Up to 152 mm (6") : 12 mm size ball gun metal valves suitable for hose connections.

Over 152 mm (6") : 20 mm size ball type gun metal valves suitable for hose connections.

3.3.7 Drains shall be provided at all low points and all drain valves shall be gunmetal ball type with facility for hose connections.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 3.3.8 Pressure gauges shall be “Bourdon’ type with minimum 100 mm dial and required range. All gauges shall be provided with gun metal plug type gauge cocks and copper or S.S capillary connection to prevent system fluctuations affecting the gauge. Gauges shall be provided wherever shown.
- 3.3.9 Thermometers shall be industrial direct reading stem type or dial type of the required range. Thermometers shall be provided in separable wells where shown on drawings.

4.0 Pipe Installation

4.1 General

- 4.1.1 Shop drawings for the routing of pipes shall be prepared generally on the basis of layout drawings issued. The shop drawings shall reflect the site conditions, structural beams and columns, obstructions by way of any construction elements or any other service pipes, ducts etc duly co-ordinated with other services. The drawings should clearly indicate openings required in brick or concrete walls, drain valves at low points, air valves at high points, isolating valves, if any, and invert levels at every 15m intervals. The drawings should also indicate typical details of hangers, supports, brackets etc. After approval of the drawings, pipe routes shall be marked with a distinct colour of paint on the site and got approved by the Project Manager.
- 4.1.2 All openings and chases in brick walls shall be made neatly and refilled to a reasonable finish with 1:2:4 cement sand plaster with GI chicken wire mesh as a base. However, final finishing will be done by the civil contractor. Openings in concrete walls or floors shall, however, be made only with the approval of the Engineer-in-charge. All such openings for pipe penetrating shall be core-drilled and pipe penetrations, through wall or floor, shall be sealed with an approved fire resistant sealant
- 4.1.3 Good workmanship and neat pipe layout are the prerequisites of these specifications. Horizontal pipes shall be truly horizontal with necessary slopes and hangers or supports as specified and shown on drawings. Vertical pipes shall be truly vertical and shall be laid away from the walls at least by 50mm or as required by the Project Manager / Engineer - in charge. All pipe runs shall be parallel to the ceiling or walls for presenting a neat appearance. Multiple pipe runs shall be parallel with neat gross – overs. Pipes buried in wall shall be laid in machine-made chases.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.1.4 All pipes before and after testing shall be protected with wooden or brass plugs to prevent ingress of dust, sand or any extraneous matter.

4.2 Pipe supports; hangers & clamps

4.2.1 Pipe supports, clamps, suspenders shall be pre-fabricated and galvanised (after fabrication). The support systems shall generally follow the types specified under “PIPE SUPPORTING SYSTEMS”. Application of support systems shall follow the guidelines in the above specifications. Any other types of support, suspension or clamping to meet the site conditions shall be got approved before use.

4.3 CPVC/UPVC Piping

4.3.1 Supports for CPVC/UPVC piping shall be as shown under “PIPE SUPPORTING SYSTEMS”.

4.3.2 All fittings shall be screwed type unless specified otherwise. However, flanged joints shall be provided at the following positions:

i) Pairs of flanges for isolation and removal of flanged equipment. ii)

Mating flanges for valves, strainers, as the case may be.

iii) Pair of flanges or unions at every 25m continuous run of piping for isolation

4.3.3 Entire piping shall be self-draining using eccentric reducers at all change of sections and shall be pitched 0.3% towards low points where a drain outlet with a shut off valve shall be provided. All high points in the piping shall have air vents with shut off valves.

4.4 Insulation

4.4.1 Insulation for hot water pipe lines shall be as follows:

Pipe size	Material	Thickness	Finish
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ANNEXURE-E1 TECHNICAL SPECIFICATION

15 – 40 (buried in wall chase&exposed)	Elastomeric Class 'O' nitrile rubber	6mm	<u>PVC tape</u>
25 -80mm above (exposed in pipe shafts)	Elastomeric Class 'O' nitrile rubber	9mm	<u>28 SWG aluminium cladding</u>
100mm &above	Elastomeric Class 'O' nitrile rubber	13mm	<u>28 SWG aluminium cladding</u>

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.5 Instrumentation

4.5.1 The following instrumentation shall be provided:

Location	Pressure		Temperature	
	Gauge cock	Gauge	Sensor ⁽²⁾	Thermometer
i) Pump suction	x	x	x	-
ii) Pump discharge	x	x	x	-
iii) Cold & Hot water piping ⁽¹⁾	x	-	x	x

(1) Location of instruments as shown on drgs. or as decided by the Project Manager / Engineer in charge

(2) Sensor is only provision of a separable well.

4.5.2 Pressure gauge shall be bourdon tube 100mm dia suitable for the fluid used. Gauge cocks shall be gun metal/brass providing tight shut off. Gauges shall have coiled or capillary type pressure snubber.

4.5.3 Separable well is only for a future temperature sensor or gauge. Sensor will be provided by others. Thermometer wherever required should be dial type or industrial type with a suitable range (40 - 80C) complete with a separable well.

5.0 Acceptance, Testing & Commissioning

5.1 Before testing and commissioning, water shall be filled and circulated through the piping system and flushed out to ensure clean piping. Entire piping installation with all valves fully open, except the terminal fixture valves shall be subjected to a hydraulical test pressure whichever is higher of the following:

i) 2 times the dynamic head of the pump plus the gravity head of an over- head storage or pressure tank.

ii) 2.5 times the no-delivery head (head developed when the discharge valve is closed) of the pump.

5.2 The test shall be for the entire water supply system and shall hold for a minimum of 3 hours without loss of pressure. During the testing period, the contractor should walk along the entire piping system along with the Project Manager / Engineer in charge and validate that there are no leaks anywhere in the system. Such validation shall be carried out segment by segment and recorded. Should there be any leaks in any segment, the system shall be drained, leaks

ANNEXURE-E1 TECHNICAL SPECIFICATION

attended and tested once again as above till the entire piping system is rendered leak-tight and acceptable.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.3 Flow tests at each and every outlet shall be conducted as specified in Section "SANITARY SYSTEM" and all test readings and statements of verification shall form the acceptance test documentation. If the piping was tested in sections during construction phase, all such test records shall form an appendix to the above documentation.

6.0 Mode of measurement

6.1 a) All pipes above ground shall be paid for the length measured along the centre line of the pipe line laid and shall be inclusive of all fittings such as couplings, tees, bends, elbows, union. Deduction for valves shall be made. Rate quoted shall be inclusive of all fittings, supports, suspenders, clamps, painting cutting holes chases and making good the same with fire resistant sealant and all items mentioned in the specifications and schedule of work.

b) Core drilling of concrete floors complete with sealing shall be paid per unit.

6.2 All pipes underground or buried or embedded shall be paid for length measured along the centre line of the pipe line laid and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions and protective coating and wrapping, and supporting systems.

