TENDER DOCUMENT
TENDER No.: NRO/CON/662/527

FOR

CONSTRUCTION OF MAIN ENTRANCE GATE, BOUNDARY WALL AND LANDSCAPING, ARCHITECTURE BUILDING AND CANTEEN BUILDING
AT
NIT, RAIPUR (CHATTISGARH)

FOR

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR (CHATTISGARH)

VOLUME – IIB

TECHNICAL SPECIFICATIONS

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VOLUME – II B

Tender for Construction of Main Entrance Gate, Boundary Wall and Landscaping, Architecture Building and Canteen Building at NIT, RAIPUR, Chattisgarh.

NIT No. : NRO/CON/662/527

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1  ALUMINIUM COMPOSIT PANEL WORK

1.1 Scope of Work
The work shall include providing 4mm thick Aluminium composite panel (0.5mm PVDF coated Aluminium skin on top & bottom plus 3mm thick polyethylene core) cladding of approved shade of required profile to Brick/Concrete wall/MS frame, canopy, parapet, coping, bends, pergola or any type architectural feature wherever required as shown in drawing, either segmental curved or straight in plan wherever specified with extruded aluminium sections, angle cleats, weather sealants, stainless steel screws, rivets, fasteners, Galvanised brackets (Galvanising to be done conforming to IS:4759-1996 upto 610 gms. per sqm, 80-90 micron thickness), drilling and fixing the cladding to either masonry/reinforced cement concrete/MS structural frame work including making grooves of required size applying non staining weather sealant, backer rod, all necessary accessories etc. complete in all respects as per details, all as shown on the "Good for Construction" drawings or as specified or as directed by the Engineer-in-Charge and also as per the specifications, standards and codes as given herein under, complete in all respects to give the quality of finished work as desired by and to the entire satisfaction of the Engineer.

Note: The contractor shall submit fabrication drawings for approval of the Project Manager. (MS frame work for this work shall be measured and paid separately) The fabrication work shall start only after approval of the fabrication drawings. Any change required in the fabrication drawings shall be carried out at no extra cost.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Engineer-in-Charge.

1.2 Materials

1.2.1 Aluminium
Aluminium shall conform to IS: 733, designation HE9-WP or HV9-WP alloy. Aluminium shall be of superior quality extruded sections made by Indian Aluminium Co. or Hindustan Aluminium or Jindal or an approved equivalent manufacturer, of a gauge suitable for the work, anodised or powder coated to desired shade/colour, as specified.

1.3 Handling and Storing Materials

1.3.1 Aluminium Work Fabrication and Components
All self-finished work shall be wrapped, taped or protected in an approved manner with non-absorbent coverings.

These shall be delivered to a programme to reduce or eliminate site storage.
Coverings shall be removed just sufficient to enable jointing and assembling and shall be replaced thereafter.

### 1.4 Workmanship

#### 1.4.1 General

ACP Work shall be undertaken in accordance with sound engineering practice and as follows:

(a) ACP work shall be done as much as possible in the properly equipped workshop.

(b) Site work shall be restricted to fixing and other operations that cannot be undertaken in the workshop.

(c) Burrs, sharp edges and angles, coarse file marks, excess weld metal and similar imperfections shall be removed.

(d) Work shall not be permitted to corrode or otherwise deteriorate between fabrication and final treatment/fixed.

(e) ACP work shall be fixed in the Works in a manner that prevents corrosion due to contact with incompatible metals and other materials.

### 1.5 Sealants

Structural grade and weathering grade silicon sealant “Dow Corning” or “GE Silicon” or equivalent of approved colour and make shall be used as specified, as per the design requirement.

### 1.6 Isolation

Where aluminium comes into contact with masonry, brick work, plaster or dissimilar metals, it shall be coated with an insulating coat of lacquer, paint or tape to ensure that electro chemical corrosion is avoided. The Contractor shall submit his proposal for the approval by the Engineer-in-Charge before related materials are ordered.

Any disfigurement, discoloration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer-in-Charge as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

### 1.7 Cleaning and Completion

This area of aluminium work shall be retained as a sample of the finished work, wherein the effects of weather, movement and other conditions shall be reviewed over a period not exceeding one month and the effects if found leading to unsatisfactory work, shall be remedied by the Contractor, until a satisfactory sample of finished work is accepted. All other work shall thereafter be completed to the same standard and quality as approved.
Scaffolding

Scaffolding shall be erected for all painting work. Ladders shall only be used in exceptional circumstances where permitted by the Engineer-in-Charge. Care shall be taken to avoid any damage to floors and walls.

1.8 Measurements

Aluminium composite work shall be paid by area basis (sqm.)

1.9 Rate

The rate shall include the cost of materials, labour involved in all the operations described above. The cost for providing sealants shall not be paid separately.
2 PAINTING AND POLISHING

2.1 Scope of Work
The finishing works shall include providing plastering, painting, sealing coats and decoration to internal and external surfaces of the building, all as shown in the drawings and as specified or as directed by the Engineer-in-Charge.

2.2 Applicable Specifications
All work shall generally be carried out as per CPWD Specifications 96 Part 13 - Finishing except as modified hereunder:

2.3 Materials

a) General

i) All materials shall be obtained only from approved shade, texture, finish of approved manufacturers of building paints; ICI, Berger, Jenson and Nicholson, Nerolac, Asian Paints and Goodlass Nerolac.

ii) Paint containers shall not exceed 5 litres capacity.

iii) All paints and other materials shall be delivered in sealed containers bearing information as per statutory requirements. The Contractor shall in addition furnish a letter with each consignment from the manufacturer giving the following data:

(a) Manufacturer's name or recognised trade Mark.

(b) The appropriate title and specification number.

(c) Whether priming, undercoat or finishing coat.

(d) Lead free, if required.

(e) Whether for interior or exterior use.

(f) The colour reference.

(g) The method of application.

(h) The batch number and date of manufacture.

iv) For containers of materials other than paints the above data shall be provided to the extent that it is appropriate.

v) No paint shall be used after a period of 6 months from the date of manufacture or the expiry period given by the manufacturer. If this period is exceeded, the paint shall be removed forthwith from the site by the Contractor and nothing extra shall be paid on this account.

vi) Only such number of containers as are required for immediate use shall be opened.

vii) All brushes, paint rollers, spraying equipment, kettles etc., used in carrying out the work shall be clean and dry. They shall be thoroughly re-cleaned before being used for a different type or class of material.

viii) Cutting in shall be neatly and accurately performed.

ix) No painting shall be done during inclement weather conditions, in dusty atmosphere or when it is raining or when the temperature is less than 10°C or when the humidity is high.
x) Sequence shall be properly planned such that finished work is not spoiled by subsequent preparatory works.

xi) Flood coat shall be provided for preservatives.

xii) Successive coats of undercoat shall have different tints.

xiii) Paint shall be applied only to properly prepared, clean, sound and dry surfaces.

xiv) Each coat of paint shall be thoroughly dry before the next coat is applied and the surfaces of primers and undercoats shall be lightly rubbed down and dusted off.

xv) Coats of paint shall be applied at proper intervals to secure maximum adhesion. Where two hard gloss finishing coats are scheduled, the second coat shall be applied within 48 hours.

xvi) The method of application by brush, roller or spray shall be decided by the Engineer-in-Charge.

b) Paints from one manufacturer

Materials for the priming coat, putty undercoats and finishing coats of paint for any one system shall be obtained from the same manufacturer.

c) Paints, Primers, Distempers and Textured

i) Synthetic enamel shall be approved make and shade.

ii) Priming paints for steel work shall be red lead priming paint, conforming to IS:102 or red oxide zinc chrome priming paint conforming to IS:2074.

iii) Distempering with oil bound washable distemper of approved brand and manufacture to give an even shade New work (two or more coats) over and including priming coat with cement primer.

iv) Plaster of Paris Putty of 2 mm thickness over plastered surface to prepare the surface even and smooth complete

d) Filler with Plaster of Paris

Interior plaster shall be filled, made even and smooth with Plaster of Paris, anhydrous gypsum, conforming to IS:2547.

e) French spirit polish

French polish shall conform to IS:348. It shall be prepared by dissolving pure shellac (conforming to IS:347) in methylated spirits. Also refer clause 13.50.1 of CPWD Specifications 96.

f) Colours

Paints for the work shall match the colours specified/ approved by the Engineer-in-Charge. Blending of paints or tinting shall not be permitted.

The Contractor shall assume that multi-colour schemes of decoration will be adopted in which changes of colour will occur only at internal or external angles of wall and ceilings. Nothing extra shall be payable for use of more than one colour of paint in one area/surface.

g) Samples

Samples for testing may be taken from the sealed containers, spray gun containers or from the workmen's kettles on the works. In addition the Engineer at his discretion may require sealed containers to be set aside for subsequent testing.
Any work found to be done with unsatisfactory materials or not done in an acceptable manner shall be rejected. Such works shall be made good by the Contractor at no extra cost, to the entire satisfaction of the Engineer.

If any paint that is delivered to site is found to be defective or unsatisfactory its use shall be suspended and the manufacturer and the Engineer notified immediately.

h) Storage and Handling

Inflammable materials like thinners etc. shall be stored separately. An adequate number of fire extinguishers of suitable type shall be kept in ready to use condition in the store.

i) Surface preparation

Iron and steelwork

(a) Bare iron and steelwork including sheeting and pipes shall be thoroughly prepared by removing all dirt, rust and loose mill scale to the entire satisfaction of the Engineer-in-Charge.

(b) Preparation shall include the use of chipping hammers, scrapers, power tools with mechanical wire brushes and Carborundum grinding discs. The use of mechanical chisels and other impact tools may exceptionally be ordered if in the opinion of the Engineer-in-Charge their use is necessary.

(c) All rivets, welds, angles, joints and openings shall be properly cleaned.

(d) All tools shall be operated in such a manner that no sharp ridges or burrs are left and no cuts made in the steel.

(e) Dust and other loose material shall be removed after cleaning. Oil and grease shall be removed with white spirit.

(f) The priming coat shall be applied before any contamination or rusting occurs.

(g) All surfaces shall be washed with mineral spirits to remove any dirt or grease before applying paint. Where rust or scale is present, it shall be wire brushed and cleaned with emery paper.

(h) Steelwork shall be given one shop coat of primer before delivery to site. In case this gets damaged in transit the damaged areas shall be cleaned off, wire brushed, and spot primed immediately after delivery. A second coat of primer shall be applied at site after erection.

j) Precautions

(a) Old brushes, if they are to be used with emulsion paints, should be completely dried of turpentine or oil paints by washing in warm soap water. Brushes should be quickly washed in water immediately after use and kept immersed in water in break periods to prevent the paint from hardening on the brush.

(b) In the preparation of surfaces for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes, etc.
(c) Splashes on floors etc. shall be cleaned out without delay and definitely everyday, as they will be difficult to remove after hardening.

(d) Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

**k) Preparation of paint**

**i) Mixing:**

(a) All liquid paints shall be thoroughly stirred using mechanical stirrers with a minimum speed of 650rpm to a uniform consistency when containers are opened and before being transferred to paint kettles.

(b) Paste paints shall be beaten up thoroughly as directed by the manufacturer prior to thinning.

**ii) Thinning**

(a) Thinning for oil paints shall not normally be permitted. In exceptional circumstances, the Engineer-in-Charge may permit thinning with up to 5% of white spirit by volume or a thinner as recommended by the paint manufacturer to maintain the paint in a working consistency.

(b) PVA emulsion paints shall be thinned with potable water for the first coat only depending on the porosity of the surface to be painted. In any case, the quantity of water shall not exceed 50% by volume. Subsequent coats shall not be thinned.

**iii) Straining**

Any paint showing bittiness in application shall be strained through fine gauze.

(a) Addition of other materials

With the exception of the thinners given in (b) above, no other materials shall be added to the paints.

(b) Mixing of different paints together

Mixing of different paints together shall not be permitted.

**l) Protection**

(a) All ironmongery, finger plates, power points, lighting fixtures, grills, diffusers, fixtures of other services, machinery, plant and equipment, flooring, glazing etc. shall be protected using PVC sheets weighing 1000g/sqm and masking tapes. Flooring, wherever laid, even though it may not have been polished shall be protected likewise.

(b) Masking tapes shall be used.

(c.) Covering for protection shall be left in position upto completion, to the satisfaction of the Engineer.

**m) Method of Application**

**i) Brush painting**

a. Paint shall be applied so that the finished surface is free from brush marks.

b. All areas or parts shall be laid off correctly.
c. All paint edges shall be good, sharp and true to line.

ii) Primers

d. Priming coats shall be applied by brush to give a coat of adequate thickness with no misses and to satisfy the porosity of the surface. The priming shall be well worked into the surface, joints, angles and other places where moisture is likely to collect.

e. Steelwork surfaces shall be primed immediately after cleaning. Priming coats applied off-site that have suffered from exposure on the site or in transit shall be touched up or re-primed as necessary before undercoating.

f. Where there is a doubt as to the adequacy of the primer to fully satisfy the porosity of the surface, the Engineer-in-Charge shall be informed and his directions taken.

iii) Undercoats

e. Undercoats shall be applied evenly over the whole surface to give a solid film, care being taken to avoid uneven thickness of paint at edges and angles.

iv) Finishing coats

g. Finishing coats shall be applied evenly over the whole surface to give a solid film free from brush marks, sags, runs, peeling or other defects.

h. Finished work shall be uniform, of approved colour, smooth and free from runs, sags, defective brushing and clogging. Edges of paint adjoining other materials or colours shall be sharp and clean, to correct lines and levels without overlapping.

v) Protection

All finished work shall be protected upto completion and handing over.

n) Cleaning

All areas shall be left in a neat, clean and tidy condition after the painting work is over.

o) Scaffolding

Scaffolding shall be erected for all painting work. Ladders shall only be used in exceptional circumstances where permitted by the Engineer-in-Charge. Care shall be taken to avoid any damage to floors and walls.

p) Measurements

i) Painting shall be measured as per clause 13.25.6, 13.33.6 of CPWD Specifications 96.

ii) Painting in small widths and girths, cornices etc., shall also be measured in general painting. Painting for all floor levels and all heights shall be measured under the same item.

q) Rate

The rate shall include the cost of materials, labour involved in all the operations described above. The cost for primer work shall be paid separately.
2.4 Acrylic Emulsion Paint

2.4.1 Materials
Emulsion paint of approved brand and manufacture shall be used. The primer where used as on new work shall be primer as described in the item. These shall be of the same manufacture as emulsion paint. The acrylic emulsion paint be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of paint required for day’s work shall be prepared.

The paint and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight’s work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

2.4.2 Preparation of the Surface
For new work the surface shall be thoroughly cleaned of dust, The surface shall be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease dirt etc.

The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the paint shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

2.4.3 Application
Priming Coat
The priming coat shall be with primer, as required in the description of the item. The application of the primer shall be as described in 13.30.2.2.

Acrylic emulsion paint is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be painted before a period of six months shall be given a coat of alkali resistant priming paint conforming to IS : 109 and allowed to dry for at least 48 hours before distempering is commenced.

For old work no primer coat is necessary.

2.4.4 Acrylic emulsion Coat
For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the paint, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of paint properly diluted with thinner (or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat.
The subsequent coats shall be applied in the same way. Two or more coats of
distemper as are found necessary shall be applied over the primer coat to obtain an
even shade.

A time interval of at least 24 hours shall be allowed between successive coats to
permit proper drying of the preceding coat.

For old work the paint shall be applied over the prepared surface in the same manner
as in new work. One or more coats of paint as are found necessary shall be applied
to obtain an even and uniform shade.

15 cm double bristled painting brushes shall be used. After each days work, brushes
shall be thoroughly washed in hot water with soap solution and hung down to dry.
Old brushes which are dirty and caked with paint shall not be used on the work.

The specifications in respect of scaffolding, protective measures and measurements
shall be as described under 13.25.

2.4.5 Rate

The rate shall include the cost of all labour and materials involved in all the above
operations (including priming coat) described above.

3 Stainless Steel Work

3.1 Scope of Work

The work shall include providing and fixing of handrail and other things
necessary to complete the work as specified and shown in the drawings complete in
all respect to give the quality of finished work as desired by and to the entire
satisfaction of the Engineer.

3.2 Approvals

The sample of the material shall be submitted to the Engineer for approval before
fabrication of the work.

3.3 Material

Handrail, railing, Q partition and any other stainless steel work, shall be made of
welded cold drawn solution annealed and pickled; stainless steel tubes grade 304 as
per ASTM-A 249-95a. Outer diameter of the tube will be as specified and shown in
the drawing. Thickness of wall will be 1.65mm. Finish of the tubes will be
matt/buff as specified.
Material shall confirm to mechanical test of tensile strength, yield strength, elongation, hardness, flanges, flattening, heat analysis, reverse bending etc.

Chemical composition in % will be as follows:

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<th>Mn</th>
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3.4 Installation

G.I. sleeve of 40mm dia will be grouted in the steps / landing of staircases or railing as specified and shown in the drawing. Stainless steel baluster will be bolted to the sleeve and lead jointed. Wherever required, ends of the handrail tube to be capped. Assembly is to be true in line and upright as per requirement.

Work shall include providing and fixing stainless steel works as specified and required as per relevant drawing. The whole work shall be finished absolutely clean, true in line and lengths and in workman like manner. Approval for specific items shall be obtained in advance from the Engineer.

Installation will be done to suit the site conditions and as shown in the drawings. All necessary screws, nuts, bolts, welding, threading, chasing, cutting, supporting and making them good shall be done as required.

3.5 Measurements

Metal Work shall be measured in kgs unless indicated otherwise in the Schedule of Quantities. The actual dimensions including any embedded portion shall be taken and the weight calculated in kgs to the nearest second place of decimal using the standard coefficients for converting the area/ length of the member to weight.

All wastage and variations are deemed inclusive in the item rate quoted by the Contractor and nothing extra is admissible on this account. Payment will be made only for the measured quantity of metal work incorporated in the work. Lugs of the inserts shall also be measured under the item of Inserts.

3.6 Rate

The rate quoted shall include the cost of materials and labour involved in all the operations described above.
4  POP Work

POP punning

Providing and applying plaster of Paris (super fine quality) punning with minimum thickness of 6mm and finish the surface smooth in line and level including scraping and hacking the existing finished surfaces, scaffolding etc. complete as per drawing.

POP cornice

Providing and making decorative plaster of Paris (super fine quality) cornice (cast in situ), moulding, flutings etc. in the required profile and smooth in line and level to the entire satisfaction of Project Manager complete as per design and drawing.
TECHNICAL SPECIFICATIONS FOR PLUMBING WORKS

SECTION-01 :: BASIS OF DESIGN

1. BASIS OF DESIGN

The Plumbing, Sanitary, Drainage System for the project is designed keeping in view the following:

1.1 Requirement of adequate and equal pressure availability of cold t water lines in Toilets.

1.2 Adequate storage of terrace domestic water tanks...

The execution of works and materials used shall be as per the latest relevant I.S. specifications.

Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or Schedule of Quantities.