6.3 CPVC/UPVC pipe laid above ground shall be paid for the length measured along the centre line of the pipe line laid including all fittings joints etc. Deductions for valves shall be made. Pipe going into the socket shall not be measured. Rate shall be inclusive of supports, suspenders and clamps, laying, fixing, cutting holes and chases and making good and shall include all items mentioned in the specifications and schedule of work.

6.4 Items such as gate valves, globe valves, ball valves, butterfly valves, non return valves, air valves, scour valves pressure reducing valves etc. shall be measured and paid by number.

6.5 Making connections to pumps, equipment heat exchanger and appliances shall be paid on the basis of unit length under the relevant items.

6.6 Steel structural supports for storage tanks etc. shall be paid by weight of actual length of member installed at site multiplied by its theoretical weight given in the manufacturer's catalogue. Rate shall be inclusive of hoisting, welding, bolting, painting, cutting and making good the walls and all items described in the schedule of work and specifications.

6.7 Special supporting systems for supporting multiple pipes of multiple agencies shall be paid on the following basis:

ANNEXURE-E1 TECHNICAL SPECIFICATION

- i) Theoretical weight of structural members used multiplied by the quoted cost per quintal.
- and ii) Deduct for cost of normal supports as specified at the rate of 5% on quoted rate of all the pipes supported (excluding cost of valves & insulation but including cost of fittings & flanges)

ANNEXURE-E1 TECHNICAL SPECIFICATION

3. TECHNICAL SPECIFICATION FOR INTERNAL DRAINAGE SYSTEM

1.0 Scope of Work

1.1 The scope of work shall cover:

- i) Soil and waste drainage piping including:
 - a) soil, waste and vent stacks. b) connections to sanitary ware
 - c) waste connections to kitchen, laundry, other appliances, floor traps etc.
 - d) connections to Sewage Treatment Plant and External Sewerage system
- ii) Storm water drainage piping including
 - a) roof drainage
 - b) storm water downtakes & catch basins
 - c) connections to external storm water drainage system. d) making water harvesting percolation pits.

2.0 Standards

2.1 All materials and the installation shall meet latest of the following standards:

- 1) IS : 3989 Centrifugally cast iron pipes for low pressures
- 2) IS : 1536 Centrifugally cast iron pressure pipes
- 3) IS : 1726 CI manhole frames & covers
- 4) IS : 5329 Code of Practice for Sanitary pipe work
- 5) IS : 3114 Code of practice for laying of cast iron pipes
- 6) IS : 1239 Steel tubes & tubulars
- 7) IS : 1879 Malleable iron GI fittings
- 8) IS: 13592 UPVC Pipes
- 9) IS : 14735 UPVC Fittings

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.0 Materials

3.1 General

3.1.1 All materials shall be new and of the best quality conforming to the specifications. Where different makes are specified, the choice of make shall rest with the consultants.

3.1.2 All samples of materials with necessary catalogues and performance data shall be submitted and got approved before use on the work. Approved samples of all materials shall be neatly displayed on a board and such a display board of samples shall always be in exhibition in the sample room of the construction office of the Project Manger / Engineer – in charge. Such a display shall be used for the day-to-day checking of the materials on site.

3.1.3 In cases where the materials are supplied by the clients, all such materials shall be inspected and received in good condition and thereafter, it will be totally under the safe custody of the tenderer/contractor till they are handed over satisfactorily after installation, testing and commissioning.

3.2 Cast Iron Pipes & Fittings

3.2.1 Cast iron pipes shall be centrifugally cast low pressure type with spigot and socket ends conforming to Indian Standards specified and generally meeting the following:

Nominal Diameter (mm)	Thickness (mm)	Weight of 1.83m length (Kg)	Internal Diameter of socket (mm)	Depth of lead (mm)
50	3.5	8.5	73	25
75	3.5	12.7	99	25
100	4.0	19.2	126	25
150	5.0	35.5	178	38

ANNEXURE-E1 TECHNICAL SPECIFICATION

Acceptable tolerance for pipes to IS 3939 and IS 1729 shall be as follows a) Wall

thickness -15 %

b) Length +/-20 mm c) Weight

-10 %

All joints shall be with epoxy based drip seal.

3.2.1 Centrifugally a cast low pressure iron pipe without sockets (socket-less) shall generally follow requirements of IS 6163. Fittings shall be socket-less and all joints shall be with a synthetic rubber sealing collar with a stainless steel clamp with two S.S bolts for application of uniform pressure. All materials shall be from approved manufacturers.

3.2.2 Wherever specified centrifugally cast pressure pipes of 'LA' class shall be used. The pipes and fittings shall conform to IS 1536. Fittings shall be spigot and socket type suitable for epoxy drip seal. Where necessary flanged pipes and fittings may be used with a teflon gasket.

3.2.4 Fittings shall be cast iron compatible with the pipes used. Tees, bends, crosses and other specials shall have easy sweep as specified. Cleaning eyes shall be provided wherever required and shall be complete with a sealing gasket and suitable bolts. Cleaning eyes should not be along the flow (such as bends) but behind (such as Y or T).

3.3 Steel Pipes and Fittings

3.3.1 Steel pipes shall be galvanised heavy quality tubes to IS:1239. Fittings shall be galvanised malleable iron conforming to IS:1879 (i to x). Fittings shall include long radius bends, tees, reducers, unions etc.

3.4 PVC Drainage Systems

3.4.1 PVC drainage piping shall be factory made complete systems of any approved makes with all the fittings. The pipes and fittings shall meet with the following specifications:

Pipes : IS: 13592
Fittings : BS: 4574 DIN 19531

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.4.2 All joints shall be snap fit or solvent cement type with rubber ring and shall always produce a 100% water tight joint. Pipe and fittings shall be suitable for the snap fit joint.

3.5 Traps & Seals

3.5.1 All traps shall be self-cleaning and the material and the seal depth shall be as specified below wherever the traps are not integral with the appliances or ware.

Appliance or ware	Trap		
	Material	Type	Seal depth (mm)
Lavatory/Wash basin ⁽¹⁾	CP brass	P	50
Sinks ⁽¹⁾	CP brass	P	50
Floor drain	Cast Iron built-in	P or S	50
Kitchen Floor drain or fabricated drain boxes	Fabricated Stainless Steel (built-in)	P	50
Urinals ⁽¹⁾	C P brass	P	50
Fan Coil Units	Galvanised steel or PVC	P	25
Air Handling Units	Galvanised steel or PVC	P	50
(All P-traps shall have cleaning eye or other cleaning facility)			
Roof Drain outlet	Cast iron	-	-
Plant room floor drains	Cast iron/ fabricated Steel	-	-

⁽¹⁾ Bottle type traps shall be used only with the approval of the engineer.

Any other appliance shall have an appropriate trap as specified by the Engineer-in-charge or as required.