2. CONCEPT OF THE SYSTEM

The following services are envisaged for the complex:

2.1 Domestic (Cold) water supply through by gravity system.

2.2 Sewage and Sullage collection system based on IS: 1742 and applicable standards for domestic drainage.

2.3 Storm / Rain water drainage system from various levels of the building and disposal to available nearby storm water disposal.

3. WATER STORAGE & DISTRIBUTION SYSTEM

3.1 Water Requirement

The water requirement for the project is proposed to be based on the provisions of IS:1172 and prevalent practice. The estimated requirement of water per day for the Campus is based on the number of users and other services.

3.2 Source of Water

It is expected that part of the daily domestic water requirement for the Campus shall be through borewell / municipal mains supply.

3.3 Water Storage

The over head domestic water storage tank of sized for 10 KL.

3.4 Water Quality

Disinfected Water: It is proposed to provide localized UV units for water consumption points for direct consumption at water cooler.

3.5 Water Distribution

The water distribution for cold water supply for the Toilet area shall be supply by terrace water tank through gravity.

3.6 Appurtenant
Following components shall be included in the water supply system for efficient functioning:

i. Automatic air vent at each of the high point.

ii. Drain valve at each of the low point.

4. **SEWAGE, SULLAGE AND STORM WATER**

The soil and waste shall be carried down in separate independently vented pipes. Two pipe drainage systems shall be adopted as per NBC (Part-IX). Provision of ASP vertical vent shall also be made for hygiene, safety consideration and to avoid foul smell entering through trapped gully in WC. Provision of grease trap shall be made for waste water from Kitchen.

4.1 **Design Limitations**

The system is designed considering the following:

a. High thrust developed at soil & water pipe connections.

b. Termination of vent cowl at terrace level.

c. Provision of adequate slope for horizontal header pipes for achieving self-cleaning velocity in the pipes.

d. Provision of cleanout plug.

5. **WORKMANSHIP**

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner’s Site Representative. All materials and/or Workmanship which in the opinion of the Owner’s Site Representative / Architect / Consultant is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

6. **MATERIALS**

All materials shall be best of their kind and shall conform to the latest Indian Standards.

All materials shall be of approved quality as per samples and origins approved by the Owner’s Site Representative / Architect / Consultants.

As and when required by the Owner’s Site Representative / Consultant, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Owner’s Site Representative / Consultant, the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Owner’s Site Representative / Consultant. To prove that the materials used are as specified the contractor shall furnish the Owner’s Site Representative with original vouchers on demand.
SECTION-02 :: SANITARY FIXTURES & FITTINGS

1. **SCOPE**

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of following items:

a. Sanitary appliances and fixtures for toilets.
b. Chromium plated brass fittings
c. Stainless steel sinks
d. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
e. Hand driers, drinking water fountains etc.

Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

All exposed pipes within toilets and near appliances/fixtures shall be of chromium plated brass or copper unless otherwise specified.

2. **GENERAL REQUIREMENT**

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks etc and mirrors, hand driers, drinking water fountains etc as listed in the relevant items in the Schedule of Quantities shall be supplied free of cost by the Owner’s Site Representative. The rates shall be inclusive of accessories (in such case) required for installation. All sanitary fixtures and fittings shall received from the Owner’s Site Representative and thereafter be stored under covered roof and handled carefully to prevent any damage by the Contractor.

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / Owner’s Site Representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / Interior Designer.

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

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturers recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.
All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

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

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

i. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)

ii. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

iii. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

iv. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

vi. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

vii. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may vary within ±10% and the same shall be provided and no claim for extra payment shall be entertained. NOR shall any payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

2.1 Water Closet

Water Closet shall be wash down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Owner's Site Representative). Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Owners Site Representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.
Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

2.2 **Urinals**

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with 15mm dia CP spreader, 32mm dia CP domical waste and CP cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Owner’s Site Representative. Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit.

Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

**Urinal Partitions**

Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Owner’s Site Representative.

2.3 **Cisterns**

Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer’s specification to the satisfaction of the Owner Site Representative.

2.4 **Wash Basin**

Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner’s site representative. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Schedule of Quantities.

Each basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

2.5 **Sinks**

Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm dia CP waste and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner’s site representative.
Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. Installation of fittings shall be measured and paid for separately.

2.6 **Flow Control Device**

Approved / rated flow control fitment in brass body, chrome outer cover, rated for flow / discharge of the fixture.

2.7 **Toilet Paper Holder**

Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.

Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work. The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with rawl plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner’s Site Representative.

2.8 **Towel Rail**

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner’s Site Representative.

2.9 **Janitor's Sink**

Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner’s Site Representative.

The supply fittings for Janitor's sink shall be wall mounted type of size as mentioned in Schedule of Quantities.

2.10 **Liquid Soap Dispenser**

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only by key provided.

Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

The valve shall operate with less than 2.27 Kg (5 lbs) of force.

2.11 **Hand Drier**

The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).

The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply.
3. **TOILETS FOR THE DISABLED**

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner’s Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

4. **MOCKUP AND TRIAL ASSEMBLY**

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant.

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

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

5. **SUPPORTING AND FIXING DEVICES**

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

6. **FINAL INSTALLATION**

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

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

7. **PROTECTION AGAINST DAMAGE**

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

8.1 Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

8.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Owner’s Site Representative.

9. **TESTING**

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

**SECTION-03 :: WATER SUPPLY (COLD & HOT)**

1. **SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

   a. Bore well / Municipal / Tanker Water supply.
   b. Drinking Water Supply.
   c. Flushing Water Supply
   d. Washing
   e. External water supply to cater for Horticulture and Cooling Towers drawn from the Treated Sewage Water Tank through an independent pumping System (as required).
   f. Connection to various mechanical equipments to be supplied and installed by the other specialist contractors.

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

2. **PIPING MATERIALS**

The piping system shall consist of CPVC SDR 11.0 piping from 15 mm to 50 mm & Schedule 40 from 65 mm to 150 mm for cold water supply & schedule 80 from 65 mm to 150 mm for hot water supply.

The piping system shall also consist of heavy class galvanized iron pipes and fittings conforming to IS:1239. The sizes and makes is specified in the Schedule of Quantities.

For any internal works, the CPVC pipes / galvanized iron pipes and fittings shall be embedded in the wall chase or run on the floor/ceiling unless otherwise specified. No unsightly exposed runs shall be permitted.

A. **CPVC Pipes & Fittings**

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases
& fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager. Pipes from 65 mm to 150 mm dia shall be Schedule 40 for CWC & Schedule 80 for HWS / HWR.

i. Joining Pipes & Fittings

a. Cutting:
   Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

b. Deburring / Beveling:
   Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fittings during assembly.

c. Fitting preparation:
   A clean dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

d. Solvent Cement Application:
   Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

e. Assembly:
   After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.

An even bead of cement should be evident around the joint and if this bead is not continues remake the joint to avoid potential leaks.

Set & Cure times:
Solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

Minimum Core prior to pressure testing at 150 PSI

<table>
<thead>
<tr>
<th>Ambient Temperature during Core period</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>½&quot; - 1&quot;</td>
</tr>
<tr>
<td>Above 15 deg. C</td>
<td>1 Hr</td>
</tr>
<tr>
<td>4-15 deg. C</td>
<td>2 Hrs</td>
</tr>
<tr>
<td>Below 4 deg C</td>
<td>4 Hrs</td>
</tr>
</tbody>
</table>

Special care shall be exercised when assembling flow guard systems in extremely low temperature (below 4°C) or extremely high temperature (above 45°C) In extremely hot temperatures, make sure that both surfaces to be joined are till wet with cement solvent when putting them together.

f. Testing

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 psi(10 Bar) for one hour.
During pressure testing, the system should be fitted with water and if a leak is found, the joint should be cut out and replacing the same with new one by using couplers.

ii. **Transition of Flow guard CPVC to Metals**

When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight puts one half turn should be adequate.

iii. **Threaded Sealants**

Teflon tape shall be used to make threaded connections leak proof.

iv. **Solvent Cement**

Only CPVC solvent cement conforming to ASTM F 493 should be used for joining pipe with fittings and valves. Flow guard CPVC cement solvent have a minimum shelf life of 1 year. Aged cement solvent will often change colour or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company’s seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below:

<table>
<thead>
<tr>
<th>Diameter of pipe in inch (flow guard)</th>
<th>½”</th>
<th>¾”</th>
<th>1”</th>
<th>1¼”</th>
<th>1½”</th>
<th>2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx. nos. of joints which can be made per litre of solvent cement.</td>
<td>200 Nos</td>
<td>180 Nos</td>
<td>150 Nos</td>
<td>130 Nos</td>
<td>100 Nos</td>
<td>70 Nos</td>
</tr>
</tbody>
</table>

v. **Hangers and supports**

For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (1.2m) intervals for larger sizes.

Hangers should not have rough or sharp edges which come in contact with the tubing.

Supports should be as per the below mentioned table:

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>21°C</th>
<th>49°C</th>
<th>71°C</th>
<th>82°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
</tr>
<tr>
<td>½”</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>¾”</td>
<td>5.5</td>
<td>5.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>1”</td>
<td>6.0</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>1¼”</td>
<td>6.5</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1½”</td>
<td>7.0</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>2”</td>
<td>7.0</td>
<td>6.5</td>
<td>4.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

### SCHEDULE - 40

**Recommended Support spacing (in feet)**

<table>
<thead>
<tr>
<th>Nom. Pipe Size</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(In)</td>
<td>23 49 60 71 82</td>
</tr>
<tr>
<td>(mm)</td>
<td>65 7 6 7 6.5 6</td>
</tr>
<tr>
<td>2 ½</td>
<td>7 7 6 7 3 3</td>
</tr>
<tr>
<td>3</td>
<td>8 7 7 7 6 3</td>
</tr>
<tr>
<td>4</td>
<td>8 7 7 7 6 4</td>
</tr>
<tr>
<td>6</td>
<td>9 8 8 7 7 4.5</td>
</tr>
<tr>
<td>8</td>
<td>9 8 8 7 7 5</td>
</tr>
</tbody>
</table>
### SCHEDULE - 80

**Recommended Support spacing (in feet)**

<table>
<thead>
<tr>
<th>Nom. Pipe Size</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(In) (mm)</td>
<td>23</td>
</tr>
<tr>
<td>2 ½ 65</td>
<td>8</td>
</tr>
<tr>
<td>3 80</td>
<td>8</td>
</tr>
<tr>
<td>4 100</td>
<td>9</td>
</tr>
<tr>
<td>6 150</td>
<td>10</td>
</tr>
</tbody>
</table>

### B. Galvanised Iron Pipes & Fittings

The pipes shall be galvanised mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of IS:1239. The Galvanising shall conform to IS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the pipe.

The fittings shall be malleable iron and comply with all the requirements of the pipes. The size of pipes and fitting is specified in the schedule of quantities.

### Laying And Jointing Of GI Pipes

The galvanised pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted for pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Owner’s Site Representative, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be painted with anticorrosive bitumastic paints of approved quality. Under the floors the pipes shall be laid in layer of sand filling.

Galvanised iron pipes shall be jointed with threaded and socket joints, using threaded fittings. Care shall be taken to remove any burr from the end of the pipes after threading. Teflon tape, White lead or an equivalent jointing compound of proprietary make shall be used, according to the manufacturer’s instructions, with a grommet of a few strands of fine yarn while tightening. Compounds containing red lead shall not be used because of the danger of contamination of water. Any threads exposed after jointing shall be painted with bituminous paint to prevent corrosion.

### 3. FERRULES

The ferrules for connection with main shall generally conform to IS:2692. It shall be of non-ferrous materials with a bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting of the water supply to the communication pipe, as and when required.

#### 3.1 Fixing Ferrules

For fixing ferrule in cast iron mains, the empty main shall be drilled and tapped at 45 deg to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.
4. TESTING

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required. In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the contractor during the defects liability period without any cost.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner’s site representative.

5. DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 liters of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

6. STERILIZATION OF MAIN

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.

7. CUTTING CHASES IN MASONARY WALLS
Cold water distribution pipes to fixtures and equipment exposed to view in the bathrooms, kitchens, and sanitary compartments shall be chased into walls or floors or placed in wall cavities. The Contractor shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a diamond cutter shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect.

The chases upto 7.5 x 7.5 cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architects. Chases shall be made by chiselling out the masonry to proper line and depth. After the pipes etc are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as may be specified, and made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of the Structural Consulting Engineer, the Contractor shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

8. VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature upto 80° C.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Valve</th>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Isolating Valve</td>
<td>15 mm to 50 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 mm and above</td>
<td></td>
<td>Flanged</td>
</tr>
<tr>
<td>b.</td>
<td>Sluice Valve &amp; Butterfly Valve</td>
<td>65 mm and above</td>
<td>Cast Iron</td>
<td>Flanged</td>
</tr>
<tr>
<td>c.</td>
<td>G.M. non return valve</td>
<td>15 mm to 50 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 mm above</td>
<td></td>
<td>Flanged</td>
</tr>
<tr>
<td>d.</td>
<td>Flap Type – Non return valve</td>
<td>65 mm and above</td>
<td>Cast Iron</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

All valves shall be suitable for the working pressure involved.

8.1 Pressure Reducing Valve Set

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.
Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the preset down stream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type.

### 8.2 Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

### 8.3 Pressure Gauge

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg/cm square and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

Calibration certificate shall be obtained and submitted for each pressure gauge.

### 9. WATER FITTINGS

Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

### 10. CONNECTIONS TO VARIOUS MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies shall be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturers instructions and the directions of the Owner’s site representative / Architect. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House area and other similar areas. The work of connections to the various equipments shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner’s site representative / Architect. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.

### 11. CONNECTIONS TO RCC WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.
Full way gate valves of a approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles upto the overflow level. Alternatively food grade epoxy to be applied.

**Tiling of Walls**

The floor and the walls of the tanks shall be tiled with glazed tiles up to the overflow level. Alternatively food grade epoxy to be applied to the floor and the walls of the tanks.

12. **MEASUREMENTS**

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include pipe and fittings such as coupling, bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities. All pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

13. **LAWN HYDRANTS**

Lawn hydrants shall be of 25mm size unless otherwise indicated. All hydrants shall be provided with gate valves and threaded nipple to receive hose pipes. Lawn hydrant valves shall be of approved make and design. Where called for lawn hydrants shall be located in masonry chambers of appropriate size.

14. **PIPE PROTECTION**

*(FOR COLD WATER PIPES BURIED IN TRENCHES / GROUND / EARTH)*

All buried pipes shall be cleaned with zinc chromate primer and bitumen paint, wrapped with three layers of fiber glass tissue, each layer laid in bitumen and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. The pipes where laid under floor shall be encased with 100 mm thick jamuna sand all around in addition to protective coating as described above. Alternatively pypcoat / coatek insulation for protection of pipe would also be acceptable as per final approval of project engineer / consultant.

15. **THRUST BLOCKS**

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Owner’s site representative.

16. **MASONRY CHAMBER**

i. All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as per supplied drawings.

ii. The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the Owner’s site representative.
iii. Concrete shall be of cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size.

iv. Brick shall be of class designation 75 in cement mortar 1:5 (1 cement : 5 fine sand)

v. Inside Plastering not less than 12 mm thick shall be done in cement mortar 1:3 (1 cement : 3 fine sand) finished with a floating coat of neat cement.

17. SHIFTING OF EXCAVATED SURPLUS MATERIAL

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Owner’s site representative at free of cost within time limit.

SECTION-04::INTERNAL DRAINAGE (SOIL, WASTE, VENT & RAIN WATER PIPES)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

2. BASIC PIPING SYSTEM

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of heavy class GI.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner’s site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under ‘painting’. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of cast iron or galvanised mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that atleast one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanised mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanised mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.
All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

3. PIPING MATERIALS

3.1 Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS:3989 / IS:1729 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialities

If required, Cast iron speciality items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

<table>
<thead>
<tr>
<th>Nominal size of Pipe (mm)</th>
<th>Lead per Joint (Kg)</th>
<th>Depth of Lead Joint (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.77</td>
<td>25</td>
</tr>
<tr>
<td>80</td>
<td>0.88</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>0.99</td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>1.5</td>
<td>38</td>
</tr>
</tbody>
</table>
**Drip Seal Joints:**

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

**Application Procedure:**

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

3.2 **Galvanised Iron Pipes**

Waste pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS:1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

3.3 **UPVC Pipes and Fittings**

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS:4985-1981. The pipes shall be of Class-III; 6 Kg/sqm pressure rating.

**Fittings**

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

**Laying and Jointing**

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner’s site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner’s site representative.

**Supports**

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.
Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

3.4 Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS:1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS:1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with drip seal / lead joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the drip seal. Lead to be poured in.

Laying

i. Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

Drip Seal Joints :

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (*The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.
ii. Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

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<tbody>
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<td>45</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
<td>45</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>50</td>
</tr>
</tbody>
</table>

iii. The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten Lead shall then be poured to the remainder of the socket.

iv. For lead wool joints the socket shall be caulked with tarred gasket, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

4. PIPES HANGERS, SUPPORTS, CLAMPS ETC.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor’s shop drawings. Clamps shall be fixed in accordance to manufacturer’s details/shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g., trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks.
and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

5. INSTALLATION OF SOIL, WASTE & VENT PIPES

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with drip seal / Best Quality pig lead free from impurities confirming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The depth of the lead joints for the cast iron pipes shall be 45mm for the pipes upto 100mm dia and 50mm for the pipes beyond 100mm dia respectively. The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes
All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU’s pump rooms, waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.

Balcony / Planter drainage
Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

6. TRAPS

6.1 Floor Traps

Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).
Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

6.2 **Floor Trap Inlet /Hopper**

Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from GI pipe, with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal/Lead Caulked. Inlet shall be connected to a CI “P” trap. Floor trap inlet and the traps shall be set in cement concrete blocks where burried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner’s site representative. All fabricated hopper shall be hot dip galvanized.

6.3 **Floor Trap Grating**

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner’s site representative.

6.4 **Cleanout Plugs**

**Floor Clean Out Plug**

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Y” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be drip seal joined/ Lead Caulked to the drain pipes.

**Cleanout on Drainage Pipes**

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner’s site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

7. **PIPE SLEEVES**

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

8. **PIPE PROTECTION**

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

9. **CUTTING AND MAKING GOOD**

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they
shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

10. **PAINTING**

Soil, waste, vent and rain water pipes in exposed location, in shafts and pipe space shall be painted with two or more coats of ready mix oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner’s site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

11. **TESTING**

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests, all materials obtained and used on site must have manufacturer’s hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections. After the installation is fully complete, it should be tested by flushing the toilets, running atleast 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase in plastered or the pipe encased or buried.
SECTION-05:: EXTERNAL DRAINAGE (SEWAGE & STORM WATER DISPOSAL)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of external drainage & sewage disposal services.

1.1 General Scheme

The contractor shall install a drainage system to effectively collect, drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the STP. The piping work mainly consists of laying of Salt glazed stoneware pipes, reinforced cement concrete pipes and cast iron soil pipes as called for on the drawings. All piping shall be installed at depth greater than 80 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers as indicated. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructive and concealed. The work shall be executed strictly in accordance with IS: 1742. The sewage system shall be subject to smoke test for its soundness as directed by the Project Manager. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Project Manager.

Without restricting to the generality of the foregoing, the drainage system shall inter-alia include:

a. Sewer lines including earth work for excavation, disposal, back filling and compaction, pipe lines, manholes, drop connections and connections to the municipal or existing sewer.

b. Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Project Manager.

General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approval of the Owner’s site representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / Owner’s site representative.

Drainage lines and open drains shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

Location of all manholes, etc shall be got confirmed by the Project Manager before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager in writing.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

2. TRENCHING FOR PIPES AND DRAINS

2.1 General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.
Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc. shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by the Project Manager.

2.2 **Alignment & Grade**

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive mortar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes shall be laid at least 60cms below the finished ground level or as called for on the drawings.

2.3 **Setting out Trenches**

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

2.4 **Trench Excavation**

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cms.

2.5 **Timbering of Sewer and Trenches**

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy starta and below the surface of the sub soil water level.

All timbering, sheeting and piling with their wallings and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

2.6 **Shoring of Buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.
2.7 **Obstruction Road**

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

2.8 **Protection of Pipes etc**

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

2.9 **Trench Back Filling**

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

2.10 **Contractor to restore settlement and Damages**

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

2.11 **Removal of Water from Sewer, Trench etc.**

The contractor shall at all times during the progress of work keep the excavations free from water which shall be disposed by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any road or streets, nor cause any interference with the use of the same by the public.

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the contractor at his own expense and charges to the requirements of the Project Manager.

2.12 **Removal of Filth**

All night soil, filth or any other offensive mater met with during the execution of the works, shall not be deposited on the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain.
but shall be immediately, after it is taken out of any trench, sewer or cess pool, put into the carts and removed to a suitable place to be provided by the Contractor.

2.13 **Width of Trench**

The Project Manager shall have power by giving an order in writing to the Contractor to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

3. **PIPING MATERIAL**

3.1 **RCC pipes**

All pipes shall be centrifugally spun RCC pipes NP2. Pipes shall be true and straight with uniform bore throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS:458-1971.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

**Laying**

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

**Jointing**

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

**Curing:**

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

**Cement Concrete for Pipe Supports:**

a. Unless otherwise directed by the Project Manager cement concrete for bed, all round or in haunches shall be as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Upto 1.5 m depth</th>
<th>Upto 3 m depth</th>
<th>Beyond 3 m depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneware pipes buried in open ground (No sub soil water)</td>
<td>All round (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
</tbody>
</table>
### Measurement:

**a. Excavation**

Measurement for excavation of pipes trenches shall be made per linear meter.

**b. Trenches**

Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

**c. RCC pipes**

RCC pipes shall be measured for length of the pipe line per linear meter.

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

#### 3.3 Cast Iron Class (LA) Pipe

All drainage line passing under building, floors and roads with heavy traffic shall be Cast Iron Class (LA) Pipe.

Cast Iron Class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provide that the specified mechanical properties are satisfied.

**Material**

Cast iron pipe shall be centrifugally spun cast iron pipes and conforming to IS:1536-1976.

**Fittings**

Fittings shall be used for Cast Iron Class (LA) Pipes shall conform to IS:1538-1976. Whenever possible junction from branch pipe shall be made by Wyes.

**Laying**

Fittings used for C.I drainage pipe shall conform to IS:1538-1976. Whenever possible junction from branches pipes shall be made by a Wyes.

All cast iron pipes and fittings shall be jointed with best quality soft pig lead (conforming to IS 782-1966) which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as given in table below:
Lead caulked Joints with Pig Lead

The approximate depth and weights of Pig Lead for various diameters of C I pipes and specials shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Size of Pipe</th>
<th>Lead per joint</th>
<th>Depth of Lead Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>Kg</td>
<td>mm</td>
</tr>
<tr>
<td>80</td>
<td>1.8</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
<td>45</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>50</td>
</tr>
</tbody>
</table>

The spigot of pipe of fittings shall be centred in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

Drip Seal Joints:

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

Measurement:

a. Excavation

Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. C.I class (LA) pipes shall be measured for the length of the pipe line per linear meter i.e:

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.
ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

3.4 Salt Glazed Stoneware Pipes

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with IS:651 and have the manufacturers name marked on them.

Laying of Salt Glazed Stoneware Pipes:

Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be lightly struck with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes shall be segregated, marked in a conspicuous manner and their use in the works prevented by expeditiously removing them from the work site.

The pipes shall be laid with sockets leading uphill and shall rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 20mm nominal size) at the Contractor's cost and charges.

Jointing of Salt Glazed Stoneware Pipes:

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from the inside of the joint with a suitable scarper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sackling or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection by the Project Manager. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

S.W. Gully Trap

Gully trap shall be stoneware conforming to IS:651. These shall be sound and free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300mm the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

Fixing of S.W. Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Project Manager /Consultant / Architect. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet
to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

Measurements

Gully traps shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame.

4. CONSTRUCTION OF MANHOLE

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be built on a base concrete 1:3:6 of 150mm thickness for manholes upto 1500mm depth and 250mm thickness for manholes from 1500 to 2500mm depth and 300mm thickness manholes of depth greater than 2500mm. Reinforcement as shown shall be provided in the base slabs.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semi circular channels of the same diameter as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with poly propylene coated steel reinforced foot rest. The polypropylene shall conform to ASTM D-4101 specification, injection moulded around 12 mm dia IS-1786 grade FE-415 steel reinforcing bar. These rungs shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

4.1 Measurements

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover.

Manhole with depth greater than specified under the main item shall be paid for under 'Extra Depth' and shall include all items as given for manholes depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel. The following are inclusive in the cost of manhole viz:

i. Bed concrete

ii. Brick work.
iii. Plastering (inside & outside)
iv. R C C top slab, benching and channeling including drop connections.
v. Supply and fix foot rests.
vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary de-watering and disposing off surplus soil to a places as directed by Project Manager.
viii. Curing.
ix. Cost of angle frame and embedding the frame in concrete bed.
x. Testing.
xi. De-watering of chambers.

4.2 Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with atleast one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with CI / CI class LA pipe, 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 hinges type frame and cover 30cms x 30cms. The connection and tee upto the surface chamber of the tee.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

4.3 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

5. GREASE TRAP

5.1 Size of Grease Trap

The size given in Bill of Quantities and drawings shall be internal size of chamber. The work shall be done strictly as per standard drawing and following specifications.

5.2 Bed Concrete

Shall be in 1:4:8 cement concrete 150 mm thick.

5.3 Brick work

Brick work shall be with best quality bricks in 1:5 CEMENT MORTAR.
Baffle walls shall be of R.C.C and of size as mentioned in Bill of Quantities. Brick partition constructed of best quality table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber.

5.4 **Plaster**

The walls of chamber shall be plastered from inside with 12 mm thick cement plaster 1:3 and finished smooth with a floating coat of neat cement & rough plaster on outside in cement mortar 1:3.

5.5 **Chamber Covers**

Covers shall be of size and duty as mentioned in Bill of Quantities. Covers shall be of cast iron as per the details given in the drawing and shall be fixed on frame embedded in concrete.

C. I steps shall be provided at two corners of the chamber.

All Cast Iron and MS items shall be painted with two coats of bitumastic paint.

5.6 **Cast iron Manhole cover and Frame**

The Cast Iron Manhole Cover and Frame shall conform to IS:1726 and the grade and types have been specified in the Bill of Quantities. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate non-slip grip.

The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

6. **TESTING**

All rights of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of water. The test pressure will however, not exceed 6 meters head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time. Sewer lines shall be tested for straightness by:

i. Inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball shall roll down the invert of the pipe and emerge at the lower end.

ii. means of a mirror at one end a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

iii. The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Owner’s site representative.

iv. A test register shall be maintained which shall be signed and dated by contractor and Owner’s site representative.
SECTION- 6 :: COMMISSIONING & GUARANTEE

1. **SCOPE OF WORK**

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. **PRECOMMISSIONING**

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fittings and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

   - Remove oil, grease and foreign residue from the pipe work and fittings;
   - Pre-condition the metal surfaces to resist reaction with water or air.
   - Establish an initial protective film;
   - After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
   - Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

d. Check all clamps, supports and hangers provided for the pipes.
e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

6. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Pipe Lines</th>
<th>Ground / Base Colour</th>
<th>First Colour Band</th>
<th>Second Colour Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drinking Water (All cold water lines after filter)</td>
<td>Sea Green</td>
<td>French Blue</td>
<td>Single Red</td>
</tr>
<tr>
<td>2</td>
<td>Domestic Hot Water</td>
<td>Sea Green</td>
<td>Light Grey</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Drainage (Storm Water)</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Drainage (Sewage Water)</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. CHECK LIST FOR COMMISSIONING

Water Supply and Drainage

a. Remove grease trap manhole covers. Check for cleanliness, check for partitions, and put back the cover.

b. Remove manhole covers on sewer lines, inspect for cleanliness. After they are found to be clean, pour water into the first manhole and see that all the lines are clear. Make sure that all the covers are put back after the inspection.

c. Check gully traps by opening of covers and check that water seal in the traps are maintained. Check for general cleanliness.

d. Check installation of proper vents and cowls at the roof level for all soil and waste pipes.

f. Simulate low level in the domestic water tanks to trip domestic Filter Feed Pumps. Simulate high level in treated water tanks to trip softener feed pumps. Simulate low level in treated water tanks to trip treated water hydro-pneumatic pumps.
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TECHNICAL SPECIFICATIONS

1.0 DISTRIBUTION BOARDS

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be constructed out of steel sheet all weld enclosure with double door IP42 protection and shall be powder coated. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements. The MCBs shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars. Each incoming MCB isolator shall be provided with solderless cable sockets for crimping. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall nitch or if required mounted on the surface of the wall with necessary clamp bolts etc. The mounting height shall not exceed 1350mm from finished floor level. Distribution board shall be provided with proper circuit identification nameplate and danger sticker/plate as per requirements.

All the distribution boards shall be marked with ‘lighting’, ‘power’ or ‘Emergency’ with DB Nos., as the case may be. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number and phase.

Each distribution board shall have a separate neutral connection bar and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together and connected to the distribution board earth bar.

MCB’s shall have quick make and break non-welding silver alloy contacts, both on the manual and automatic operation. MCBs shall be of thermal magnetic type with inverse time delay over-current tripping having a short circuit rupturing capacity of 10KA. MCBs shall comply with IS:8828/1996. In case of multiple breakers, the tripping must be on all the poles. Wherever MCB isolators are specified they are without the tripping elements. Necessary built in adopter box of suitable size shall be provided in the DB to facilitate the wiring and nothing extra shall be payable on this account.

Where oversized cables are specified due to voltage dip problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangement are provided and nothing extra shall be payable on this account.

2.0 CUBICLE SWITCH BOARDS

Cubicle switch boards shall be metal clad, totally enclosed, single front, floor mounted, cubical type for use on 415 volts 3 phase, 4 wire, 50 cycles A.C. system with a fault level of 25 KA RMS symmetrical. The switch board shall be made up of the requisite vertical sections, which when coupled together shall form continuous dead front switch boards of dust and vermin proof construction. The panels shall be fully compartmentalized and shall be arranged in multi-tier-formation. Unless specified otherwise, access shall be front only. The top and bottom of each compartment; shall have barriers, etc. and shall be made of 2mm CRCA sheet steel and shall be painted with powder coated paint. The structure shall be of rigid welded/bolted construction. The doors and covers shall be made of 1.6mm thick CRCA sheet steel being non load bearing members. A rigid base channel of folded sheet steel of minimum 3mm thickness and 50mm height shall be provided. No mounting shall be provided 300mm above base channel i.e. 350mm from floor in which no switch gear shall be fixed. Joints of any kind in sheet metal shall be seam welded, all welding slab grounded off and welding pits wiped smooth with plumber metal.
All panels and covers shall be properly fitted and square with the frame. Reinforcing ribs shall be welded to the back of the front plate/doors in any location where cut out may weaken the plate/door. Welding marks, dimples or blemishes shall not appear on the front of the plate/door where welding has taken place. Cut out shall be machine cut and flame cutting shall not be permitted. A pocket shall be provided inside the doors for storage of schematic and manuals. Where PLCs are mounted internally, the door shall incorporate a perpix vision panel suitably positioned to view the I/O module status LEDs. Front doors shall be lockable using approved lockable “T” handles or alternatively front plates shall be removable by means of screw fixing. Holes in the panel shall be correctly provided and tapped into on adequate thickness of metal or provided with nuts, for convenient fixing of screws. Self threading screws shall not be used in the fabrication of the panels. All doors shall be provided with neoprene gaskets. Each vertical panel structure shall contain a cable way alley of adequate width with provision for suitable cable supports. The cable compartment shall have hinged door. There shall be a separate gland plate for each cable entry so that there will not be dislocation for already wired circuits when new feeders are added. The entire switch board shall be factory assembled conforming to IS:8623 and shall be made in the works of the switchgear manufacturer of approved make. The contractor shall get shop drawing approved by the consultant before undertaking manufacturing of switch boards.

The panel shall include the requisite MCCB’s incorporating high rupturing capacity, aluminium bus bars as specified in item of work.

The units should be arranged in tier formation to provide a compact switch board having a pleasing appearance. The minimum depth of switch board shall be 400mm and the height be restricted to 2300mm steel hinged lockable doors shall be duly interlocked with MCCBs to prevent opening of the panel when the switch is in “ON” position. Rotary operating mechanism with door interlock and pad lock facility shall also be provided. All the MCCBs shall be provided with vertical operation.

The bus bars shall be positioned at top or side position. The bus bars shall be air insulated and made of high conductivity, high strength aluminium alloy of current density not less than 1.0 AMPS/Sq.mm complying with requirement of class E91E of IS:5082 designed and shall be of uniform cross section throughout the length. The bus bars shall be held by sheet metal polyester glass moulding (SMC) at sufficiently close intervals to prevent bus bar sag and to effectively withstand electro magnetic stresses in the event of a short circuit. All the bus bars and risers shall be fully insulated with Heat Shrinkable Sleeves with necessary colour coding. High tensile bolts and spring washers shall be provided at all bus bars joints. Vertical bus bars for outgoing compartments shall run the full height of the panel to cater to all combinations of modules in a section.

All indicating instruments shall be of the flush mounting industrial pattern, conforming to the requirement of IS:1248. Indicating lamps shall be of the LED type. Separate compartment shall be provided for accommodating instruments, indicating lamps, control contactors and fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, MCCBs, bus bars and connections.

Horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between different vertical sections. Control wiring shall be of copper conductor and shall be colour coded for easy identification of circuits. This should be of not less than 2.5 sq.mm. Not more than two connections shall be made of any one terminal.

All cables shall be neatly bunched and shall be secured to wiring cradles. All outgoing cables shall be fitted with identification ferrules at each end. Laminated circuit diagrams showing the arrangement of circuits shall be pasted on the inside of panel door. Knockout holes of appropriate size and number shall be provided within panel in conformity with the location of incoming and outgoing cables/conduits. Facility shall be provided for termination of cables from both top and bottom of the panel. Where cables enter from below, cables glands shall be fitted at the bottom and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. Aluminium flat of suitable size with two earthing cable eyes shall be provided for connections to main earth.
The earth bar shall run within the base frame. All devices shall be mounted so that positive bonding is achieved by metal to metal contact with the panel. All the door frames shall be bonded with flexible copper wire of green colour. Provision of vertical earth bar in each vertical section of bus bar alley shall be provided.

All steel material used in the construction of the switch board should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process. The steel work should then receive two coats of zinc chromate primer before final coat of stoving synthetic enamel paint of approved shade.

Engraved plastic labels shall be provided indicating the feeder details. Danger notice plate shall also be provided as per I.E. Rules. Adequate provision shall be made for escape of hot gases by providing louvers. The louvers shall be located as to direct the hot gases away from the operating personnel and shall be covered with perforated sheet having less than 1mm diameter perforations to prevent entry of vermin. All nuts, bolts and washers shall be cadmium plated. Each panel incomer section shall be provided with voltmeter 0-500 volts with 3 way on and off selector switch, ammeter of appropriate range with selector switch as per the bill of material in the tender.

On large or heavy panels, lifting eye-bolts shall be located at the corner of each enclosure. These bolts shall be removed after panel installation and replaced with suitable blanking plugs to maintain the IP rating.

3.0 L.T. CABLES

A. Wires

The design manufacture, testing and supply of single core PVC insulated 1.1 KV grade twisted wires under this specifications shall comply with latest edition of following standards.

IS : 3961 Current rating for cables.
IS : 5831 PVC insulation and sheath of electric cables.
IS : 694 PVC insulated cables for working voltage upto and including 1100 volts.

Copper/Aluminium stranded twisted conductor FRLS PVC insulated wires shall be used for conduit as per item of work.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line, indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of cable/wire.

B. Cables

The design, manufacture, testing and supply of the cable under this specifications shall comply with latest edition of following standards:

IS : 8130 Conductors for insulated electric cables and flexible cords.
IS : 3975 Mild steel wires, strips and tapes of armouring cables.
IS : 3961 Current rating of cables.
IS : 694 PVC insulated electric cables for working voltage upto and including 1100 volts.

(F-3)
IS : 7098(I) Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage upto 1.1 KV.

ASTM-D:2863 Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).

ASTM-D:2843 Standard test method for measuring the density of smoke from the burning or decomposition.

IEEE : 383 Standard for type test Class-IE, Electric cables, field splicers and connections for power generation station.


IS : 10418 Cable drums.

C. Technical Requirements:

a) The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

b) They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

c) The aluminium/copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.

d) The cable should withstand 7KA for 1 sec with insulation screen/armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration. Copper screen of each core shall be suitable for carrying full fault / earth current.

e) The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.

f) Progressive automatic in line, indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'FRLS' marking in case of 'FRLS' cables.

g) Strip/wire armouring following method (b) mentioned in IS : 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.

h) Allowable tolerance on the overall diameter of the cables shall be ± 2mm.

i) The normal current rating of all PVC insulated cables shall be as per IS:3961.

j) A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS:5831.

k) Outer sheath shall be provided by extrusion process as per IS:5031.

l) The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.

m) In plant repairs to the cables shall not be accepted.

n) All the cables shall be supplied in non-returnable drums as per IS:10418.
D. Inspection:

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

E. Joint in Cables

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilization and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, the location of such joints shall be got approved from the Employer/Consultant. The joints shall be done by qualified joiner strictly in accordance with manufacturer’s instruction/drawings.

F. Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

G. Jointing of Cables

All cable joints shall be made in suitable, approved cable joints boxes. On the jointing of cables in the joint box, the filling in of compound shall be done in accordance with manufacturer’s instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with Heat Shrinkable push on type termination. Cable glands shall be 1.1KV grade, double compression type in case of out door cables and single compression in case of indoor installation and made to tin plated heavy duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury to cable.

All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS:8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using corrosion inhibitory compound, with crimping tool.