3.5.2 All floor drains shall be cockroach proof covered with perforated stainless steel grating of size specified or required. Roof drain outlets shall have domegrates unless specified otherwise. Plant room floor drains shall have cast iron or fabricated steel grating.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.6 Cleanouts

3.6.1 Cleanouts other than those integral with the fitting, shall be of brass and screw down type. Wherever cleanouts are required in cast iron piping, galvanised steel adaptor shall be provided as part of the cleaning system. Cleanouts shall be accessible from the floor served.

4.0 Drainage System Installation

4.1 General

4.1.1 Shop drawings for the routing of pipes shall be prepared generally on the basis of layout drawings issued. However, the drawings shall reflect the site conditions, structural beams and columns obstructions by way of any construction elements or any other service pipes, ducts etc duly co-ordinated with other services. The drawings should clearly indicate openings required in brick or concrete walls and invert levels at every 15m intervals. The drawings should also indicate typical details of hangers, supports, brackets etc. After approval of the drawings, pipe routes shall be marked with a distinct colour of paint on the site and got approved by the Project Manger / Engineer- in - charge.

4.1.2 All openings and chases in brick walls shall be made neatly and finished with 1:2:4 cement sand plaster on chicken mesh but the final, finish will be by others. Openings in concrete walls shall, however, be made only with the approval of the Project Manger. Pipe penetrations, through wall or floor, shall be sealed with an approved fire resistant sealant.

4.1.3 Good workmanship and neat pipe layout are the prerequisites of these specifications. Horizontal pipes shall be truly horizontal with necessary slopes and hangers or supports as specified and shown on drawings. Vertical pipes shall be truly vertical and shall be laid away from the walls at least by 50mm or as required by the Project Manger / Engineer – in charge. All pipe runs shall be parallel to the ceiling or walls for presenting a neat appearance. Pipes buried in wall shall be laid in machine-made chases with galvanised steel anchors.

4.1.4 All pipes before and after testing shall be protected with wooden or brass plugs to prevent ingress of dust, sand or any extraneous matter.

4.2 Pipe supports; hangers & clamps

ANNEXURE-E1 TECHNICAL SPECIFICATION

4.2.1 All pipe supports, hangers & clamps shall be standard pre-fabricated galvanised (after fabrication) units. Pipe supports shall generally follow the types specified under "PIPE SUPPORTING SYSTEMS" and the associated drawings. Any other type of support, suspension or clamping to meet site conditions shall be got approved before use.

4.3 Soil & Waste Piping

4.3.1 Horizontal pipes shall be suspended from the structural ceiling slab or wall brackets at centres specified in the section "Pipe Supporting Systems".

Pipes shall be laid to an optimum slope of 1 in 60 as far as possible. A liberal provision of easily accessible cleanouts shall be made on all horizontal pipes. Cleaning facility shall preferably be from the floor above the ceiling slab for all underfloor installations. Where horizontal pipes are laid in a sunken floor slab, adequate slopes shall be achieved through galvanised saddles or cement mortar bedding. All such pipes, after testing, shall be covered with and set in cement concrete (1:2:4) so that the pipes are not disturbed during the filling up of the sunken floor.

4.3.2 Vertical stacks shall be truly vertical and parallel to the wall and supported on saddles so that the pipes are at least 50mm away from the finished surface. Branch pipe connections shall be aligned with the bend or tee on the stack. Where the vertical stack meets the horizontal run or a manhole, a 45° tee connection with a cleanout shall be employed to facilitate smooth flow and easy cleanability.

4.3.3 Cast iron spigot and socket pipes and fittings shall be jointed through epoxy based drip seal.

4.3.4 Cast iron socket-less pipes shall be jointed by using rubber/neoprene sealing tube and a stainless steel clamp with two bolts. All materials and method of jointing shall strictly conform to manufacturers standards and recommendations.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.3.5 Galvanised steel drain piping shall be used for appliances, wash basins, sinks, bath tubs etc. using screwed malleable galvanised fittings with approved sealants. Elbows may be avoided as far as possible and long- sweep bends are preferred for smooth flow. Joints between the galvanised steel pipe and cast iron shall be done through appropriate fitting and epoxy sealant as shown on drawings or as instructed by the Project Manager / Engineer – in charge. Exposed pipes shall be CP brass.
- 4.3.6 Where specified, PVC pipes may be used for waste, vent and WC connections. Pipe size shall be as shown on drawings or as required for the appliance. Pipe connection to the cast iron piping shall be through appropriate adapter.
- 4.3.7 All pipes shall be fixed in a gradient towards the outfalls of drains. Pipes inside a toilet room shall be in wall chase unless otherwise shown on drawings. Where required, pipes may be run at ceiling level in suitable gradient and supports as shown in the section “PIPE SUPPORTING SYSTEMS”.
- 4.3.8 Cast iron floor drains shall be set in 1:2:4 cement concrete. Kitchen floor drain boxes shall be as shown in drawings and kept flush with the finished floor. The drain boxes shall have a minimum of 50mm water seal and a suitable perforated grating. Drain boxes shall be connected to the cast iron drain piping through a flanged galvanised steel drain connection.
- 4.3.9 All waste connections shall have the following minimum sizes: Appliance

	Diameter (mm)
Wash basins	32
Sinks	50
Urinals	50
Bidets	32
Shower trays	40
Bath tubs	50
Floor drains	65/75

4.4 Vent Piping

- 4.4.1 Building vent stacks shall be not less than 75mm dia. Where the vent stack becomes one with the main soil or waste stack the main stack size shall not be

ANNEXURE-E1 TECHNICAL SPECIFICATION

reduced. Vent connections on any branch waste drain line shall be at least two thirds the diameter of the branch drain subject to a minimum of 25mm. Vent connection to a soil drain line shall be a minimum of 32mm dia. Vent connections shall be as near to the crown of the trap as possible.

4.4.2 No water shall enter vent lines. Vent lines shall be laid vertically terminated at least 150mm above the open-to-air roof. Vents may be connected back to the waste or soil stack above the highest appliance connection and the said stack extends beyond the roof by at least 150mm into the air.

4.5 Cleaning plugs

4.5.1 Cleaning plugs shall be easily accessible and convenient for rodding. Such plugs shall be liberally provided so that the entire drainage system could be easily cleared of all possible chokes. All clean outs shall be behind the flow and as far as possible, plug bends may be avoided. In the case of under slung drainage systems, the clean outs should be on top of the floor and NOT under the floor.

5.0 Acceptance, Testing & Commissioning

5.1 Pre-commissioning checks

5.1.1 A walk-through inspection shall be carried out and the following checks made:

- i) Layouts are according to the drawings. Identify variations.
- ii) Materials used are as specified, new and as per approved samples.
- iii) All fixtures viz. suspenders, brackets, clamps etc. are adequate and firmly fixed and spaced as specified.
- iv) Cleaning eyes are duly plugged and are easily accessible. v) No visible damages or cases of bad workmanship.
- vi) Check water seals in traps by discharging adequate number of appliances.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 5.1.2 During construction, the piping shall be tested in sections so that the maximum static head of water is not more than 4.5m. All such sectional tests shall be witnessed and signed by the Engineer-in-charge. Records of these tests shall form the Acceptance Test documentation.
- 5.1.3 An air test shall be conducted as specified in IS:5329 with a test pressure of 50mm water gauge. If the pressure is not holding, then a smoke test shall be conducted through a smoke generator to track down the leaking points. After attending to the leaks, the piping shall be air tested again.
- 5.1.4 Hydraulic Performance Tests shall be conducted on each stack by simultaneous release of water through various appliances like WC's and bathtubs to ensure water sealing of traps.

6.0 **Mode of measurement**

- 6.1 The following notes shall be taken into account while arriving at the unit rates.
- i) When the G.I waste piping from wash basins, sinks, fan coil units, AH units and bath tubs are directly connected to C.I waste stack necessary C.I fittings shall be provided in the C.I waste stack for making the connection, and this shall be measured along with the waste pipe and no extra shall be payable on this account.
 - ii) Tenderers are requested to indicate the material, labour & total rate for the various items in the schedule, especially for items under Sanitary Installation. It may be noted that the employer reserves the right to supply items of Sanitary wares and CP fittings. Accessories for the corresponding items under "Schedule of Work" will have to be provided by the contractor.
 - iii) While quoting rates for steel piping as per schedule of work, the tenderers have to quote for Tata make pipes. Contractor may indicate rebate on piping work, if they are allowed to use non Tata pipes such as Jindal, Zenith, etc.
- 6.2 All CI soil, waste & vent pipes shall be measured net when fixed correct to a centimetre including all fittings along its lengths including supports, suspenders, brackets, clamps, jointing etc. When collars are used, in CI soil, waste and vent pipes they shall be measured alongwith and paid as pipes and no extra shall be paid for collars or fixing them to wall with holder bat clamps. No allowances shall be made for the adjacent pipes or fittings. The above will apply whether pipes are fixed on wall face or pipes are embedded in masonry or pipes suspended from the ceiling.

ANNEXURE-E1 TECHNICAL SPECIFICATION

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.3 CI LA class pipes shall be measured net, when fixed correct to a centimetre including all fittings along its length including concrete supports, suspenders, brackets, clamps jointing etc.
- 6.4 GI, PVC Polyethylene or polybutylene pipes shall be measured per running meter correct to a centimetre for the finished work, which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts, supports, suspenders, clamps etc. The length shall be taken along centre line of the pipes and fittings.
- 6.5 Cement concrete around pipes excluding masonry/ concrete pipe supports, shall be measured per cubic meter and shuttering and centering cutting complete as described in the relevant specifications.

ANNEXURE-E1 TECHNICAL SPECIFICATION

4. TECHNICAL SPECIFICATION FOR EXTERNAL DRAINAGE SYSTEM

1.0 Scope

1.1 The scope of work shall cover supply, installation and commissioning of:

- i) External sewerage piping including:
 - a. excavation and back filling of pipe trenches.
 - b. construction of inspection chambers and manholes
 - c. final sewer connection to public sewerage or private sewage treatment plant.

- ii) Storm water drainage including
 - a. excavation and back filling of pipe trenches.
 - b. construction of open drains & catch basins
 - c. laying of pipe drains
 - d. final connection to the public storm water drainage

2.0 Standards

2.1 All materials and the installation shall meet latest of the following standards revised upto date:

- 1) IS : 3989 Centrifugally cast (spun) cast iron pipes & fittings

- 2) IS : 6163 Centrifugally cast low pressure cast iron pipes i)
Spigot and socket type
ii) Socket-less type

- 3) IS: 1536 Centrifugally cast LA class cast iron pipes, spigot
& socket or flanged type.

- 4) IS: 1538 Cast iron fittings and specials
(Part 1 to 24)

- 5) IS : 1879 Malleable cast iron pipe fittings
(Part 1)

ANNEXURE-E1 TECHNICAL SPECIFICATION

6)	IS : 1239	Mild steel tubes and tubulars (6 to 150mm)
7)	IS : 3589	Seamless and ERW steel pipes for water, gas and sewage (168 to 2032mm)
8)	IS : 1239 (Part 2)	Mild steel tubulars and other wrought steel pipe fittings.
9)	IS : 65	Salt glazed stoneware pipes
10)	IS : 458	Concrete pipes
11)	IS : 4989	HDPE pipes for potable water supplies, sewage & industrial effluents
12)	IS : 985	UPVC pipes for potable water supplies
13)	IS : 110221	Code of practice for coating and wrapping of underground mild steel pipe lines.
14)	IS : 3114	Code of practice for laying of cast iron pipes

3.0 Materials

3.1 General

3.1.1 All materials shall be new and of the best quality conforming to the specifications. Where different makes are specified, the choice of make shall rest with the consultants.

3.1.2 All samples of materials with necessary catalogues performance data shall be submitted and got approved before use on the work. Approved samples of all materials shall be neatly displayed on a board and such a display board of samples shall always be in exhibition in the sample room of the construction office of the Project Manager. Such a display shall be used for the day-to-day checking of the materials on site.

ANNEXURE-E1 TECHNICAL SPECIFICATION

3.1.3 In cases where the materials are supplied by the clients, all such materials shall be inspected and received in good condition and thereafter, it will be totally under the safe custody of the tenderer/contractor till they are handed over satisfactorily after installation, testing and commissioning.

3.2 Pipes & Fittings

3.2.1 Cast iron pipes shall be centrifugally cast low pressure type (Not LA class). Fittings shall be spigot and socket type suitable for the make of pipe used. All joints shall be epoxy based drip seal. Socket less pipes maybe used with suitable fittings recommended by the manufacturers.

3.2.2 Where specified or when higher pressures are encountered, pipes shall be centrifugally cast pressure pipes of 'LA' class to IS : 1536. Fittings shall be spigot and socket type suitable for drip-seal joints. Where required, flanged fittings with teflon sealing gasket may be used.

3.2.3 Stoneware pipes shall conform to IS : 651. Pipes shall be salt glazed and of uniform thickness. Pipes shall be free from cracks, air-blows and fire blisters. All joints shall be made of cement mortar 1:1.

3.2.4 Cement concrete spun pipes shall conform to IS : 458 and shall be of NP₂ class. All pipes shall be dowelled for making a leak tight joint with a collar. Collar joints shall be made of cement mortar 1:1.