H. Testing of Cables

Cables shall be tested at factory as per requirement of IS:1554 Part-I. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to burying of cables, following tests shall be carried out:

a) Insulation test between phases and phase and earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Architect/Owner:

a) Insulating resistance test (sectional and overall)
b) Continuity resistance test.
c) Sheathing continuity test.
d) Earth test.
I. Laying of Cable

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. At all changes in directions in horizontal and vertical places, the cable shall be bent with a radius of bend not less than 20 times the diameter of cable.

The cable of 1.1 KV grade shall be laid not less than 750mm below ground level in a 350mm wide trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-Charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstances the depth per tier shall be increased by 300mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable.

Greater care shall be exercised in handling the cable in order to avoid forming ‘Kinks’. The cable drum shall invariably carried on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

In case cables are laid in trenches in single tier formation, 20 cms total sand cushioning be provided below and above the cable before a protective cover is laid. For every additional vertical tier, 30 cm of sand cushion be provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick or tiles shall cover all cables and project at least 8 cms. over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

RCC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters and at with change of direction.

Where the cables are to be laid in ducts (pucca trenches) in side the building, they will have to be laid on MS rack/on MS cable trays grouted in walls. Cables sizing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor. Where cable run through wall they shall be sleeved with PVC conduit.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray and rack shall be neatly dressed and clamped at an interval of 3000mm and 900mm for horizontal and vertical cable run respectively and at each bend of cable. All power cables shall be clamped individually and control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation and clamped with trefoil clamps made of PVC/fibre glass.
Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape and bitumen compound or by any other suitable method to prevent ingress of water.

After the cables are laid, they shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

J. **Fire Seal System**

a) All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

b) The fire proof seal system shall fully comply with the requirements of relevant IS/BS:476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.

c) The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antirodent and anti-termite.

d) The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

e) Type of fire proof seal system shall be foaming type or flamemastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is no fault in the jointing.

Cables for use on low and medium voltage system (1.1 KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester. In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal and laying will be made good by the contractor.

Cable shall be installed so that separation shown in the table below are observed.

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Cable - HV Cable</td>
<td>50mm</td>
</tr>
<tr>
<td>ELV &amp; LV - ELV &amp; LV cable</td>
<td>50mm</td>
</tr>
<tr>
<td>HV Cables - ELV &amp; LV cables</td>
<td>300mm</td>
</tr>
<tr>
<td>LV Cables - Telephone/Instrument cable</td>
<td>350mm</td>
</tr>
<tr>
<td>All Cables - All hot pipe work</td>
<td>200mm</td>
</tr>
</tbody>
</table>

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation. Wherever equipment has to be re-positioned due to lack of site liaison, no extra cost shall be incurred by the client.

4.0 **MAIN L.T. PANEL**

The L.T. Cubical type panel boards shall be metal clad, totally enclosed, rigid, floor mounting, air insulated for use on 433 V 3 phase 50 cycles system with a fault level withstand of 18 MVA. The LT panel should be readily extensible on both sides by addition of vertical sections after removal of the end covers. MCCBs shall be arranged in multi-tier formation to provide a compact switch board. The height of the switch board shall not exceed 2430mm including base frame. The degree of protection shall be IP42 as per IS:2147/1962 with latest amendment.

The equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning and repairs for use in installation as continuity of operation is of prime importance.

The entire LT panel shall be factory assembled conforming to IS:8623 with latest amendment. In order to provide access for cable termination, hinged doors shall be provided at the rear of the panel. Cable entries and terminals shall be provided in the switch board to suit the
number, type and size of aluminum conductor power cables as specified in the schematic diagram. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated. All outgoing cables would be fitted with identification ferrules at each end. Ventilation louvers with screen of fine wiremesh shall be provided. Flats 40X6mm or suitable size with two earthing cable eyes shall be provided for connection to main earth. The flats shall run the entire length of the switch board.

All steel material used in the construction of the switch board should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process. The steel work should then receive two coats of filler oxide primer before final coat of stoving synthetic enamel paint of light gray shade 631 to IS-5 1978 with latest amendment. Touch up paint shall however be applied before handing over the installation after completing the job at site. Danger notice plate shall also be provided. Necessary lifting hooks shall be provided in each panel as required, which shall be removed after installation of the switch board and plugs shall be provided in place of hooks. The power control centre shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as well as the effects of humidity, which are likely to be encountered in the normal service.

Each vertical section shall comprise:

1. A front-framed structure of rolled/folded sheet channel section of minimum 2mm thickness rigidly bolted together. This structure shall house the components contributing to the major weight of equipment such as circuit breakers, MCCB’s main horizontal bus bars, vertical risers and other front mounted accessories. M.C.C. B’s shall be vertically mounted. The structure shall be mounted on a rigid base frame of folded sheet of minimum 3mm thickness and 50mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

2. A rear cable chamber shall house the cable end connections and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

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

4. Front and rear doors shall be fitted with dust extruding neoprene gaskets with fasteners designed to ensure proper compression of gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. All doors/covers providing access to live power equipment circuit shall be provided with test operated fasteners to prevent unauthorized access.

Doors and covers shall be of minimum 1.6mm thick CRC sheet steel. Shrouds and partitions shall be also minimum 1.6mm thickness. All sheet steel work forming the exterior of switchboard shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

The apparatus and circuits in the panel shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety. The operating handle of the highest unit shall not be more than 1.8 meter from floor level. The general arrangement for multtier construction shall be such that the horizontal tiers formed present an aesthetic look. The general arrangement shall be got approved before fabrication of the panel.

Apparatus forming part of the power control center shall have the following minimum clearances.
a) Between phases - 25mm
b) Between phases and neutral - 25mm
c) Between phases and earth - 25mm
d) Between neutral and earth - 19mm

When for any reason, the above clearance are not available, suitable insulation shall be provided and clearance shall be maintained during normal service conditions. Creepage distances shall comply to those specified in relevant standards.

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

Metallic / insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

a) Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
b) Cable terminations of one functional unit, when working on those of adjacent unit/units.

The bus bars shall be of high conductivity electrolytic aluminium alloy complying with the requirements of grade E 91E of IS: 5082 with latest amendment and of current density not less than 1.3 A/Square mm. The main phase bus bars shall have continuous current rating throughout the length of LT panel and the neutral bus bars shall have a continuous rating of atleast 50% of the phase bus bars. High tensile bolts and spring washers shall provide at all bus bar joints connections.

The bus bars shall be supported on glass reinforced polyester (SMC) sheet moulding compound insulators placed vertically at sufficiently close intervals to prevent bus bars sag and to effectively withstand electric magnetic stresses in the event of a short circuit. All bus bars and risers shall be fully insulated with PVC sleeving with necessary colour coding for identification. For rating more than 2000A the bus bars shall have interleaving system for better current distribution and reduced temperature rise.

The MCCB shall be of the load break, heavy duty, cubical type conforming to latest IS:.. The MCCB’s shall be provided with a front operating handle with marking of ON/OFF positions. Inter locks shall be provided so as to prevent opening of the unit door when the switch in the ON position and also to prevent closing of the switch with the door not properly secured. It should, however, be possible for a competent examiner to operate the MCCB with the door open by releasing the interlock. The handle of the switch should be suitable for locking the MCCB switch in the OFF position by means of a padlock. The MCCB’s shall be cubical mounted.

Routine tests shall be conducted in accordance with IS: 8623 and shall comprise:

a) Inspection of LT panel including inspection of wiring and electrical operational tests where necessary.
b) Dielectric tests.
c) Checking of protective measures and electrical continuity of the protective circuits.

Circuit breaker panel shall be of one/two tier, cubical, dust and vermin proof, free standing, dead front, fully interlocked pattern fabricated out of 14 SWG sheet steel and shall be easily extensible on either side. It shall be suitable for use on 433 V, 3 phase, 4 wire, 50 CPS system.

The circuit breaker shall be triple/four pole as per B.O.Q. This should be air break type in order to eliminate fire and explosion risk. The air circuits breaker shall be of robust and compact design and shall comply with the requirements of IS: 2516 with the rupturing capacity of not
less than 18 MVA at 415 V. The basic unit shall consist of a horizontal withdrawable pattern fully interlocked; independent, manual spring operated air circuit breaker.

These shall be having triple pole IDMTL over current and earth fault relay having three over current and one earth fault element relay type CDG – 31 and shunt trip. The relays shall be contained in dust proof cases and shall be flush mounted on the front of the panel as per B.O.Q.

All current carrying parts in the breaker shall be silver-plated and suitable auxiliary arcing contacts shall be provided to protect the main contacts. Arc – chutes shall be provided to each pole, and these should be suitable for being lifted out for the inspection of main and arcing contacts. The main contacts are made out of silver plated electrolytic copper and arcing contacts are made out of silver plated copper tungsten to avoid any welding.

The breaker shall have three distinct positions as follows:

1. SERVICE Position: with main and auxiliary contact connected
2. TEST Position: with power contacts fully disconnected and control circuit contacts connected.
3. ISOLATED Position: with both power and control circuit contacts fully disconnected.

At this position provision should be kept in all L.T. distribution including panels to trip the respective H.T. breaker feeding to it with necessary control cables as required.

It shall be possible to achieve any of the above position with the door closed. Mechanical position indicators shall be provided for the three positions of the breaker.

Self-aligning isolating contacts shall be provided for the circuit breaker with automatically operated shutters to screen live contacts when the breaker is withdrawn from the cubical. Adequate provision shall be made for escape of hot gases by providing louvers. The louvers shall be covered with perforated MS sheets and shall be located as to direct the hot gases away from operating personnel. The door shall not from an integral part of the drawn out portion on the ACB so that entry of dust and vermins into the cubical is not possible even when the circuit breaker is drawn out.

Secondary isolating contact connections including those for auxiliary and control wiring should be fitted with self-aligning contacts. The fixed portion of the connections should have easy access for maintenance purposes.

The frame of the circuit breaker should be positively earthed when the breaker is racked into the cubical. Interlocks shall be provided to ensure the following:

It shall not be possible for the breaker to be switched ON until it is either in the fully “inserted” position or for testing purposes it is in the fully isolated position. This should be achieved by providing access to the closing (or operating) mechanism only when the breaker is ON or in fully “isolated” position.

A safety catch should be provided to ensure that the movement of the breaker, as it is withdrawn, is checked before it is completely out of the cubical, thus preventing its accidental fall due to its weight.

It should be possible to accommodate on the panel a variety of instruments and relays. All meters should be of the flush mounting type and 144 square mm size. Voltmeter and ammeter of suitable scale with selector switches shall be provided. Indicating lamps, red and green shall be of the LED type. Phase indicating lamps and shall also be provided for each incomer ACBs. CT’s shall be of cast resin type and shall comply with the requirements of IS: 2705 with latest amendment. Control wiring shall be carried out with 660 V grade single core PVC cable having stranded copper conductor of 2.5 square mm section. Wiring shall be neatly bunched and shall be secured to cradles for easy access and maintenance. Numbered ferrules at each
end shall identify wires. Control circuit fuses shall be mounted in front of the panel and shall be easily accessible. Terminal blocks shall be of 500 V grade of the stied / clamp type and insulating barriers shall be provided between adjacent terminals.

Flats of suitable size with two earthing cable eyes shall be provided for connecting to earth pits. The flats shall run the entire length of each panel.

All sheet steel material shall undergo a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid solution and recognized phosphating process. The steel work shall then receive two coats of red oxide primer before final coat of stoving synthetic enamel paint of light grey shades 631 of IS – 5/1978 with latest amendment.

5.0 OUTDOOR LIGHTING

The pole shall be erected in plumb, buried 1/6th of the pole size underground in cement concrete foundation as per details given in the schedule of quantities and the drawings. A MS plate of size 300x300x6mm thick shall be welded bottom of the pole of GI pipe. The pole shall have a brick/concrete collar duly plastered around it at the ground level. A MS junction box of size 250x200x100mm depth for looping incoming and outgoing cables shall be fabricated with 16 SWG sheet steel having hinged cover on the front with neoprene gasket and locking arrangement. The box shall incorporate two aluminium strips on SMC insulators, 2 nos. cable glands and one 6A single phase MCB. Two pieces of 40mm GI pipe shall be fixed to the pole so that PVC Al. cables could be protected from mechanical damages. An earthing stud with copper lugs for connecting 8 SWG GI wire for earthing shall be provided. The poles shall be given a coat of red oxide primer. After the erection of the pole, two coats of enamel paint of approved colour shall be applied. Touch up paint shall be given at the time of handing over the work. Marking of circuit and pole number shall be done on the poles with sheet steel stencil. MS box shall also undergo same painting treatment as given above for the pole.

A sample of the pole to be erected shall be got approved before procurement and erection. All the poles shall be in accordance with the approved sample.

6.0 OUTDOOR TYPE DISTRIBUTION FEEDER PILLARS

The feeder pillar shall be of the floor mounting type, totally enclosed and weather proof, conforming to IS-IP 55 incorporating MCCBs/MCBs having a certified rupturing capacity as per bill of quantities in the tender.

The cubical should be fabricated out of heavy gauge sheet steel of 2mm thickness and thick stiffeners, Hinged doors of not less than 2mm thick should be provided at the front and rear of the cubical to provide access for installation, operation, test and inspection. The rear door is provided to facilitate cable termination and the front door for inspection of MCCBs/MCBs. All doors should also be fitted with suitable locking arrangements with 6 lever GODREJ pad lock with 2 keys to prevent unauthorized opening. The cubical should be designed for mounting over cement concrete plinth by the roadside and should be of substantial construction capable of withstanding the vibrations normally experienced due to vehicular traffic. The top of the feeder pillars is of slanting construction in all directions to prevent any collection of water due to rain. The front and rear sides of the concrete plinth foundation shall be closed with brick masonry and the surface all round shall be plastered. A gland plate is provided at the bottom of the feeder pillar (removable) for mounting the cable glands. The feeder pillar shall be fitted on an angle iron pedestal at the bottom covered with sheet metal from all the four sides which facilitates cable bending etc. specially with aluminium cables. Two lifting hooks shall be provide at the top. A door switch shall be provided in the feeder pillar so as to switch ON and OFF the lamp fixed in the brass batten holder below the top sheet of the pillar.
7.0 CABLE TRAYS

Cable trays shall be ladder type fabricated out of mild steel/slotted angles and flats of required width as per design. Bends shall be prefabricated. The cable tray shall be primed and painted with two coats as approved by Owner/Consultant. Suitable provision shall be made where a tray crosses expansion joints. The width of the tray shall allow for a suitable separation between cables. The design shall allow for adequate bending radius for the sizes of cables. No sharp bend is to be allowed in cable tray. Joints between sections shall be bolted.

The tray shall be suspended from the soffit of the concrete slab by means of approved steel hangers spaced at a distance of not more than 100cms. Suitable bushes shall be provided where cables pass through apertures in the tray. Cables must be securely fixed to the tray with clamps. In routing necessary barrier and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angle and these two shall not run in close proximity. Full details of the tray shall be approved by the Consultant/Site Engineer before fabrication. Earth continuity shall be maintained between each section of cable tray and each total run of tray shall be effectively bonded to the nearest earth continuity conductor. All nuts and bolts used shall be of galvanized steel.

8.0 LIGHTING FIXTURES & ACCESSORIES

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

8.1 Scope:

Scope of work under this section shall include inspection at suppliers/manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

8.2 Standards:

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires:

- Part-1 Tubular fluorescent lamps - IS – 1913 (Part-1)
- Industrial lighting fittings with metal reflectors - IS - 1777
- Decorative lighting outfits - IS - 5077
- Bayonet lamp holders - IS - 1258
- Bi-pin lamp holders for tubular fluorescent lamps - IS - 3323
- Electronic Ballasts for fluorescent lamps – General & Safety requirement - IS – 13021 (Part-1)
- Electronic Ballasts for fluorescent lamps – Performance requirement - IS – 13021 (Part-2)
- Ballast for HP MV lamps - IS - 6616
- Tubular Fluorescent lamps - IS - 2418 (Part-1 to 4)
- Luminaries – General requirement - IS – 10322 (Part-1)
8.3 Light Fittings-General Requirements:

a). Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.

b) Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.

c). All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Out door type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.

d) Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

e) All hardwares used in the fitting shall be suitably plated or anodized and passivated.

f) Earthing: Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

g) Painting/Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.

h) The housing shall be powder coated/stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.

i) Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of 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 burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.
8.4 Accessories for Light Fittings - Reflectors

The reflectors shall be made of CRCA sheet steel/aluminium/Silvered glass/Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled/mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches/blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

8.5 Lamps

8.5.1 TLD

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply to ROHS (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast upto 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to "PHILIPS color 84 or color 86 color 82 or "OSRAM color 21 or color 11 or color 41 (as required at site)".

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

T 5 – High Efficiency ECO-Friendly Lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D/80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35oC in free burning position. T-5 lamp can be ignited from -15oC to + 50oC. Lamp should be fully recyclable and must comply to ROHS (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens / W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

8.5.2 Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & stands and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM / GE / PHILIPS/ Havells Sylvania only.

8.6 High Frequency Electronic Ballast

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for ≤10% total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor C1.7%.
- No Stroboscopic Effect
Constant Wattage / Light output between 240 V ± 10%.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- PF > 0.99 for fluorescent / T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI < 30 MHz
- Total Harmonic Distortion (THD) ≤10%
- Immunity to interference
- Safety
- Performance
- Vibrations & Bump tests
- Quality Standard
- Environmental Standard
- DC Operation
- Emergency Lighting Operation

Total System consumption (lamps + ballast) for

1 x 36 W TLD, shall not exceed 36 W
1 x 28 W T-5, shall not exceed 28 W
1 x 35 W T-5, shall not exceed 35 W
1 x 14 W T-5, shall not exceed 14 W
1 x 18 W CFL, shall not exceed 18 W
1 x 36 W CFL, shall not exceed 36 W
INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

1. BASIS OF DESIGN

An Intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The IFAS shall be of the digital, distributed processing, real time, multitasking, multi-user and multi-location type.

The system shall be provided with Addressable and Analog fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors, beam detectors, thermal sensors, manual call points, etc., can be identified with point address. The system shall be capable of:

a. Setting smoke sensor sensitivity remotely (from the Fire Work Station) to either high sensitivity manually or on a pre-programmed sequence e.g. occupied/unoccupied period. The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a prealarm condition or the need of maintenance.

b. Read-out or address an actual space temperature at thermal detector points. The operator shall also be able to adjust alarm and prealarm thresholds and other parameters for the smoke sensors.

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

d. Provide alarm verification of individual smoke sensors. Systems that performs alarm verification on a zone basis shall not be acceptable. Alarm verification shall be printed on the printer at the Control Station’s printer to enhance system maintenance and identify possible problem areas.

e. Provide local numeric point address and LED display of device and current condition of the point. Local annunciation shall not interfere with annunciation from the Fire Control System.

f. Provide outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

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

a. The System Alarm LED on the main fire alarm control panel shall flash.

b. A local piezo-electric sounder in the control panel shall be sounded.

c. The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.

d. Printing and history storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.

e. The audio portion of the system shall direct the proper signal (tone or voice) to the appropriate speaker circuit.

f. Pre-recorded alarm messages shall be played through interface with Public Address system.
2. **FIRE ALARM CONTROL PANEL (FACP)**

2.1 The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software and memory and should be listed under UL864 or EN54. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.

2.2 The memory data for panel configuration and operation shall reside in non-volatile memory (EEPROM). Removal of the board shall not cause loss of memory. If such removal can cause loss of memory, then the card containing the memory shall have battery back-up for upto 100 hours on the board itself.

2.3 FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition.

2.4 FACPs shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

2.5 Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.

2.6 FACPs shall provide indication for communication with the central console and alarm/trouble conditions in each sensor loops.

2.7 FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system:

   a. The FACP shall be UL or EN54 listed independently as a fire alarm control panel.

   b. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

2.8 FACP switches shall allow authorized personnel to accomplish the following, independent of the central console:

   a. Initiate a general alarm condition.

   b. Silence the local audible alarm.

   c. It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).

   d. Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.

   e. Perform a complete operational test of the microprocessor and memory with a visual indication with each board.

   f. Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group).
2.9 Monitor modules shall be provided to monitor and address contact-type input devices. The monitor module shall be supervised by FACP.

2.10 The FACP shall process the true continuous analog signal from the sensors. System using step setting to represent analog signal will not be accepted. The FACP shall be able to set dual alarms threshold for occupied and unoccupied periods. During unoccupied period, the alarm threshold shall automatically be lowered to facilitate quicker response. In addition, the FACP shall further process all analog values for pre-alarm limits to prompt the operator for early maintenance. If a sensor value increases to an above normal level or a pre-alarm limit for an extended duration, the FACP shall communicate a maintenance pre-alarm.

   a. Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued.
   b. Limits and sensor values shall be displayed, modifiable, and reported in decimal values.
   c. The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate Pre-alarm and Alarm limits if required, after comparing each sensor’s operating characteristics with the set sensitivity. This should be carried out at least once in every 24 hours. FACP should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).
   d. The FACP should be UL listed or EN 54 approved to provide the sensitivity measurement and documentation required by NFPA72E.

2.11 FACP shall be backed up with its built in UPS power and shall also be connected to central DG Power available in the building.

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

2.13 The FACP should truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the alpha-numeric keys on the FACP panel to reconfigure the above parameters. Panels, which require external programming devices to perform the above function will not be acceptable.

2.14 The FACP should have a degraded mode of operation. In the event of the CPU failure the field devices (detectors & modules) should report the condition on a simple digital communication mode to ensure reliability even during failure.

2.15 Power supply unit of FACP shall have following characters:

   a. The main power supply shall be 230 VAC±10%, 50 Hz±1% and shall in turn provide all necessary power of the FACP.
   b. It shall provide a battery charger for 24 hours for standby power using dual-rate charging technique for fast battery recharge.
   c. It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.
   d. It shall provide indication for battery voltage and charging current.
3. **DETECTORS & ADDRESSABLE DEVICES**

3.1 General features common to all detectors:

a. **Compatibility**: All automatic fire detectors shall be interchangeable without requiring different mounting bases or alterations in the signal panel.

b. **Response Spectrum**: Combustion gas detectors shall respond to both visible and invisible aerosols; size and colour of the aerosols shall not have a decisive influence on the response of the detector.

c. **Sensitivity**: On average 30 mgs of burned material per cu.m. (as measured in a 1 cu.m. chamber) shall release an alarm sensitivity which shall be adjustable according to the use of the space.

d. **Power Consumption**: Each detector shall use the minimum of power, for economic circuits, so that it shall have capacity to connect at least 99 detectors, 50 modules and 20 fault isolator modules in one loop.

e. **Built-in-response indicator**: Each detector shall incorporate indicator “LED” at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

f. **Maintenance**: All detectors shall be fitted either with plug-in system or bayonet type connections only, from the maintenance and compatibility point of view.

g. **Continuous Operation**: An alarm release shall not effect a detector’s functioning. After resetting the alarm, the detector shall resume operation without any readjustment.

3.2 **Addressable Photoelectric Smoke Detectors**

Smoke detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum to 99 intelligent detectors should connect to one loop. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog value for smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be activated remotely on command from the control panel.

The detectors shall provide address-setting means on the detector head using rotary decimal switches. Systems which use binary jumpers or DIP switches to set the detector address shall not be acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector. Detectors providing address setting through hand held programmers shall also be accepted.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

The detector sensitivity shall be set through the Fire Alarm Control Panel, and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
Using software in the FACP, the detectors shall compensate for dust accumulation and other slow environmental changes which may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The area covered by each smoke detector shall be as per IS-2189.

3.3 Addressable Thermal Detectors

Thermal detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum 99 intelligent thermal detectors may connect to one loop.

The detectors shall use an electronic detector to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements. The detectors shall be ceiling-mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated remotely on command from the control panel.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions. In certain applications, LEDs may be selected to be polled without flashing through system programming. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected.

An output connection shall be provided in the base to connect an external remote alarm LED.

3.4 Addressable Manual Stations

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. Minimum 99 addressable manual stations may be connected to one loop.

The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Press/break stations with resettable capability are also acceptable.

Manual stations shall be constructed of high impact LEXAN sheet with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.5 Response Indicator

In addition to built-in response indicator in each detector. Secondary response indicator of LED type shall be provided outside the rooms wherever asked for by the Architect/Interior Designer, for indication of fire through detector in the room. The design & colour shall be as per Interior Designer approval.

3.6 Control Module

The control module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.
3.7 **Addressable Hooters**

All field hooters should preferably be addressable and software configurable. All hooters should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 90db. All hooters should be UL/FM listed.

4. **TWO WAY COMMUNICATION SYSTEM FOR FIRE EVACUATION SYSTEM**

Two way communication systems for fire evacuation system shall be provided. The system shall be used for providing emergency communication in case of fire. There shall be one main console located on Ground floor in the Fire Control Room. All communication units provided on floor shall be able to transmit & receive voice signals to main console. However, communication between two floor units shall not be required.

5. **CABLES**

All PVC insulated FRLS copper conductor stranded cables shall be 650 volts grade and shall generally conform to IS-1554-1988 and meet the signal cabling requirement of the system manufacturer.

Strands of cables shall not be cut to accommodate & connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer’s. All cables shall be laid with minimum one diameter gap and shall be clamped at every meter and shall be tagged for identification with aluminium tag and clamped properly. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination. If numbers of cables are >4 than cable tray of appropriate size to be used.

These shall be measured on linear basis including the fittings required like, end termination junction boxes.

6. **EMERGENCY VOICE EVACUATION (EVAC)**

The FACP shall contain all equipment required for audio, communication, signaling and supervisory functions. This shall include speaker zone indication, digital voice units, microphone.

a. **Function :** The EVAC system equipment shall perform following functions:

1. Operate as a supervised dual channel emergency voice communication system.
2. Operate as a two-way emergency communication system control center.
4. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
5. Provide all-call activities through activation of a single control switch. Provide selectable zone calling.
6. Provide automatic, digitally-recorded voice messages or field-programmed through the microphone.

b. The system shall be modular in construction and shall be capable of being field programmable without requiring the return of any components to the manufacturer.
7. FUNCTIONAL REQUIREMENTS

7.1 Intelligent System Devices

a. Each device shall be assigned a unique address via easily understood decade (01 to 99) switch. Address selection via binary switches is not acceptable. Devices which take their address from their position on the circuit are unacceptable.

b. Devices shall receive power and communication from the same pair of conductors.

7.2 Sensors

a. All fire sensors shall mount on a common base to facilitate the changing of sensor type if building conditions change. The base shall be incompatible with conventional detectors to preclude the mounting of a non-intelligent device.

b. Each sensor shall contain an LED which shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP shall command the sensor LED to get latched on.

c. Each sensor shall be capable of being tested for alarm via command from the FACP.

d. Each sensor shall respond to FACP scan for information with its type identification to preclude inadvertent substitution of another sensor type. The FACP shall continue operation with the detector installed but shall initiate a mismatch (trouble) condition until the proper detector is installed.

e. Each sensor shall respond to FACP scan for information with an analog representation of measured fire-related phenomenon (smoke density, particles of combustion, temperature). Systems which only monitor the presence of conventional detector in an addressable base shall not be acceptable.

f. Photoelectric smoke sensors shall contain an optical sensing chamber with nominal sensitivity of 2.3% foot obstruction.

g. Ionization smoke sensors shall contain a unipolar dual chamber with nominal sensitivity of 2.3% foot obscuration.

7.3 Input Devices

a. The input device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations etc.

b. The input device shall provide a supervised initiating circuit. An open-circuit fault shall annunci ate at the FACP (subsequent alarms shall be reported).

c. The device shall contain an LED which will blink upon being scanned by the FACP. Upon determination of an alarm condition, the LED shall be latched on.

7.4 Automatic Functions at FACP

The alarms shall be displayed at the FACP on an LCD display. The display shall indicate the device in alarm by ID number, the appropriate alarm state, and the current time and date. It shall also display a point description of minimum 32 characters and, the respective analog value. The display shall also contain a minimum 40 characters alarm message. It shall be possible to see the number of acknowledged alarms, number of current fire alarms, number of trouble conditions and number of other miscellaneous alarms in the system. The FACP printer shall print out same information displayed on the LCD display. The LCD display and printer shall be powered directly from the panel.
7.5 **Manual Functions at FACP**

I. At any given time, operator shall have the following manual capabilities at FACP by means of switches located behind a key-locked cover:

a. Initiate an alarm summary display on the FACP LCD display. This display shall step through all currently active alarms in the system.

b. Initiate a summary printout of all currently active alarms on the FACP printer.

b. Initiate an “all-point summary” printout on the FACP printer recording the status of each system point (initiating circuits, indicating circuits etc.)

c. If the alarm is ignored by an operator than the history of same to be available

II. At any time, the operator shall have following manual capabilities at the FACP under password control; Operator privileges and ID numbers of upto four digits shall assignable by the main operator or designated alternate. Actions taken by operators shall automatically be printed on the FACP printer with operator initials, time and date.

a. Commands output points to different mode. Such commands shall be printed with selected descriptors ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT etc. In addition, command shall be used to ISOLATE or DISCONNECT points. When isolated, alarms and troubles shall be received but not acted upon.

b. Select a system status report for printing on the printer from the control station. The following real time reports shall be provided:
   - all point log.
   - alarm summary
   - trouble summary
   - status summary
   - sensitivity log
   - disabled points log.
   - isolated points log
   - disconnected points log
   - logical group points log

The sensitivity log shall print the analog value of each addressable analog sensor.

d. Select printing of a trend sensitivity log which when enabled, shall print minimum last 24 analog values for every addressable analog sensor taken at predetermined intervals. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.

e. Select a sequence of programmed commands which can be automatically executed, in sequence, via a single command.

7.6 **Fire Control Sequences**

Upon activation of a fire alarm devices:

FACP will display the exact address & alarm in the panel.

The Central Control Station shall switch OFF the AHUs of the affected floor fire damper and toilet exhaust fans while the AHUs on the other floors shall remain operational so as to keep the area under positive pressure.

Staircase pressurization fans shall be operated through the fire alarm system.
Appropriate fire messages shall start to broadcast automatically (synthesized voice) after time delay.

Activate the fire alarm signaling devices.

Capture the lifts and return them to the ground floor.

The lifts and escalators alarms (provided by lift and escalator contractor) shall be tied to the Fire Alarm System. The Fire Alarm System shall function as follows:

In the event of a fire, a signal will be provided by the Fire Alarm System to return all lifts to ground floor.

Should an emergency alarm originate from an individual lift, an audible alarm shall sound at both Fire Control Stations, and print out at the printers.

When an alarm is detected

- all include annunciating devices on the floor one above and one below shall sound.

If the alarm has not been acknowledged at the central panel within one minute, all audible annunciating devices on the floor above and the floor below shall sound.

If the alarm has not been acknowledged at the central panel within three minutes, all audible annunciating devices on the building shall sound.

It shall be possible to accomplish the following, independent of the central console:

a. Initiate a general alarm condition.

b. Silence the local audible.

c. Silence the alarm signals. It shall be possible to acknowledge (silence) the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication of satisfactory communication with each board.

f. Test all panel LED’s for proper operation without causing a change in the condition of any zone.

g. Print reports of all points based on Historical data.

h. Read the status of each point based on LCD display and print the status information.

k. Disable points/zones.

l. Change sensitivity of sensors.
**SPECIFICATION FOR LIFT IN ARCHITECTURE BUILDING**

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation Of Lift (gearless)</td>
<td>Passenger Elevator (Gearless)</td>
</tr>
<tr>
<td>No of lifts</td>
<td>1</td>
</tr>
<tr>
<td>Stops/Entrances</td>
<td>02S / 02E</td>
</tr>
<tr>
<td>Floor designation</td>
<td>G &amp; 1</td>
</tr>
<tr>
<td>Capacity/Size</td>
<td>8 Passenger / 544 Kg</td>
</tr>
<tr>
<td>M/C Room Location</td>
<td>Top of the shaft</td>
</tr>
<tr>
<td>Total Travelling Height</td>
<td>4.8 mts</td>
</tr>
<tr>
<td>Speed</td>
<td>1.0 m/s</td>
</tr>
<tr>
<td>Power Supply (Machine)</td>
<td>415 V Three Phase 50 HZ AC,</td>
</tr>
<tr>
<td>Drive</td>
<td>AC VVVF</td>
</tr>
<tr>
<td>Control</td>
<td>Simplex</td>
</tr>
<tr>
<td>Door Protection</td>
<td>Multi Beam Door Sensor.</td>
</tr>
<tr>
<td><strong>Car Finishes</strong></td>
<td></td>
</tr>
<tr>
<td>Cage Finish</td>
<td>S/S hairline with wide S/S mirror panel</td>
</tr>
<tr>
<td>Ceiling</td>
<td>SS Hairline Finish</td>
</tr>
<tr>
<td>Flooring</td>
<td>PVC</td>
</tr>
<tr>
<td>Car Door</td>
<td>SS Hairline Finish</td>
</tr>
<tr>
<td>COP</td>
<td>LED Displays</td>
</tr>
<tr>
<td>Hall Call</td>
<td>Standard</td>
</tr>
<tr>
<td>Available/Required Hoist Way</td>
<td>1800mm (W) X 1640mm (D)</td>
</tr>
<tr>
<td>Car Size</td>
<td>1300mm (W) X 1100mm (D)</td>
</tr>
<tr>
<td>Clear Opening</td>
<td>800mm (W) X 2000mm (H)</td>
</tr>
<tr>
<td>Pit Depth</td>
<td>500mm</td>
</tr>
<tr>
<td>Over Head</td>
<td>3800 mm</td>
</tr>
<tr>
<td><strong>Lobby/Entrance Finishes</strong></td>
<td></td>
</tr>
<tr>
<td>Landing Doors</td>
<td>SS Hairline Finish</td>
</tr>
<tr>
<td>Door Type</td>
<td>Automatic Centre Open</td>
</tr>
<tr>
<td>Door Operation</td>
<td>Vector Drive DC Operator</td>
</tr>
<tr>
<td>Door Jambs</td>
<td>Standard</td>
</tr>
<tr>
<td><strong>Others Optional Features</strong></td>
<td></td>
</tr>
<tr>
<td>Unit Price for Equipment Supply, Installation and one year free maintenance as per above Specs.</td>
<td></td>
</tr>
<tr>
<td>(Inclusive of freight, import duty and Service tax)</td>
<td></td>
</tr>
<tr>
<td>Total AMC Charges for 5 years</td>
<td></td>
</tr>
</tbody>
</table>
HVAC Specifications

Section 1  System Design Data

1. General

1.1 The system design, basis of design, estimated requirements and other relevant data are outlined in this section. The detailed specifications and specific requirements are outlined in the subsequent sections.

2. Location

2.1 The National institute of Technology is located at Raipur, Chattishgarh.

3. Scope of work

3.1 The work proposed under this tender includes providing and fixing VRV System, Ducting, drain piping, insulation, electrical wiring, basement ventilation etc. for the above project.

3.2 The work shall also include false ceiling work wherever required chasing of walls for piping, rough plaster to seal the changes, embedding of drain piping under floor, wiring from electrical point up to unit etc.

4. System Design

4.1 There shall be VRV type air conditioning system for the entire building - Auditorium, Readers Room, and Lecture Room etc. of the architecture faculty.

4.2 The out door condensing units shall be located on the terrace/ outside at suitable position.

4.3 Microprocessor based BMS system shall be provided for metering of energy consumption for air-conditioning at each indoor unit of shop, restaurant, cinema hall etc.

5. Basis of Design

5.1 Outside Conditions  

<table>
<thead>
<tr>
<th>Season</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>41.7°C DB ; 25.0°C WB</td>
</tr>
<tr>
<td>Monsoon</td>
<td>33.3°C DB ; 28.3°C WB</td>
</tr>
</tbody>
</table>

5.2 Inside Conditions  

A. Summer & Monsoon : 24.0°C +/- 1.0°C DB

5.3 Lighting Load : 30 W/Sqm.

5.4 Equipment Load : 20 W/Sqm

5.5 Fresh Air : 17 CFM/ person

5.6 Occupancy : 

- Readers Room : 2 persons/per room
- General Areas : 60 Sq ft/person
- Auditorium : As per seating plan

5.7 Glazing : All window will have Single glass in
5.8 Roof Insulation

All the exposed roof shall be insulated with 50mm thick expanded polystyrene or equivalent insulation.