4.0 Excavation and Back filling

4.1 Excavation for pipe trenches shall not be excessive but adequate for pipe laying and jointing. Generally trench width shall be pipe diameter plus 200mm on either side subject to a minimum of 600mm upto a depth of 2000mm and 750mm beyond and upto 5000mm. Bottom of trench shall be 100mm below the pipe invert level. Actual excavation will be measured and paid for on actuals subject to the maximum as defined above. Wherever directed by the Project Manager, the depth of excavation may be increased owing to poor soil conditions. In all such cases, the trench will be filled up with gravel or cement concrete upto the required level. All such extra excavation and gravel or cement concrete filling shall be paid for as extra.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 4.2 Excavation for manholes, inspection chambers, and catch basins shall be done 300mm around the base foundation. This is to allow ease of construction. Excess excavations shall not be admissible for payment.
- 4.3 Excavation for pipe trenches shall be in open cutting with reasonably vertical sides. For excavation deeper than 1500mm, the trench sides shall be shored up with timber or steel sheets with adequate strut support to prevent slippage and side collapse.
- 4.4 The drainage lines shall be set out in straight lines between manholes. The alignment shall be done by suitable ranging rods and levels established by proper levelling instruments.
- 4.5 All excavated soil and debris shall be neatly stacked alongside the trench as directed and used for refilling and the surface finished to its original condition. Surplus soil and debris shall be promptly disposed off making the site clean and clear of unwanted debris. Wherever subsoil water enters the trench, proper arrangements shall be made for dewatering. Wherever the excavated surface is a turf or paving, care shall be taken in properly preserving the turf and paving material so that the same can be reused when the surface is refinished. Rates for excavation shall therefore cover all the costs of the contingent works.
- 4.6 Trench excavation, pipe laying, testing and refilling shall be programmed along with the Project Manager so that needlessly long lengths of trenches may not remain open causing undue obstructions to site movements. Where blasting is unavoidable, it shall be permitted after securing the approval of the authorities concerned. Hours of blasting and safety precautions shall meet with the requirements of the local authority and the directions of the Engineer-in-charge.
- 4.7 After the laying of the pipe line or any other work has been finished and proved to be watertight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this, so that no damages shall be caused to the pipe drains and other permanent work. The filling in the haunches and upto 750 mm above the crown of the pipe, shall consist of the finest selected material placed carefully in 250 mm layers and watered and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 250 mm layers being watered to assist in the consolidation, unless the Engineer-in-charge shall otherwise direct.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5.0 Cement Concrete Laying

- 5.1 Wherever required, cement concrete shall be laid for foundations or bedding or saddles. The cement concrete shall consist of clean hard broken stone with irregular surfaces, clean washed sand and Portland cement mixed in the proportions indicated in the drawings or as described in the detailed specifications for the particular classes of work or in the relevant items of the schedule of work.
- 5.2 The materials shall be kept clean and dry before being mixed. The mixing shall be done on a specially constructed platform. The mixture shall be thoroughly turned over several times till a thorough and uniform mix has been achieved. The concrete mix then shall be filled in iron pans and immediately carried to the works spot. Generally machine mixing shall be preferred to hand mixing for large volumes of concrete.
- 5.3 All form work or shuttering and their supports shall be of ample strength to withstand the weight of the concrete and the shocks due to ramming without distortion or sagging. They shall be finished smooth, accurately fitted and water tight. The surface against which the concrete is to rest shall be plain. Paper, lime mortar and other expedients to make good the defects in joinery, will not be permitted. Form work shall be cleaned and repaired where necessary if it is to be reused.
- 5.4 The concrete shall be conveyed to the place in such a manner that there shall be no tendency for the separation of the different ingredients and it shall not be dropped into position from a height greater than 1.5 m. The concrete shall be placed, rammed and tamped as shall be required by the Project Manager. It shall not be interfered with once it has commenced to set. When new concrete is to be placed on the existing concrete, the surface of the old concrete shall be thoroughly washed roughened before the new concrete is laid thereon. The joint between the old and the new work shall be made with cement sand slurry (1:1) being laid over the surface of the old concrete which is roughed, washed and wetted.
- 5.5 The concrete shall be kept wet atleast for 15 days after laying. After it has been laid, it shall be covered with gunny bags which shall be kept constantly wet by the applications of water.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.0 Pipe Laying

6.1 General

6.1.1 A shop drawing of the proposed layout of the sewerage and storm water drainage shall be prepared after a detailed route survey. The drawing shall indicate among others:

- i) Surveyed route of the sewer lines and storm water drain lines indicating existing obstructions by way of pathways, buildings, lawns, any other known service lines.
- ii) Locations of inspection chambers (IC), gulleys, manholes and catch basins in relation to the paving patterns, if any.
- iii) Invert levels vis-a-vis outfall public sewer or storm drain or any sewage treatment plant.
- iv) Proposed diversion of existing service lines.

On approval of the drawings and details the work shall be commenced.

6.2 Stoneware pipe laying

6.2.1 Stacking and laying of stone ware pipes along the trenches shall be done in a manner as to cause the minimum inconvenience to public and traffic. Cracked pipes whether at the socket or body shall be rejected. All stoneware pipes should be carefully fitted together on the surface of the ground to ensure proper fit before they are lowered. The barrels, spigots and sockets are properly cleaned, scrapped and brushed and lowered by hand to the bottom of the trench and on to the bedding. The bedding shall be minimum of 100mm of shifted earth and after laying the bedding is to be worked and compared upto the centre of the pipe so as to ensure proper bedding of the pipe. After testing and rectification of leaks the back filling shall be compacted upto 750mm above the crown of the pipe in 250mm layers and then only should the back filling to the top completed.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.2.2 Pipes shall be laid carefully to the alignment, levels and gradients as directed and care shall be taken to prevent any sand, earth or other matter from entering the pipes during laying. The pipes between manholes shall be laid truly, in straight lines, without vertical or horizontal deviations. All inverts shall be laid from sight rails fixed at the true levels, with proper boning rods. The pipes shall have sockets facing up the gradient beginning at the lower end, and with the socket resting in the socket holes cut in the concrete bed if specified. Each pipe shall be laid singly, and no pipe shall be laid until the trench has been excavated to the required depth for a distance of 20 mts. in front of the pipe to be laid.

6.2.3 In each joint a gasket of tarred yarn shall be placed round the joint, and inserted in it by means of suitable jointing tools. More strains of yarn shall be added and well rammed home. The yarn will be moistened to avoid absorption of water from the mixed cement mortar. Portland cement mortar (1:1) shall be fixed in the joint as described hereunder:

The cement mortar paste shall be carefully inserted into the joint by hand and shall be caulked into the joint with wooden caulking tools. More cement shall be added until the space of the joint is filled completely with tightly caulked cement mortar paste and smoothly finished. Depths of yarn and cement mortar paste for different sizes of pipe joints are given below.