5.9 General Ventilation

Toilets: 10 air changes per hour

6. Estimated Requirement

Based on the above design parameters the air conditioning load requirements are as under:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Area (Sq.ft)</th>
<th>Occupancy</th>
<th>Fresh Air (CFM)</th>
<th>Dehumidified CFM</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Ground Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>r-room+prof+meeting</td>
<td>1420</td>
<td>20</td>
<td>340</td>
<td>4184</td>
<td>10.62</td>
</tr>
<tr>
<td>2</td>
<td>lect. room</td>
<td>1000</td>
<td>12</td>
<td>204</td>
<td>2084</td>
<td>5.47</td>
</tr>
<tr>
<td>3</td>
<td>exib. hall</td>
<td>1250</td>
<td>25</td>
<td>425</td>
<td>2550</td>
<td>7.58</td>
</tr>
<tr>
<td>4</td>
<td>Office</td>
<td>91</td>
<td>2</td>
<td>34</td>
<td>498</td>
<td>1.23</td>
</tr>
<tr>
<td>5</td>
<td>HOD+ Exam Room</td>
<td>588</td>
<td>6</td>
<td>118</td>
<td>1371</td>
<td>3.49</td>
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<tr>
<td>6</td>
<td>Auditorium</td>
<td>2238</td>
<td>150</td>
<td>2550</td>
<td>4656</td>
<td>22.86</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>6587</td>
<td>215</td>
<td>3671</td>
<td>15343</td>
<td>51.25</td>
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<tr>
<td></td>
<td><strong>First Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Reader.1-4+Prof.1-2</td>
<td>1162</td>
<td>14</td>
<td>238</td>
<td>2867</td>
<td>7.31</td>
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<tr>
<td>2</td>
<td>Lecture.1-4</td>
<td>925</td>
<td>10</td>
<td>185</td>
<td>2207</td>
<td>5.61</td>
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<tr>
<td>3</td>
<td>Computer Rm</td>
<td>1475</td>
<td>34</td>
<td>578</td>
<td>3080</td>
<td>9.49</td>
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<tr>
<td>4</td>
<td>Reprography+Photography</td>
<td>280</td>
<td>4</td>
<td>68</td>
<td>725</td>
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<td><strong>Total</strong></td>
<td>3842</td>
<td>62</td>
<td>1069</td>
<td>8879</td>
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<tr>
<td></td>
<td><strong>Grand Total</strong></td>
<td>10429</td>
<td>277</td>
<td>4740</td>
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</table>
AC Units details are given below:

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<tr>
<th>NIT, Raipur, Chattishgarh</th>
<th>LIST OF A.C. Units</th>
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<tbody>
<tr>
<td></td>
<td>09-02-10</td>
</tr>
<tr>
<td></td>
<td>Ductable (In TR)</td>
</tr>
<tr>
<td></td>
<td>Hi-wall (TR)</td>
</tr>
<tr>
<td></td>
<td>Floor Mounted (TR)</td>
</tr>
<tr>
<td></td>
<td>HRV Units (In CFM)</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
</tr>
<tr>
<td>FLOORS</td>
<td>6.54</td>
</tr>
<tr>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>2.08</td>
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<td>1.65</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>588</td>
</tr>
<tr>
<td></td>
<td>882</td>
</tr>
<tr>
<td></td>
<td>1176</td>
</tr>
<tr>
<td>Ground</td>
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</tr>
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<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>6</td>
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<td></td>
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<td>5</td>
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<td></td>
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<td>16</td>
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<tr>
<td></td>
<td>0</td>
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<td></td>
<td>32</td>
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<tr>
<td>Total Tonnage</td>
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<tr>
<td></td>
<td>6.6</td>
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<td></td>
<td>16.6</td>
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<td>8.25</td>
</tr>
<tr>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>93.61</td>
</tr>
</tbody>
</table>

7. **Items to be provided by other Agencies**

The following items of works shall be provided by other agencies. The HVAC contractor shall be responsible for the adequacy and accuracy of these works and shall ensure that these are completed as per the required time schedule.

7.1 Provision of 220v/1 PH/50 Hz electric supply up to each indoor unit.

7.2 Provision of three phase Power with MCB near outdoor units

7.3 Finishing of wall chases.

8. **Drawings**

Tender drawings are diagrammatic only and indicate arrangement of system and the extent of work covered in the contract. These drawings indicate point of supply and point of termination and suggest the route to be followed. The architectural drawings and details shall be examined for exact location of equipment, cutouts etc. Contractor shall follow the tender drawings in preparation of shop drawings and for subsequent installation work and will collaborate with other services also.

9. **Test data**

The whole system shall be tested as per specifications given elsewhere and complete test data shall be furnished on prescribed data sheet.

10. **Deviation from specifications**

Deviation from specifications may be accepted, provided such deviations are found necessary and appropriate, in order to conform to the design of established foreign collaborators/manufacturers.

11. **Completeness of Items**
The prices of each equipment shall include the cost of all accessories or miscellaneous items listed in the respective section, except for the items where "Price Separately" is indicated. The item shall be complete regardless of whether or not it is listed in the BOQ.

12. **Technical data**

Each tenderer must submit along with the tender the technical data for all items listed herein in the indicated format. Failure to furnish technical data with tenders may result in summary rejection of the tender.

13. **Performance guarantee**

13.1 The contractor shall guarantee that the air conditioning system shall maintain the design inside temperature within ± 1.0°C tolerance.

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

13.3 The contractor shall ensure that the system shall be free of all objectionable vibrations and disturbing sounds under all conditions of operation.

0.0.0.0.0
Section 2  VRV / VRF System

1. **General**

1.1 The equipment for variable refrigerant volume/flow (VRV/VRF) system shall be air-cooled consisting of Outdoor units and multiple Indoor units for cooling the space in summer and heating in winter (whenever Heat pumps are specified).

1.2 The system shall consist of suitable Outdoor units, Indoor units as required, interconnecting refrigerant piping, control cabling and accessories as required.

1.3 It shall be possible to connect multiple Indoor units on a single refrigerant circuit. The Indoor units on any circuit may be of different type and should allow individual control.

1.4 The minimum length of Refrigerant piping in a branch circuits or all circuits shall be as per chart given later on but the total piping length shall not be less than 300 m.

2. **Outdoor Unit**

2.1 The Outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing, constructed from rust-proofed mild steel panels complete with powder coated finish.

2.2 Each module of Outdoor units shall consist of scroll compressor(s), air-cooled condenser as Heat Exchanger, high efficiency propeller fans with low noise motor, internal Refrigerant piping, safety controls, Air Inlet grilles, fan protection grille etc. all enclosed in weather proof housing.

2.3 The Outdoor unit shall have multiple scroll compressors and shall be able to operate even in case of breakdown of one of the compressors. (The smallest capacity unit may have only one compressor).

2.4 The Outdoor unit shall be suitable for mix and match connection of various types and capacities of Indoor units as per demand.

2.5 The noise level shall not be more than 62 dB(A) under normal operation, measured horizontally, 1 m away and 1.5m above ground.

2.6 The Outdoor unit shall be modular in design and shall allow for side by side installation of multiple Outdoor units, to match the requirement.

2.7 All the units shall be provided with built-in microprocessor control panel, for automatic operation and capacity control.

2.8 The units shall be suitable for Refrigerant R-410A.

3. **Compressor**

3.1 Each unit shall have single/multiple hermetically sealed scroll compressor.
3.2 The scroll compressor shall consist of two spiral disc, where one is fixed and the other rotate. The disc shall be mounted eccentrically to allow orbital movement. This shall permit compression of Refrigerant gas, as it move up between the eccentric discs.

3.3 Both the spiral disc out rotor shall be mounted on a common shaft with antifriction bearing, suitable for handling both radial and axial thrust.

3.4 The compressor casing shall be fabricated from mild steel of thickness capable of withstanding the working pressures. The casing shall have built-in oil reservoir with a sump of adequate capacity.

3.5 The compressor shall be complete with a suitable High efficiency motor hermetically sealed within the compressor housing.

3.6 The compressor housing shall also have oil reservoir for lubrication and suitable means like an oil pump or pressure differential device shall be provided to lubricate all moving parts.

3.7 One or more compressor shall be provided with suitable sine wave or equivalent DC Inverter for capacity modulation.

4. **Condenser / Heat Exchanger and Fans**

4.1 The condenser shall be air-cooled type, where heat exchanger shall be fabricated from copper tubes, mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be given anti-corrosion treatment. This treatment shall be suitable for areas of high pollution, moisture and salt laden air.

4.2 The condenser fans shall be with multi blades of aerofoil design for low noise level, high efficiency and fitted with an high efficiency fan motor.

4.3 The fan outlet shall be protected by a suitable wire guard on the outside.

4.4 Suitable devices and heat exchanger means shall be built-in the unit to provide maximum super-cooling of refrigerant to increase system efficiency.

4.5 The unit shall be complete with safety controls and suitable microprocessor based master control module.

4.6 The module should be capable of connecting to web or to other devices through common Bacnet or Lan networks.

4.7 All the above component shall be housed in a compact mild steel cabinet having air Inlet louvers, safety guard on the condenser fan. The ambient shall be mode weather proof using suitable anti corrosion treatment and finishing point.

5. **Indoor Units (IDU)**

5.1 The system shall permit connection of a variety of non ductable or ductable Indoor units on to single refrigerant piping circuits, as per description given later.

5.2 The capacity of the IDU shall vary as per the requirement of the given area.
5.3 The types of IDU which may be connected may be any of these given below:

5.3.1 High Wall mounted Unit.
5.3.2 Cassette type of different configuration.
5.3.3 Concealed Ceiling suspended units
5.3.4 Ceiling Suspended High static Unit.
5.3.5 Ceiling Mounted Exposed unit.
5.3.6 Floor standing (exposed or concealed) units.
5.3.7 Ductable ceiling mounted High Capacity units.

5.3 Common features of Indoor Units

5.3.1 The cooling / heating evaporator coils of the various types of Indoor Units shall be of direct expansion type.

5.3.2 The coils shall be fabricated from copper tubes of min 8 mm dia. with extended aluminium fins and designed for low velocity.

5.3.3 The fins shall be bonded to the tube using hydraulic expansion of tubes ensuring tight bonding between tube and fins for efficient heat transfer.

5.3.4 The coils shall be complete with well designed tube circuiting and liquid distributor.

5.3.5 All types of units shall have a built in electronic expansion valve and suitable control units.

5.3.6 The control units shall control temperature, fan speed and features specific to each unit such as night mode, set back, etc.

5.3.7 Suitable drain pan and drain arrangement shall be part of all IDUS.

5.3.8 The control units shall permit control from a cored or a wireless remote controller.

6. High Wall Mounted units

6.1 The high wall mounted units will be complete with cross flow fan, vertical DX coil, filters, control units and plastic outer cabinet.

6.2 The cross flow fan should be of generous dia. and length to deliver the required air quantity at high speed and be very quiet with Noise level below 38 dbA.

6.3 The fan assembly shall be directly mounted on a low noise, high efficiency motor.

6.4 The DX evaporator coil and other common features shall be as given under para 5.3

6.5 The air filter shall be electrostatic type to remove dust, polan and other impurities.

6.6 The outer casing shall be made of high grade plastic, complete with return air grille, motorized supply air louvered opening and suitable metallic back panel for mounting all items.
7. **Cassette type units**

7.1 The cassette type Indoor Units may be of any of the three configurations, as given below and as may be mentioned in Bills of quantity.

7.1.1 Four way or circular air distribution arrangement which ever is specified or is available.
7.1.2 2-way air distribution arrangement.
7.1.3 1-way or corner type air distribution arrangement.

7.2 The unit shall be complete with turbo fans of multiblade type, duly statically and dynamically balanced to give the required air flow.

7.3 The filter shall be of synthetic type to suit the configuration.

7.4 The unit housing shall have provision for connecting fresh air duct, wherever required.

7.5 The unit shall be complete with built-in high head fail-safe pump with safety cutouts.

7.6 The unit shall include all items as given in 5.3

7.7 Each type of unit shall be supplied complete with Air distribution panel whether specified or not.

7.8 The panel shall have removable return air core for cleaning air filter and maintaining motor etc.

8. **Concealed ceiling suspended unit**

8.1 The concealed units shall be complete with fan assembly, DX evaporator coil, air filter, outer casing and control unit.

8.2 The fan shall be centrifugal type with housing and mounted directly on the motor shaft.

8.3 The air filter shall be preferably electrostatic type.

8.4 The outer casing shall be of heavy gauge G.I. sheet duly treated for long life and shall be complete with 25 mm deep duly insulated drain pan.

8.5 The unit shall include all other items as listed in Para 5.3

9. **Ceiling Suspended High Static Unit**

9.1 The unit shall be complete as described in Para 8, except for the fan section.

9.2 The fans shall be selected and designed for highest air static pressure, to allow for at least 5 to 6 m of ducting with grilles.

10. **Ceiling Mounted Exposed Unit**

10.1 The exposed type unit shall be similar to the concealed type as described in Para 8, except for the outer casing.
10.2 The unit shall have a decorative outer casing with built-in supply air grilles and return grilles.

10.3 The casing shall be with anti-corrosive treatment and finished with powder coated paint in attractive finish.

11. **Floor Standing Units**

11.1 The floor standing units shall be vertical in design and may be suitable for concealed furred in installation or cabinet type for exposed installation.

11.2 The fans shall be centrifugal type mounted directly on the motor shaft.

11.3 The air filter shall be cleanable electrostatic type.

11.4 The concealed type of vertical unit casing shall be of heavy gauge galvanized sheet with anti-corrosive paint.

11.5 It should be complete with deep drawn insulated drain pan and shall permit easy access for filter cleaning and maintenance of coil and fan motor.

11.6 The cabinet type of exposed vertical units shall in addition have a decorative cover with built in supply and return air grilles.

11.7 All other components in both type shall be as in para 5.3

12. **Ductable Units**

12.1 The ductable indoor units shall be ceiling suspended type, complete with fan assembly, DX coil, air filters, control units and outer casing.

12.2 The fan shall be centrifugal suction type with fan casing and direct driven motor. The fan shall have a minimum external static pressure of 100 Pa.

12.3 The air filter shall be cleanable type with mold resistant resin net fixed to an integrally moulded plastic frame. The filter shall be sliding type with frame for ease of insertion and removal.

12.4 The outer casing shall be of heavy gauge galvanized duly treated for corrosion resistance and finished with powder coated paint. It should have internal insulation to prevent condensation and absorb fan noise.

12.5 There shall be suitable deep drawn insulated drain pan.

12.6 All other component shall be as in para 5.3

13. **Indoor Control Unit**

13.1 All types of indoor unit shall have one of the following controllers:

13.1.1 Cordless Type

13.1.2 Corded Type
13.2 Unless otherwise specified the controller to be provided shall be as follows:

13.2.1 **Cordless Remote:** Wall units or other units which are located in an enclosed cabin.

13.2.2 **Corded Remote:** in open offices or and areas not covered above.

13.3 A Computerized DIP control shall be used to maintain room temperature.

13.4 The unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.

13.5 The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance.

13.6 It shall be able to control up to 16 indoor units and change fan speed individually in the group.

14. **Refrigerant Piping Capabilities**

14.1 The unit shall be capable of long length of piping and for providing lift of Refrigerant due to level difference between the Outdoor unit and Indoor units at the highest levels.

14.2 The minimum distance capability of the unit shall be as follows:

14.2.1 Total Piping length of system Min. 300 m.

14.2.2 Actual length in any circuit Min. 150 m.

14.2.3 Equivalent piping length any circuit Min. 175 m.

14.2.4 Level difference between ODU and IDU Min. 50 m.

15. **Refrigerant Piping**

15.1 All refrigerant piping for the VRV/VRF system shall be carried out using hard drawn seamless copper pipe using either soft, half hard or hard pipes as per chart below:

15.1.1 The piping thickness shall be as follows:

<table>
<thead>
<tr>
<th>OD(Inch)</th>
<th>OD(mm)</th>
<th>Min. Wall Thickness (mm)</th>
<th>Soft</th>
<th>Half Hard or Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>6.35</td>
<td>0.80</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>9.52</td>
<td>0.80</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>12.70</td>
<td>0.80</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>15.88</td>
<td>1.00</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>19.05</td>
<td>1.00</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>22.20</td>
<td>1.00</td>
<td>X</td>
<td>√</td>
</tr>
<tr>
<td>1.1/8&quot;</td>
<td>28.58</td>
<td>1.00</td>
<td>X</td>
<td>√</td>
</tr>
</tbody>
</table>
15.2 The branching of refrigerant piping from the main line shall be carried out using either specially designed ‘Tee’ connectors or ‘Y’ joints. These joints should ensure that each branch receives the required refrigerant flow.

15.3 All pipe sizing shall be on the basis of sizing data of the concerned manufacturer and should ensure adequate oil return back up to the compressor.

16. **Pipe Insulation**

16.1 **Refrigerant Pipe Insulation**

16.1.1 The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick Nitrile close cell rubber, so that condensation does not occur.

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

17. **Drain pipe insulation**

17.1 Drain pipe carrying condensate water shall be insulated with 6 mm nitrile rubber insulation having K value 0.037 W/mk at a mean temperature of 20°C at min. density of 55 kg./m³.

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

18. **Centralized Intelligent Touch Remote controller**

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

18.2 The Graphic controller shall act as an advanced air conditioning management system to given complete control of VRV air conditioning equipment. It shall have ease of use for the user through its touch screen. Icon display and colour LCD display.

18.3 It shall be able to control up to 64 groups of Indoor Units with the following functions:

18.3.1 Starting/stopping of air-conditioning as a zone or group of individual units.

18.3.2 Temperature setting for each Indoor units of zone.

18.3.3 Switching between temperature control modes, switching of the fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

18.3.4 Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.

18.3.5 Display of air conditioner operation history.
18.3.6 Daily management automation through yearly schedule function with possibility of varying schedules.

18.4 The controller shall have wide screen, user friendly colour LCD display which could be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from the Indoor unit.
Section-3  Ventilation System

1. General

The packaged air washer shall be complete in all respects and shall generally comply with the following specifications given below:

2. Single Stage Air Washers

2.1 The packaged air washers and air scrubber shall be of G.I. Sheet metal and Stainless Steel sectionalized constructions and shall include fan section, cooling pad section, motor drive etc.

2.2 Fan Section

2.2.1 The fan impeller shall be fabricated from GI sheets complete with multiple, double inlet double width forward curved blades. It shall be both statically and dynamically balanced.

2.2.2 The fan housing shall be fabricated from GI sheet of sturdy construction and with smooth air inlets.

2.2.3 The impeller shall be mounted on suitably sized steel shaft and two bearings, one on either side. The shaft should have key for fixing the drive pulley.

2.2.4 The fan section shall be fabricated from 16 G GI sheets and hot dipped galvanised angle iron frame. The design of top cover should prevent entry of rain water into the unit. The fan section shall be insulated with 25 mm thick expanded polystyrene from the inside.

2.2.5 The fan section shall be complete with multi 'V' groove, balanced pulleys 'V' belts and TEFC drive motor, along with adjustable base for mounting the motor, inside the fan section.

2.3 Cooling Pad

2.3.1 The cooling pads for the air washer shall be of rigid cross fluted honey comb design, having highly water absorbent cellulose media, impregnated with anti slot insoluble chemicals. It shall provide extended and sufficient wetted surface to provide a water absorbing efficiency of 90% with air velocity not exceeding 500 FPM (2.54 M/Sec.).

2.3.2 The cooling pads for the air scrubber shall be rigid PVC fill in Honeycomb design. It shall provide sufficient wetted surface to provide atleast 70% efficiency with air velocity not exceeding 500 FPM (2.54 m/sec).

2.3.3 The cooling pads section and tank shall be fabricated from 18 G 304 A stainless steel sheets with bolted construction having suitable stiffners and FRP lining on the joints.

2.3.4 The section shall be complete with FRP water distribution header having ports and sized for uniform and adequate water flow through perforated PVC pipe.

2.3.5 The pad section shall have provision for fixing one or two sets of air filters as specified later.
2.4 **Pumps**

2.4.1 The water distribution pumps shall be of heavy duty, vertical type mounted inside the tank. It shall be complete with adjustable bleed off arrangement to prevent concentration of undesirable salts.

2.4.2 The pump shall be provided with single phase, self tripping starter.

2.5 **Air Filters**

2.5.1 The standard pre-filters shall be with 5 layers of aluminium wire mesh, fixed in a 20 Gauge aluminium frame with handles for ease of removal.

2.5.2 The above set of filters shall be fixed in filter frames made of 20 Ga aluminium sheets, shaped to prevent air leakage. The filters shall be easily removable. The filter section shall form part of the pad section.

2.6 **Miscellaneous**

Necessary accessories shall be provided wherever necessary for proper operation and shall also include.

2.6.1 PVC eliminator to avoid water drift fixed to the cooling pad housing and tank.

2.6.2 Necessary PVC piping for water circulation.

2.6.3 Vibration isolators for the pumps.

2.6.4 Nuts, bolts, shims etc., as required for the equipment.

2.6.5 Float valve in the water tank, along with quick fill connection.

2.6.6 Gate valves in drain, make up, quick fill line etc, as required.

2.6.7 Built in isolator switches for the fan and pump motor and wiring from the isolators upto the respective motors.

2.7 **Limitation**

The air velocity limits are as follows :-

2.7.1 Velocity across cooling pads shall not exceed 2.54 M/s (500 FPM).

2.7.2 Velocity at blower outlet shall not exceed 10.16 M/s (2000 FPM).

3. **Axial flow fans**

3.1 The Axial Fan Blades shall be of Cast Aluminium of aerofoil design for high efficiency and high static pressure. The blades shall be joined together on cast aluminium hub.

3.2 The mounting ring shall be of CRCA/sheet steel with steel brackets to connect the frame, with the Fan/Motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.
3.3 The fan assembly shall be statically and dynamically balanced.

3.4 The fan motor shall be totally enclosed squirrel cage type.

4. **In-line Fans**

4.1 Inline fans shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

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

4.3 Fan wheel shall be forward curved type, statically and dynamically balanced.

4.4 The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature. The bearing lubricant shall be suitable for a minimum ambient temperature of minus 15°C (admissible for a short time without reaching dew point at minus 30°C). For applications at maximum indicated ambient temperature life expectancy shall be 40000 hours minimum.

4.5 Fan motor, fans shall be supplied with built-in-thermal contact (TK) at the critical high temperature point ("B" = 130°C). The thermal contact shall open and break the power supply to the fan, Fan motors have insulation class “B” and protection class IP54.

4.6 Fans shall be direct driven type.

--0.0.0--
Section 4  Duct Works And Outlets

1.  General

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

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

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

2.  Factory Fabricated Duct Work

2.1 Material

2.1.1 All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates. Galvanizing shall be of 120gms/sq.m. (total coating on both sides).

2.1.2 In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

2.1.3 The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only, irrespective of cross-section dimensions.

2.2 Governing Standards

2.2.1 Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

2.3 Duct Connectors and Accessories

2.3.1 All transverse duct connectors (flanges/cleats) and accessories/related hardware such as support system shall be zinc-coated (galvanized).
2.4 Fabrication Standards

2.4.1 All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be of Technofabric duct or DuctoFab and Zeco. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.

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

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

2.4.4 All edges shall be machine treated using lock-formers and roller for furning up edges.

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

2.5 Selection of G.I. Gauge and Transverse Connectors

2.5.1 Duct Construction shall be in compliance with 1” (250 Pa)w.g. static norms as per SMACNA.

2.5.2 All transverse connectors shall be fabricated of the same sheet metal of tecnofabriducted or DuctoFab and Zeco imported with TDC 4-bolt systems all the bolts and flange clips to be provided by the supplier. To avoid any leakage additional sealant shall be used.

2.5.3 The specific class of transverse connector and duct gauge for a given duct dimensions shall be 1”(250 Pa) pressure class.

2.5.4 Non-toxic, AC-applications grade P.E. or PVC gasketing shall be provided between all mating flanged joints. Gasket sizes shall conform to flange manufacturer’s specification.

2.6 Duct Construction

2.6.1 The fabricated duct dimensions shall be as per approved drawings and all connecting sections shall be dimensionally matched to avoid any gaps.

2.6.2 Dimensional Tolerances : All fabricated dimensions shall be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.

2.6.3 Each duct pieces shall be identified by color coded sticker which shall indicate specific part numbers, job name, drawing number, duct sizes and gauge.

2.6.4 Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
2.6.5 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

2.6.6 Plenums shall be shop/factory fabricated panel type and assembled at site.

2.6.7 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

2.6.8 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

2.6.9 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

2.6.10 Factory Fabricated ducts shall have the thickness of the sheet as follows:

<table>
<thead>
<tr>
<th>Rectangular Ducts G. S.</th>
<th>External Pressure 250 Pa</th>
<th>Duct Section Length 1.2 m (4 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Duct Size</td>
<td>Sheet Thickness (mm)</td>
<td>Joint Type 4 Bolt Transverse Duct Connector (TDC) with built in sealant</td>
</tr>
<tr>
<td>1–500 mm</td>
<td>0.50</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>601-750 mm</td>
<td>0.63</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>751-1000 mm</td>
<td>0.8</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>1001-1200 mm</td>
<td>22</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>1201-1300 mm</td>
<td>22</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>1301-1500 mm</td>
<td>22</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>1501-1800 mm</td>
<td>20</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>1801-2100 mm</td>
<td>20</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>2101-2250 mm</td>
<td>20</td>
<td>4 Bolt TDC</td>
</tr>
<tr>
<td>2251-2400 mm</td>
<td>18</td>
<td>1.25</td>
</tr>
<tr>
<td>2401 mm and above</td>
<td>18</td>
<td>4 Bolt TDC</td>
</tr>
</tbody>
</table>

*C*-cleat; ‘S’-S cleat; ‘SS’-Standing S cleat; ‘AI’ – Angle Iro in mm

* Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct section.
2.7 **Documentation to Measurements**

2.7.1 For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

2.7.2 Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

2.7.3 All duct pieces shall have a part number, corresponding to the serial number assigned to it in the measurement sheet. The above system shall ensure speedy and proper site measurement, verification and approvals.

2.8 **Testing**

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

3. **Installations**

3.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

3.2 Great care should be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

3.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

3.4 The ducts shall be reinforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

3.5 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

3.6 The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

3.7 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

3.8 Flanges bracings and supports are to be black, mild steel and are to be painted with rust proof primer on all surfaces before erection. Accessories such as damper blades and access panels are
to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

3.9 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

3.10 Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

3.11 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

3.12 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

3.13 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

3.14 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

4. Dampers

4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.

4.2 The volume dampers shall be of an approved type, lever operated and completed with locking devices which will permit the dampers to be adjusted and locked in any positions and clearly indicating the damper position.

4.3 The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 MM (18) Gauge, reinforced with 25 MM angles 3 MM thick along any unsupported side longer than 250 MM. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

4.4 Automatic and manual volume opposed blade dampers shall be completed with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 MM steel sheets and blades shall not be over 225 MM wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 MM thickness with fine mesh.

4.5 Wherever require for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

4.6 After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.
4.7 Automatic fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade louver type. The blades should remain in the air stream in open position and shall be constructed with minimum 1.8 MM thick galvanized sheets. The frame shall be of 1.6 MM thickness. Other materials shall include locking device, motorized actuator, control panel to trip AHU motor etc.

4.8 The fire dampers shall be capable of operating automatically on receiving signal from a fire alarm panel. All control wiring shall be provided between fire damper and electric panel.

5. **Access panel**

5.1 A hinged and gasketed access panel measuring at least 450 MM x 450 MM shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

6. **Miscellaneous**

6.1 All duct work joints are to be true right angle and with all sharp edges removed.

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

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

6.4 Diverting vanes must be provided at the bends exceeding 600 MM and at branches connected into the main duct without a neck.

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

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

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

6.8 All angle iron flanges to be welded electrically and holes to be drilled.

6.9 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 MM centre.

6.10 All the flanged joints, to have a sponge rubber packing stuck to the flanges with suitable adhesive.

6.11 The G.S.S. Ducts should be lapped 6 MM across the flanges.

6.12 The ducts should be supported by approved type supports at a distance not exceeding 2.0 Metres.
7. **Standard Grilles**

7.1 The supply and return air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have single/double louvers. The front horizontal louvers shall be of extruded section, adjustable type. The return air grille shall have single horizontal extruded section fixed louvers. The grilles may or may not be with an outer frame.

7.2 The damper blades shall also be of extruded aluminium sections. The grill flange shall be fabricated out of aluminium extruded section. Grilles longer than 450 MM shall have intermediate supports for the horizontal louvers.

8. **Diffusers**

8.1 The ceiling type square diffusers shall be of aluminium extruded sections with flush or step down face, as specified with fixed pattern and neck.

8.2 All supply diffusers shall be provided with extruded aluminium dampers, with arrangement for adjustment from the bottom.

8.3 The slot diffusers shall be of aluminium extruded sections with diffusion plate and sliding damper.

9. **Linear Diffusers/Grilles**

9.1 The linear diffusers/grilles shall be fabricated from Aluminium extruded sections.

9.2 The diffusion blades shall be extruded, flush mounted type with single or double direction air flow.

9.3 The frame shall be of aluminium extruded section and shall hold the louvers tightly in fixed position.

9.4 The dampers as described under grilles shall be provided wherever specified.

10. **Exhaust Grilles**

10.1 The exhaust grilles shall be fabricated from aluminium extruded sections.

10.2 The exhaust grilles shall be horizontal fixed bar grilles with 15° blade inclination.

11. **Exhaust/Fresh Air Louvers**

11.1 The louvers shall be fabricated from aluminium extruded sections.

11.2 The blades shall be extruded flush mounted type with single horizontal throw.

11.3 The frame shall be of aluminium extruded section and shall hold the louvers in fixed positions.

12. **Painting and Vision Barrier**

12.1 All grilles, and diffusers shall be powder coated, before installation, in approved colors.
12.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.

12.3 The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24 gauge galvanized sheets. The vision barrier shall be fixed to the false ceiling frame with self-tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

13. **Testing**

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

13.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final tabulation of air quantity through each outlet shall be submitted to the Engineer-In-Charge for approval.
Engineering Projects(I)Ltd

Section 5 Insulation

1. General

The Insulation of water piping, air handling units, ducting, chillers etc., shall be as per NFPA and UL listed, as per specifications given below:

2. Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

2.1 Pipe Insulation : Rigid Polyurethane Foam (PUF)
2.2 Drain Pipe Insulation : Cross linked polyethylene
2.3 Duct Insulation : Crossed linked polyethylene
2.4 Acoustic Insulation : Thermally Bonded non-woven polyester
Fiber fabric (Mikron)
2.5 Equipment Insulation : Expanded Polystyrene (SE) (EP).

3. Pipe Insulation

3.1 The insulation for chilled water shall be carried out from rigid polyurethane foam having a ‘K’ value of 0.018 W/mK. at mean temperature of 10°C and a density of 27.2 to 39.9 kgs/cubm. The material shall be factory faced on one side with aluminium foil on the outside, reinforced with Kraft paper and fused to the insulation material. The aluminium foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints.

The aluminium foil facing shall be replaced with Kraft Paper facing wherever the pipe is to be covered with Tar felt.

3.1.2 The thickness of the insulation for chilled water pipes shall be 30 MM.

3.1.3 Preformed pipe sections shall be used for pipes upto and including 350 mm dia.

3.1.4 Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.

3.2 Drain Pipe Insulation

3.2.1 The material for insulation of drain pipes shall be preformed pipe sections of cross linked polyethylene having a ‘K’ value of 0.027 W/mK at a mean temperature of 10°C and a minimum density of 26 Kg./cubm.

3.2.2 The thickness of insulation shall be 9 mm.

3.3 Duct Insulation

3.3.1 The materials for duct insulation shall be fire retardant Crossed linked polyethylene as described earlier but conforming to I.S. 8183 of 1976. The density of insulation shall not be less than 24 kg/cubm and material shall be in the form of blankets/rolls of uniform thickness. The ‘K’ value at 10°C. Shall not be
3.3.2 The thickness of duct insulation shall be as follows:

a. Duct in conditioned space - 10 mm thick
b. Duct in unconditioned space - 15 mm thick

3.4 Acoustic Treatment

3.4.1 The material for acoustic treatment of ducts, rooms, roofs etc. shall be thermally bonded non-woven polyester fiber fabric, as described earlier, conforming to I.S. 8183 of 1976. The density of polyester fiber shall be 20 kg/cub.m and the material shall be in the form of boards of uniform density. The ‘k’ value at 10°C shall not be less than 0.03 W/mK. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. Nuts bolts or nailed to the batten work as required.

3.4.2 The thickness of insulation shall be as follow unless otherwise specified elsewhere:

a. Duct Acoustic : 25 MM
b. Room Acoustic : 50 MM

3.5 Equipment Insulation

3.5.1 The materials for equipment insulation shall be slabs of expanded Polystyrenes (Self extinguishing grade) having a ‘K’ Value of 0.035 W/mK at 10°C and a density not less than 20 Kg./cum.

3.5.2 The complete shell of the chiller as well as its two heads shall be factory insulated.

3.5.3 The insulation on chilled water pumps and expansion tank shall be of expanded polystyrene having a ‘K’ value of 0.035 W/mK at a mean temperature of 10°C and a density not less than 20 Kg/Cubm. The thickness of the insulation will be as given below:

I) Expansion tank - 50 mm
II) Chilled water pumps - 50 mm

3.6 Hot Bitumen

3.6.1 The Hot bitumen being applied as adhesive shall be of R85/25 grade conforming to IS: 702-1961.

3.7 Tar Felt

3.7.1 The Tar felt used for water proofing shall conform to IS: 1322 Type 3 Grade I.

4. Installation

4.1 Chilled Water Piping (PUF)

4.1.1 The pipe shall be throughly cleaned with a wire brush and rendered free from all rust and grease.

4.1.2 The pipes shall be given a coat of red oxide primer.
4.1.3 Two coats of hot bitumen shall be applied on the cleaned pipe surface (bitumen in the ratio of 1.5 kgs per Sq.m. for each coat).

4.1.4 The preformed sections of insulation shall be fixed tightly to the surface taking care to seal all joints.

4.1.5 All joints along the circumference of the pipe sections shall be sealed with 50 mm wide aluminium faced adhesive tape.

4.1.6 All longitudinal joints shall be further sealed with 50 mm wide aluminium faced adhesive tape.

4.1.7 Insulation on pipes and valves in the AHU room shall be covered with 0.5 mm aluminium sheet cladding.

4.2 **Drain Piping**

4.2.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

4.2.2 Then pipe section of 9 mm thick insulation shall be fixed on the pipe.

4.2.3 The longitudinal cut along the length of the insulation section shall be sealed with rubber based adhesive as recommended by the insulation manufactures. The joints between pipe sections shall also be sealed similarly.

4.3 **Ducting**

4.3.1 Clean the surface with a wire brush and make it free from rust and oil.

4.3.2 Apply two coats of cold CRPX adhesive to the surface.

4.3.3 Wrap the duct with insulation blankets of the thickness mentioned in item 3.3.2 above and covered with 0.63 mm/19 mm wire mesh netting on the outside.

4.3.4 The joints shall be sealed with aluminium tape before covering with wire netting.

4.3.5 The Ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt B.H. The tar felt shall be stuck with Hot Bitumen.

4.4 **Duct Acoustic Lining**

4.4.1 The duct surface shall first be cleaned from inside.

4.4.2 Then 25 mm square section made of 18 Ga (1.2 mm) thick G.I. sheets should be fixed on both ends of the duct piece.

4.4.3 The insulation slabs should be fixed between these sections of ducts using adhesive compound and stick pins.

4.4.4 The insulation shall the be covered with RP tissue, sealing all joint so that no fiber is visible.

4.4.5 The insulation shall then be covered with 0.5 mm perforated aluminium sheets.
4.4.6 The sheet of insulation shall be secured to the duct by means of stick pins as mentioned above.

4.5 **Equipment**

4.5.1 The surface shall first be cleaned with wire brush.

4.5.2 Then two layers of hot bitumen shall be applied.

4.5.3 The insulation shall then be fixed in one layer and sealing them with hot bitumen.

4.5.4 The insulation shall then be covered with 0.63 mm/ 19 mm mesh wire netting which shall be fixed to the insulation with brass ‘U’ nails.

4.5.5 The final finish shall be 0.50 mm aluminium cladding.

4.6 **Room Acoustic**

4.6.1 Fix 40 mm x 50 mm G.I. channels at 0.5 meter interval longitudinally then fix cross battens at 1.0 meter centre using suitable gutties, and brass screws.

4.6.2 Fill each rectangle with 50 mm glass wool and covered with RP tissue.

4.6.3 Tie with 24 gauge G.I. Wires at 300 mm intervals.

4.6.4 Then cover with 22 gauge (0.80 mm) perforated Aluminium sheet having 3 mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats.

4.6.5 All corners joints shall be covered with 25 x 25 x 2 mm thick aluminium angles.

-0.0.0.-
Section 6

Electric Cabling

1. General

The electric cable connections of motors and earthing of all equipments shall be carried out, as per specifications, given hereunder.

2. Cabling

2.1 The cabling of various equipment shall be carried using PVC Insulated and armoured cables.

2.2 The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 Core with aluminium conductors and be of 660/1100 volts grade, as per IS 1554 (Part I) 1964. The cross section of the cable shall be to suit the load and rating of the equipment. The cables shall be of aluminium conductor, PVC insulated, strip armoured with overall PVC sheathing.

2.2.1 The cables shall be laid as per IS-1255/1967, Indian standard code of practice.

2.2.2 The cables shall be laid, as per drawings in the ducts/pipes/trays etc. along a short and convenient route between switch board and the equipment, (either in trenches, on wall or on hangers, supported from the slab). Cable routing shall be checked at the site of work to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them.

2.2.3 The radius of bends of the cable should not be less than 12 times the overall dia. of cable in order to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats on M.S. Supports, when laid in trenches, or wall/ceiling suspended hangers. When laid under ground the cables should be covered with fine soft earth and protected with 2nd Class bricks. Suitable G.I. Pipe shall be used wherever cables are laid under the roads etc.

2.2.4 Wooden bushes shall be provided at the ends of pipes through which cables are connected through.

3. Surface Wiring

3.1 The surface wiring shall be cased in conduits which shall be of 1100 volts grade and conform to IS 9587-1987 (revised to date)

3.1.1 The conduits used shall be of high quality & all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1 meter or less. The connection of the conduits to switches etc., shall be secured by check nuts and ebonite bushes provided at the ends of conduits.

3.1.2 The M.S. conduits shall be heavy duty and rigid type-ISI marked/conforming to IS specifications. The wall thickness shall not be less than 2 mm. For conduits above 32 mm dia. Metallic conduits of 19 mm dia. and below shall not be used. Conduit accessories (Boxes etc.) shall conform to IS-5133-1968 and IS-2667-64 (amended-revised to date). Conduit pipes shall be jointed, wherever necessary by means of screwed couples and screwed accessories only. In Long distance straight, run of conduits inspection type couplers at suitable intervals shall be provided.
3.1.3 Threads on conduit pipes shall be between 13 mm to 19 mm long.

3.1.4 The wiring shall be carried-out as per IS 732-1989 (Amended and revised to date).

3.2 Flush inspection covers shall be provided in case of Concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.

3.3 The wires shall be drawn only after all the conduits have been properly fixed in position. Fish wires (steel wire : 16 SWG) shall be laid in conduits for drawing of wires subsequently.