Internal dia of pipe (mm)	Depth of Socket (mm)	Depth of yarn (mm)	Depth of cement mortar paste (mm)
100	50	22	28
150	60	28	28
250	65	32	32

6.3 Concrete pipe laying

6.3.1 Concrete pipe laying shall follow generally the specifications for stoneware pipes. Pipes shall be laid on cement concrete saddles as shown on drgs. and as directed by the engineer-in-charge.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 6.3.2 After the concrete saddles have been laid properly as specified in the schedule, concrete pipes shall be lowered gradually into the trenches over the concrete saddles or bed. Holes for collars shall be made at every joint. These holes will be made depending upon the particular length of the pipe being laid. The pipes shall be levelled properly to requirement. The pipe shall rest on the bed at every point throughout its length. To ensure this, the space between the under side of the pipes and the invert of the cradle shall be carefully grouted solid with thin cement slurry consisting of 1 part of cement to 3 parts of clean washed sand in such a manner that no voids shall be left. This is to ensure that the load of the pipes and the super imposed load of the earth filling shall be evenly distributed on the bedding. All precautions shall be taken before the pipes are gradually lowered on the cradle or on firm ground. After the alignment of pipes is checked and the joints are made and tested, the grouting shall be done. The saddle concrete shall be allowed to set atleast for three days, before any pipes are placed in it and the contractor shall take due care in setting the pipe in the saddle so that no damage to the saddles shall occur. If any damage to the saddle occurs, it shall be rectified or removed and replaced as decided by the Engineer – in - charge
- 6.3.3 The back filling shall be compacted upto 600mm above the crown of the pipe in 250mm layers.
- 6.3.4 The joints for the pipes shall be made by loose collars. The collars shall be specially roughened inside to provide a better grip. Two adjacent pipe ends will be so designed and manufactured that when butted together concentrically a dowel will be left between the two ends. In this dowel, cement mortar of 1:1 proportion shall be filled and the collar shall then be adjusted over the pipe so that its ends are equidistant from the pipe ends and is concentric with the pipe. The space between the collar and the outer barrel of the pipe can then be caulked with bitumen soaked hemp yarn in layers atleast upto 50 mm (and not exceeding 80 mm) from the joint on either side. The remaining space on either side of the joint upto the collar shall then be caulked with a stiff mix of cement sand mortar 1:1 with water proof compound. Every joint shall be finished smooth at an angle of 45° with the longitudinal axis of the pipe on either side of the collars. The interior of the pipe drains shall be cleared off all dirt, cement mortar and superfluous materials.
- 6.4 CI pipes
- 6.4.1 CI pipes, low pressure or LA class, shall be laid same as the concrete pipes on saddles and head caulked and back filled after the joints are made and tested generally as specified for the concrete pipes.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6.4.2 All spigot and socket joints shall be epoxy drip sealed.

6.5 Making connections

6.5.1 Contractor shall connect the new sewer line to the existing manholes by cutting the walls, benching and restoring them to the original conditions. A new channel be cut in the benching of the existing manhole for the new connections. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

Permission from municipal authorities to connect the sewer to the municipal man-hole and permission from police for cutting the road for making connection if required shall be obtained by the contractor. All connection from house sewer to the Municipal sewer shall be the responsibility of the contractor even if this is to be carried out through the municipal approved contractor.

7.0 Inspection Chambers, Manholes & Traps

7.1 Manholes shall be constructed in accordance with the drawings. The floors shall be of cement concrete and the side walls of brickwork or rubble masonry as laid down in the drawings. Proper channels shall be formed to lead the storm water/sewage from the pipe drain without interruption to the flow and all pipes required for branch pipe drain connections shall be built in the walls. Relieving arches shall be provided to prevent any load on the pipes. In case the diameter of the main drain is increased in the manhole, the crown on the incoming and outgoing pipes shall be kept at the same level and necessary slope will be given in the invert of the channel. In exceptional cases where this is not possible, connection may be made upto half the difference in diameter and built into the brick work or rubble masonry. The rungs shall be of cast iron of suitable size each weighing about 3 Kg. These shall be provided in two vertical staggered runs which may be about 38 cms apart horizontally. These rungs shall be 450 mm below the manhole covering and the lowest not more than 30 mm above the benching.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 7.2 The inside and outside of all manholes shall be rendered with cement mortar as laid down in the schedule or as shown on the drawing to the required thickness and worked to a polished face with a coat of neat cement mixed with water proof compound. Rendering shall be done only after approval of the external plaster by the Engineer-in-charge.
- 7.3 The channels shall be formed of 1:2:4 cement concrete as shown on the drawing. They shall be semicircular in bottom half and half the diameter of the sewer. Above the horizontal diameter the side shall be extended vertically preferably to the full vertical diameter and top edge shall be suitably rounded off. The branch channels also be suitably constructed in respect to the benching. At the junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. There shall be fall of not less than 38 mm in each manhole, but in flat area where it is not feasible to enforce this provision, the Project Manager shall amend or reduce the fall to be allowed in each manhole.
- 7.4 The brickwork for manholes shall meet the following specifications:
- a) All bricks to be used in the work shall be table moulded and of good quality, approved by the Project Manager before incorporation in the construction.
 - b) The bricks shall be of uniform size, deep red in colour and homogenous in texture, free from flaws, cracks, stone floats or nodules of lime or other blemishes, sharp edges.
 - c) No brick after 24 hours immersion in water shall absorb more than 20% of its own weight. Test report for the brick shall be submitted to the Project Manager.
 - d) All bricks shall be thoroughly soaked in water before usage, till the bubbles cease to come up. No half or quarter brick shall be used except as closers. The closers shall be horizontal and the wall shall be raised to plumb or as shown on in the drawings.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- e) Brick work shall be built in English bond with brick in cement and sand mortar as specified in the schedule or as in the drawings. The joints shall be raked to a depth of 12 mm to receive cement plaster.
- f) Joints in brick work shall not be more than 10 mm thick.
- g) Brick work shall not be raised more than 10 courses in a day. The brick work shall be watered thrice a day for 10 days.
- h) Brick work shall be uniformly raised around and no part shall be raised more than 900 mm above another at any time.
- i) All joints shall be thoroughly flushed with mortar at every course. The mortar shall conform to the specifications as laid in the schedule or as per drawings. Care shall be taken to see that the bricks are properly bedded and all joints completely filled to the full depth.

7.5 Cement plastering of manholes shall meet the following specifications:

- a) Materials for plastering, viz. cement and sand shall be of the best quality. All materials shall have to be approved by the Project Manager before incorporation in the work.
- b) Portland cement shall be mixed with clean sharp siliceous sand to the proportions as shown on the drawings or as described in the schedule for the particular class of work. Cement and sand shall be first mixed dry along with water proof compound upon a clean dry platform, after which sufficient clean water shall be added to bring the whole mass into a plastic condition. No mortar which has started to set shall be used nor such mortar remixed with the new one. It shall be removed from the work site at once.
- c) The surface to be plastered shall first be thoroughly cleaned and all joints raked out to not less than 12 mm depth to receive key for plaster. The surface shall be thoroughly wetted for atleast 24 hours prior to commencement of work. The mortar shall be of uniform mixture as specified elsewhere. The thickness of cement and sand plaster shall be as specified in the schedule of work. The first coat shall be just sufficient to fill up all the unevenness in the surface under treatment in case of rubble masonry. It shall not be smoothed and the second coat shall be applied while the first coat is still raw. Cement mortar which falls to the ground, during application shall on no account, be reused. The floating coat over the plaster shall be done with neat cement 1.5 mm thick as approved by the Project Manager.

ANNEXURE-E1 TECHNICAL SPECIFICATION

7.6 The channels inside the manholes and chambers shall be formed of 1:2:4 cement concrete as shown on the drawings or as specified in the relevant item of the schedule. It shall be to the full width of the pipe drain. The depth of the channel shall be as per drawing. Similar curved channels shall be built in the chambers, where branch drains, form junctions. All channels shall be given a suitable fall as shown on the drawing or as directed.

7.7 Where not specified manholes shall be constructed as follows:

Size of manhole (mm)	900 x 450	900 x 600	900 dia
Type	Rectangular	Rectangular	Conical
Maximum depth (mm)	1500 (For storm drain)	1500 to 3400 (For sewers)	
Size of cover & frame (mm)	900 x 450	900 x 600	500 dia
Weight of cover & frame (Kg)	96	125	250

The depth of manhole shall be measured from the top of cover to the invert level of the manhole.

7.8 Drop connections shall be as follows:

- a) Drop connections shall be provided between branch sewer and main sewer or in the main sewer itself in steep ground when the difference in invert level of the two exceeds 450 mm of the required sizes.
- b) Drop connections from gully traps to main sewer on rectangle manholes shall be made inside the manholes and shall have C.I special type door bend on top and heel rest bend at bottom connected by a C.I pipe. This pipe shall be supported by holder bat clamps at 1800 mm intervals with at least one clamp for each drop connection. All joints shall be lead caulked joints 25 mm deep.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- c) Drop connections from branch sewer to main sewer shall be made outside the manhole wall with glazed stoneware pipe tee connection, vertical pipe and bend at the bottoms. The top of the tee shall be finished upto the surface level and provided with a CI hinged type frame and cover 300 x 300mm. The connection shall be embedded in cement concrete 1:2:4 150 mm all round the pipe and tee upto the surface chamber of the tee.
- d) Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections. They shall be paid for under the relevant soil and waste pipes.

7.9 The manhole covers and frame shall be CI double sealed pattern to IS:1726 and of specified weight and clear size and as approved by the Project Manager. They shall be of the best foundry grey metal, tough and close grained and the samples of the manhole frame and cover submitted to the Project Manager and his approval in writing obtained thereto, before the covers and frames are ordered. The covers and frames are to be painted with two coats of anticorrosive black bitumastic paint. The covers and frames shall be clean moulded, accurately made and fitted in a workmanlike manner, the surface being smooth and even. All manhole frames shall be set to correct alignment and levels, embedded in layers of 1:3 cement sand mortar or 1:2:4 cement concrete.

8.0 Rain Water Drains

8.1 Masonry drains

- 8.1.1 Brick masonry drains shall be of a minimum width of 300 mm for a maximum depth of 450 mm. The minimum width of drains shall be 450 mm for depths beyond 450 mm.
- 8.1.2 Brick masonry drain shall be constructed in brick masonry, cement mortar, cement concrete foundations as specified in the schedule of quantities. Masonry and concrete work shall be as specified. Wherever specified, masonry drains shall be plastered with cement mortar inside. The outer surface shall be flush pointed without additional charge.
- 8.1.3 Wherever specified, all brick masonry covered drains shall be provided with cast iron or precast R.C.C. slabs.

ANNEXURE-E1 TECHNICAL SPECIFICATION

8.1.4 All drains shall be plastered with cement mortar 1:3 with a coat of neat cement with water proof compound. All finished works shall afford specified gradients and ensure free and efficient discharge.

8.2 Formed drains

8.2.1 Drains shall be formed by open excavation, dressing, forming and compacting as shown on drgs. and as directed by the Project Manager. Rubble pitching shall be done wherever shown or as directed by the Project Manager.

9.0 Acceptance, Testing & Commissioning

9.1 Since the external drainage piping gets covered underground, it is programmed in segments so that each part is inspected, tested and covered. Hence, it is necessary that all the materials are inspected during the programmed segmental execution for their quality, compliance with the specifications and their newness. Pipes which do not appear new and/or chipped or damaged in anyway shall not be permitted to be used. A proper and comprehensive record of inspection and testing of each segment and validated by the Project Manager shall be maintained. This form part of the acceptance test documentation.

9.2 After the cement mortar had time to set, the pipes shall be tested in lengths between manholes. In the lowest manhole a plug shall be inserted. At the upper manhole a circular disc to fit exactly the inside diameter of the pipe with a filling pipe with a right angle bend and an air cock shall be fixed. The length of the pipe shall be filled with water by means of pipe connection on the upper disc. The air cock in the upper disc shall be kept open while the pipe line is being filled, to permit the escape of air. When the pipe length has been filled with water and air excluded the air cock shall be shut and water shall be poured into a conical funnel attached to the filling tube of the disc in the upper manhole until the water remains in the funnel. The filling level in the funnel is about 1.5 m above the invert of the highest pipe in that stretch. Permissible leakage in 30 minutes shall be:

- 0.05 lit/m for 100mm pipe
- 0.08 lit/m for 150mm pipe
- 0.12 lit/m for 200mm pipe
- 0.16 lit/m for 250mm pipe

If it is more, the water shall be drained off and joints remade and the piping retested.

ANNEXURE-E1 TECHNICAL SPECIFICATION

9.3 After the joints and pipes have been proved to be water tight they shall be bedded or enveloped in cement concrete, if specified, to the extent necessary. Refilling shall be done with finest selected material and shall be done in layers not exceeding 250 mm thick, watered consolidated and rammed properly as specified.

10.0 Mode of measurement

10.1 Earth work excavation made for the pipe lines, manholes and inspection chambers shall be measured and paid at unit rates on the net volume excavated.

10.2 Trenches shall be measured between outside walls of manholes at top and the depth shall be average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 m or as given in the schedule of quantities.

10.3 Payment for trenches more than 1.5 m in depth shall be paid for extra depth as given in the schedule of quantities and above the rate for depth upto 1.5 m.

10.4 Timbering and shoring as specified are deemed to have been included in the rate for excavation. In case the contractors are directed to leave the timbering in place and asked to refill the trench, that timbering alone will be paid at schedule rates.

10.5 No extra payment for pumping and bailing out water shall be made for excavation in saturated soil, surface water from rain falls or broken pipe lines, or sewers and other similar sources. No payment is admissible for water collected from surface sources and broken pipe lines of sewers.

10.6 Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 50 m.

10.7 Stoneware pipes/concrete pipes/C.I pipes shall be measured for the finished length of the pipe lines per linear meter i.e. (a) lengths between manholes shall be recorded from inside of one manhole to inside of other manhole. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.

ANNEXURE-E1 TECHNICAL SPECIFICATION

- 10.8 Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I grating and sealed cover and frame.
- 10.9 Cement concrete in trench bedding or grouting or saddles shall be paid per cubic meter. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.
- 10.10 All inspection chambers and manholes shall be measured by number and shall include all items specified. Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest centimeter. Depth of the manhole shall be measured from top of the manhole cover to bottom of channel.
- 10.11 Drop connections shall be measured by number for a depth of 600mm or part thereof between invert levels.
- 10.12 Rain water drains shall be measured per unit length as specified in the schedule of work.
- 10.13 Formed drains shall be paid for at the unit rate per cubic meter of excavation handled. Rubble pitching shall be paid per square meter of surface area.
- 10.14 Final connection from house trap to the nearest Municipal manhole including excavation and resurface etc through Municipal approved contractor or by himself shall be a lumpsum amount.

ANNEXURE-E1 TECHNICAL SPECIFICATION

5. TECHNICAL SPECIFICATION FOR PIPE SUPPORTING SYSTEM

1.0 Pipe Supports

1.1 All water supply and drain pipes whether horizontal or vertical shall be suitably supported using galvanised m.s clamps manufactured by approved manufacturers.

1.2 Vertical Pipes

1.2.1 Pipes running inside masonry shafts shall be supported on galvanised Hitech rails or galvanised 50 x 50 x 6 angles fixed to wall with anchor fasteners or studs. Pipe fixing shall be done with galvanised steel flat clamps or “U” bolts.

1.3 Horizontal Pipes

1.3.1 Pipes running horizontal shall be supported from structural beam/slab by using appropriate galvanised m.s hangers of approved make.

1.3.2 Supports for horizontal piping longer than 15 m in a stretch shall be provided with swivel clamps. Otherwise, the clamps shall be universal clamps or rigid clamps as required by the Project Manager / Engineer – in-charge.

1.3.3 When the centre line distance of two adjacent pipes is less than 300 mm a horizontal rail common for the pipes shall be provided suspended from slab/beam and the pipes clamped to this rail.

1.4 Support Spacing

1.4.1 The spacing of supports shall be as follows:

ANNEXURE-E1 TECHNICAL SPECIFICATION

PVC PIPES			CAST IRON PIPES		
Nominal Bore dia (mm)	Spacing (mm)		Nominal Bore dia (mm)	Spacing (mm)	
	Horizontal	Vertical		Horizontal	Vertical
15	500	1200	32	1800	1800
20, 25	500	1200	50-100	2000	2500
32	500	1200	Over 100	2500	3000
40-50	500	1200			
65-80	1000	1800			
100 & above	1000	1800			

Note: Additional supports shall be provided at every tee-off connection or bend.

1.5 Fixing of clamps/rails etc.

1.5.1 All clamps, rails and accessories shall be fixed to the structure (beam, slab, walls etc.) by using approved good quality anchor fasteners of appropriate size. Any other mode of fixing is not acceptable.

1.6 Mode of Measurement

1.6.1 The cost of pipe supports together with clamps, Painting and fixing arrangement described above forms part of the rate quoted for piping and no extra shall be payable on this account.

1.6.2 Where multiple pipes of different agencies are supported on a common rail, the cost of such common rail shall be computed on the basis of structural steel weight.

ANNEXURE-E1 TECHNICAL SPECIFICATION

6. TECHNICAL SPECIFICATION FOR PAINTING

PAINTING

1.0 **Scope**

1.1 The scope of work covers painting of:

- i) All equipment
- ii) Piping & pipe supports
- iii) Duct & duct supports
- iv) Electric Panels & cable trays

1.0 All equipment and piping shall be painted in accordance with the following colour code (or other colours if specifically requested for by the Project Manager.)

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
COLD WATER				
Municipal	Sea green	-	-	- White Brown
Domestic	- do -	25	1500	Red Red
Flush	- do -	25	1500	(chain dotted)
Hot water supply	- do -	25	1500	
Hot water Ret	- do -	25	1500	
DRAINAGE				
	Black			
Soil	- do -	-	-	- White White
Waste	- do -	25	1500	(Chain dotted)
Vent.	- do -	25	1500	
Rain water	- do -	-	-	
FIRE				
Hydrant line	Fire Red	-	-	- White
Sprinklers	- do -	25	1500	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>Width</u> (mm)	<u>BAND</u> Spacing (mm)	<u>Colour</u>
STEAM	Silver grey			
Over 3 kg	- do -	-	-	- Red
Upto 3 kg	- do -	25	1500	Red
Condensate	- do -	25	1500	(Chain dotted)
AIR				
Compressed Air	Sky blue	-	-	- OILS
HSD	Light Brown	-	-	- White
LDO	- do -	25	1500	
NATURAL GAS	Light Brown	25	1500	White & Blue
WATER CHILLING UNIT				
a) Compressor b)	Dark Adm. Grey	-	-	-
Motor		-	-	- "
c) Condenser	Steel Blue			
REFRIGERANT PIPING				
a) Hot gas	Signal Red	25	1500	- White
b) Liquid lines c)	Signal Red	25	600	-
Suction	Riveira Blue	-	-	

ANNEXURE-E1 TECHNICAL SPECIFICATION

<u>Equipment/ Service</u>	<u>Colour</u>	<u>BAND</u>		
		Width (mm)	Spacing (mm)	Colour
PUMPS & MOTORS	Canary Yellow	-	-	-
CHILLED WATER				
a) Supply	Fiesta Blue	-	-	-
b) Return	Fiesta Blue	25	600	White
CONDENSER WATER				
a) Supply	Steel Blue	-	-	-
b) Return	Steel Blue	25	600	White
COOLING TOWERS	Steel Blue	-	-	-
DUCTS & DUCT SUPPORTS	Black or as directed	-	-	-
a) Exposed ducts b) Support	Approved colour			
UNIT COLOUR & AH	Fiesta Blue (28-9104)	-	-	-

ANNEXURE-E1 TECHNICAL SPECIFICATION

ELECTRIC PANELS Steel grey

Notes: 1) All colours and codes refer to ICI DULUX Synthetic Enamel colours. Nearest equivalent acceptable.

2) The painting shall be with synthetic enamel paint unless otherwise specified.

2.0 All surface to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat or red oxide primer shall be applied completely covering the exposed surfaces. Out finish coat of painting shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Project Manager. Black steel ducts shall be painted with a prime coat and above and galvanised steel duct need to be painted without the need of a prime coat.

3.0 **Mode of measurement**

3.1 All painting shall form part of the cost (item rate) of equipment, piping etc. No separate payment shall be admissible.