4. **Control Cabling/wiring**

4.1 Control cables shall be 1100 volts grade, as per IS 1554, made from copper conductor of 1.5 Sq mm PVC insulated single Core, strip armoured with an overall PVC sheathing.

4.2 The cables and conduits wiring shall be carried out as per details given under 2.2 and 2.3 above.

5. **Earthing**

5.1 All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of G.I. earthing conductors shall be :-

<table>
<thead>
<tr>
<th>Size of phase wire sq.mm</th>
<th>Size of G.I. conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Tape/Wire (Swg)</td>
</tr>
<tr>
<td>185</td>
<td>25 mm x 6 mm (strip)</td>
</tr>
<tr>
<td>150</td>
<td>25 mm x 6 mm (strip)</td>
</tr>
<tr>
<td>120</td>
<td>25 mm x 6 mm (strip)</td>
</tr>
<tr>
<td>95</td>
<td>4 Swg</td>
</tr>
<tr>
<td>70</td>
<td>4 Swg</td>
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<tr>
<td>50</td>
<td>6 Swg</td>
</tr>
<tr>
<td>35</td>
<td>6 Swg</td>
</tr>
<tr>
<td>25-6</td>
<td>6 Swg</td>
</tr>
<tr>
<td>4</td>
<td>6 Swg</td>
</tr>
</tbody>
</table>

Note :- Aluminium earthing conductors of equivalent Size may be used in lieu of GSS conductors mentioned above.

6. **Miscellaneous**

6.1 The final connections to the equipment shall be through Flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.

6.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.

6.3 Two separate and distinct earthing conductors shall be Connected from the equipment upto the main switch board panel.
6.4 The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.

6.5 The entire installation shall be tested as per Electricity rules and I.S.S. 732-1973 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorised person. The test report will be obtain by contractor himself at his own expenses.

6.6 All exposed switch board panels, conduits, hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.
Section 7  Control Panel, Motors & Switch Gears

1. **General**

1.1 The motor and switchgears required for various items shall generally be as per specifications given below. All electric motors shall be suitable for 3 phase, 50 Hz, 415 + 10% - 15% Volts A.C. supply.

2. **L.T. Electric Panel Boards**

2.1 The main L.T. Panel board shall be extendible type on both sides, having in it all switches, starters & accessories and shall be completely factory prewired. It shall be suitable for voltage systems upto 500 volts, 3 phase, 50 Hz, 4 wire supply capable of functioning satisfactorily in temperatures of 45°C and rupturing capacity not below 31 MVA at 415 Volts.

2.2 The main frame shall be fabricated from 2.0 mm thick, cold rolled M.S. Sheets. The front opening door panels shall be from 1.6 mm thick, cold rolled M.S. Sheets. Suitable stiffners shall be used in fabricating the housing. All steel members shall first be degreased, then descaled using dilute sulphuric acid and a suitable phosphating process then the boards shall be given 2 coats of red oxide primer with powder coated finish in RAL-7032 shade. The switch board shall be dust proof and vermin proof. The panel shall generally conform to IS 8623 (full confirmity not called for). It shall be flush in front and back. The panel shall have front and rear access.

2.3 Cable compartment of adequate size shall be provided in the main distribution board for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate support shall be provided in cable compartment to support cables. All incoming and outgoing switch terminals shall be brought out to terminal blocks in cable compartments.

2.4 Items such as ammeters, switches etc. shall be located close to the corresponding switchgear and otherwise all items shall be arranged in a neat symmetrical pattern.

2.5 The doors of the switch compartments and cable access shall be hinged type and that of busbars shall be fixed type.

2.6 The knobs of the hinged doors shall be provided with a locking arrangement to prevent them from falling down when they are unscrewed for opening the doors.

2.7 All panel doors shall have synthetic rubber gaskets with good ageing, compression and resistance characteristics.

2.8 All the breakers shall be interlocked with door so that the unit cannot be closed unless the unit door is closed. The interlock shall also prevent opening the unit door unless the switch/breaker is in OFF position.

2.9 Defeat arrangement shall be provided for deliberate inspection of switch/breaker without having to switch OFF the unit.

2.10 All the units pertaining to a motor shall be incorporated in one cabin i.e switch, starter, CTS ammeter, current operated MPRD-2 single phasing preventor, indicating lamps etc.
2.11 A danger notice plate of 200 mm x 150 mm of mild steel at least 2 mm thick vitreous enamelled white on both sides and with inscriptions in signal red colour on front side shall be provided on the panel board.

2.12 Every starter/contactor etc. shall be controlled by an isolating device of adequate rating as listed later.

2.13 A voltmeter and ammeter shall be provided to indicate incoming voltage and along with rotary phase selection switches.

2.14 Ammeters shall be provided for incoming current to all motor.

2.14.1 Ammeters for all the motors shall be CT operated with selector switch.

2.15 LED type indicating lamps in approved colours shall be provided for the 3 phases and for status of all controlled devices.

2.16 All the switchgear shall be earthed to the earth bus.

2.17 Earth shall be extended for each compartment to the door by means if a flexible, insulated copper conductor with crimped legs on either side.

2.17.1 Each panel shall be provided with suitable size of earth bus at the rear of the panel and two earth terminals on either side.

2.17.2 Suitable printed PVC ferrules shall be provided for all the conductors for easy identification.

2.18 Etched plastic name plates shall be provided for all the incoming, outgoing switchgears, ammeter, voltmeter etc.

2.19 All the control and auxiliary wiring shall be carried out with PVC insulated copper conductor of proper colour code.

2.20 The power wiring from the circuit/air breakers to the starters shall be carried out using colour coded, PVC insulated copper conductors crimped with lugs.

2.21 The outgoing wires of starters shall also be pvc insulated colour coded copper conductor crimped with lugs and terminated on a terminal block of proper rating.

**Important Note**
All Panel fabrication drawings shall be got approved, before the start of the fabrication work.

3. **Bus Bars**

3.1 The Bus Bar shall be mounted in a separate compartment in the Panel Board.

3.2 The Bus Bars and interconnections shall be of aluminium strips of Electrolytic grade E-91 unless otherwise specified.

3.3 The Bus Bar shall have rectangular cross-section of 0.8 Amp/Sq.mm per Amp. rating for full load current in the 3 phases as well as for neutral and should be extendable, if mounted horizontally.
3.4 The Bus Bars shall be insulated with heat shrink sleeves and colour coated. They should be supported on supports made of glass fibre reinforced thermosetting compound at regular intervals sufficient to withstand the force of any short circuit.

4. **Circuit Breakers**

The panel and the bus bars plus outgoing of all devices shall be protected by different types of circuit breakers as described below and conforming to specification as given later on:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type</th>
<th>Upto 40 Amp.</th>
<th>63 A</th>
<th>80 to 200 A</th>
<th>Above 200 to 400 A</th>
<th>Above 630 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Incoming</td>
<td>MCB</td>
<td>MCCB</td>
<td>MCCB</td>
<td>MCCB</td>
<td>ACB</td>
</tr>
<tr>
<td>2.</td>
<td>Outgoing</td>
<td>MCB</td>
<td>MCB</td>
<td>MCCB</td>
<td>MCCB</td>
<td>ACB</td>
</tr>
</tbody>
</table>

4.1 **Air Circuit Breaker (ACB)**

4.1.1 The air Circuit Breakers shall be Draw out type conforming to I.S: 13947 (Part 2) 1993.

4.1.2 The ACB shall be complete with solid state overload, short circuit and earth fault protection with adjustable settings.

4.1.3 Each ACB shall have 4 ‘NO’ and 4 ‘NC’ potential free auxiliary contacts, in addition to those required for its internal operating mechanisms.

4.1.4 There shall be suitable indicators for OPEN/CLOSE/SERVICE/TEST and Spring charged positions.

4.1.5 It shall be possible to close the door in Test position.

4.1.6 Castle Key and/or other interlocking devices shall be provided as required.

4.2 **Moulded Case Circuit Breakers (MCCB)**

4.2.1 The MCCB shall have TP + NL and be suitable for simultaneous manual opening and closing with rotary operating handle.

4.2.2 The ON/OFF/TRIP positions shall be clearly marked and easily visible to an operator and confirm to latest IS: 13947-1993.

4.2.3 There shall be fixed/adjustable tripping devices with inverse time characteristics for overload and short circuit protection.

4.2.4 Suitable Interlocking mechanism shall be provided, where required.

4.3 **Miniature Circuit Breakers (MCB)**

4.3.1 The MCB shall have quick make/break contacts with a heat resistant housing, having high Impact strength and confirm to IS 8828-1996.

4.3.2 The contacts shall be of silver nickel alloy.
4.3.3 The MCB shall permit over load for short duration, as required for Inductive loads and the breaking capacity shall not be less than 10 KV at 415 Volt A.C.

4.3.4 It shall be equipped with overload and short circuit protection devices and shall be suitable for DIN mounting.

4.4 **Isolator Switches**

4.4.1 Isolator switches are to be provided for equipment located outdoors or for those located in separate enclosure, other than those Nos. having the Electric Panel.

4.4.2 The Isolator Switch should be of Rotary Load Break type with a weather proof sheet steel enclosure. Its rating shall be same as the outgoing device in the Electric Panel.

5. **Contactors**

All non inductive loads shall be provided with suitable sized magnetic contactors.

5.1 The contactors shall have 3/4 poles plus a minimum 2 ‘NO’ and 2 ‘NC’ contacts. All contacts shall be of solid silver.

5.2 The No volt coil shall generally be suitable for 220 Volts + 10%, - 15% (wide band type) A.C. supply except when specified or required otherwise.

6. **Starters**

6.1 The type of starters to be provided for the motors shall be as follows:

6.1.1 Squirrel Cage motors : upto 7.5 HP (5.6 KW) Direct on Line Type
6.1.2 Squirrel Cage motors : Above 7.5 HP (5.6 KW) Automatic Star Delta Type
6.1.3 Compressor motor: Above 300 HP (225 KW) Automatic Auto Transformers (where specified)
6.1.4 All starters shall have auxiliary contacts for interlocking different machines, connecting indicating lights, controls, alarms, etc.
6.1.5 All starters shall be provided with separate single phasing preventors.

6.2 **Direct On-Line Starters**

6.2.1 These starters shall have heavy duty air break contactors of suitable rating.

6.2.2 These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be “hand reset” type.

6.2.3 The “No Volt Coil “ of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls on safety devices are connected in the starters circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

6.3 **Automatic Star Delta Starters**

6.3.1 These starters shall have heavy duty air break contactors of suitable ratings along with an adjustable timer to automatically switch the motor connections from star to delta connections.
6.3.2 Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.

6.3.3 The "No Volt Coil" shall be of 220 Volts + 10% - 15% (wide band type) rating wherever any controls of safety device are connected in the starter circuit, otherwise standing 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

6.4 **Automatic Auto-Transformer Starter**

6.4.1 These starters will be oil immersed, each one fixed on a separate panel.

6.4.2 Necessary devices shall be provided for the automatic tap setting of the starter.

6.4.3 The starter should have "No Volt Coil" wide band type circuit of 220 volts to be connected to control circuits.

6.5 The Motor starter shall be in accordance with IS 1882. The starter shall be totally enclosed metal clad, dust and vermin proof construction. The starter shall be of continuos rating.

6.6 Contactors shall have the number of poles as required for appropriate duty. The making capacity of the starters shall be as per AC 23 of ISS.

7. **Panel Accessories**

7.1 All Voltmeters and Ammeters as specified shall be square of 96 mm x 96 mm, flush mounting type.

7.2 The Indicating Lamps shall be of LED type with Low Watt Power. The Lamps shall have translucent covers of following colours.

7.2.1 Red/Yellow/Blue for phase light.
7.2.2 Green/Amber for ON/OFF indication.
7.2.3 Concealed door lock.

8. **Subsidiary Panels (With Single Switch)**

8.1 Subsidiary panels shall be provided for equipment located away from the plant room, such as air handling units, blower etc.

8.2 The construction of these panel should be similar to the main panel and shall have all related accessories, except when specified.

8.3 The sub panel shall be wall hung type and as compact as possible.

8.4 Panel fabrication drawings shall be got approved before fabrication.

9. **Squirrel Cage Motors**

9.1 The squirrel cage motors shall be either screen protected or totally enclosed fan cooled, depending on the application and as stated in "schedule of equipment". All motors shall conform to IS 325/1978, IS:1231 for foot mounted motors and IS:2223 for flange mounted motors.
9.2 The stator windings shall be with class ‘B’ insulation.

9.3 Motors shall be provided with ball/roller bearings. Bearings shall have ample capacity to deal with any axial thrust. Suitable grease nipple shall be provided for re-greasing the bearings.

9.4 Motors shall be provided with a cable box for terminating the PVC insulated, PVC sheathed armoured aluminium cables. Motor shall be suitable for 400 volts ± 10% and 50 Hz ± 5%.

9.5 Degree of protection for all motors shall IP-55.

10. **Installation of Motor**

10.1 Installation of the motor shall be in accordance with IS-900.

10.2 The motor along with its driven machine or equipment shall be provided with vibration isolation arrangement motors shall generally be provided with slide rails fixed to the base units nuts and bolts to facilitate belt installation and subsequent belt tension.

10.3 Motors shall be wired as per the detailed specifications and drawings all the motor frame shall be earthed with 2 Nos. of earthing conductors.

10.4 Motors shall be tested at works in accordance with the relevant Indian standard specifications and test certificates shall be furnished in triplicate.

Note: Rubber mats of 1100 volts capacity shall be laid in front of panel as per site requirement and no extra shall be paid.

11. **Painting**

All sheet steel work shall undergo a multi tank process of degreasing, pickling in acid, cold rinsing, phosphating, passivating and then sprayed with a high corrosion resistant primer. The primer shall be baked in oven. The finishing treatment shall be by application of epoxy powder coated paint of approved shade.
## Section 8
### Technical Data

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and bill of quantities.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Unit</th>
<th>Condition of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Split Units</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Make</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Model</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Nominal Cooling Capacity</td>
<td>TR</td>
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</tr>
<tr>
<td>1.4</td>
<td>Actual Cooling Capacity at 44 °C Ambient Temp.</td>
<td>TR</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Air Quantity of Cooling Unit</td>
<td>Cubm./Hr.</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Power Supply Requirement</td>
<td>3 PH/1PH</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>Power Consumption at Rated capacity</td>
<td>KW</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>Max. Current</td>
<td>AMPS</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>Running Current</td>
<td>AMPS</td>
<td></td>
</tr>
<tr>
<td>1.10</td>
<td>Size of Indoor Unit</td>
<td>MMxMMxMM (H)</td>
<td></td>
</tr>
<tr>
<td>1.11</td>
<td>Size of Outdoor unit</td>
<td>MMxMMxMM (H)</td>
<td></td>
</tr>
<tr>
<td>1.12</td>
<td>Type of support provided for outdoor unit</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>1.13</td>
<td>No. of Blower fans for Indoor unit</td>
<td>Nos.</td>
<td></td>
</tr>
<tr>
<td>1.14</td>
<td>Direction of fan discharge at Outdoor unit</td>
<td>Top/Side</td>
<td></td>
</tr>
<tr>
<td>1.15</td>
<td>Type of Filter</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>1.16</td>
<td>Noise level of Outdoor Unit</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>1.17</td>
<td>Noise level of Indoor Unit</td>
<td>dB</td>
<td></td>
</tr>
</tbody>
</table>

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Section 9  

Mode of Measurements

1. **Unit Prices in the Schedule of Quantities**

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

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

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

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

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

1.2.4 All the necessary measures to prevent the transmission of vibration.

1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.

1.2.6 Storage and insurance of all equipment apparatus and materials.

1.3 The contractor’s unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2. **Measurements of Sheet Metal Ducts, Grilles/Diffusers etc.**

2.1 **Sheet Metal Ducts**

2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the BOQ.

2.1.2 The unit of measurements shall be the finished sheet metal surface area in square metres. No extra shall be allowed for lapse and wastages.

2.1.3 All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.
2.1.4 The unit duct price shall include all the duct hangers and supports, dash fastners for supports and making good of the same as well as any materials and labour required to complete the duct frame.

2.2 **Grilles/Diffusers**

Grilles / Diffusers should be measured as follows:

2.2.1 All measurements of grilles shall be of the actual outlet size excluding the outer flanges.

2.2.2 The square or rectangular diffusers shall be measured in plain SQ.M. of neck areas, except for diffusers suitable for T-bar installation, which shall be measured in numbers.

2.2.3 All round diffusers and grilles shall be measured by their diameters in CM.

2.2.4 All linear diffusers and grilles shall be measured as per actual length in metres excluding outer flanges.

3. **Measurements of Piping, Fittings, Valves, Fabricated items.**

3.1 **Pipe**

3.1.1 All pipes shall be measured in linear metre (to the nearest CM) along the axis of the pipes and rates shall be inclusive of all fittings e.g. Tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.

3.1.2 Rate shall include exposing reinforcement in wall and ceiling and floors if possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.

3.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the project co-ordinator.

3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

3.1.5 The length of the pipe for the purpose of payment will be taken through the centreline of the pipe and all fittings (e.g. Tees, bends, reducers, elbows, hangers, structural supports etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies. Rate quoted shall be inclusive of all supports, hangers etc. and no additional measurement would be taken.

3.2 **Valves and Flanges**

3.2.1 All the extra CI & CM flanged valves shall be measured according to the nominal size in MM and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made, wherever valves occur.

3.2.2 All gun metal (gate & globe) valves shall include 2 Nos. of flanges and 2 Nos. 150 MM long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. Slip-on-
flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 MM thick insertion gasket of required temp. grade and all items specified in the specifications.

3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

3.2.4 Rates shall be inclusive of insulation, if required.

4. **Insulation**

4.1 The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

4.2 **Pipes, Ducts & Vessels**

4.2.1 **Pipes**

The measurements for installation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is R1 and the inner radius is R2. The centreline radius shall be measured as \((R1+R2)/2\). Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

4.2.2 **Ducts**

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

4.2.3 **Vessels**

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

4.3 **Accessories Insulation**

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated are in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.
4.4 **Acoustic Duct Lining**

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

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

4.5 **Roof and Wall Insulation & Acoustic Treatment**

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

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

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## Section 10

### SAFETY CODES

1. **IS 659**: (Reaffirmed 1991)
   Safety code for air-conditioning (revised) (Amendment 1).

2. **IS 660**: (Reaffirmed 1991)
   Safety code of mechanical refrigeration. (revised).

3. **IS 3233**: 1965 (Reaffirmed 1992)
   Glossary of terms for safety and relief valves and their parts.

   Safety relief valves.

5. **IS 954**: 1989
   Functional requirements for carbon dioxide tender for fire
   brigade use. (2nd revision)

6. **IS 1641**: 1988 (reaffirmed 1993)
   Code of practice for fire safety of buildings (general) : General principles of fire
   grading and classification. (1st revision)

7. **IS 1642**: 1989
   Code of practice for fire safety of buildings. (general) : Details of construction (1st
   revision) (1645 supersedes 1642)

8. **IS 1643**: 1988 (Reaffirmed 1993)
   Code of practice for fire safety of buildings (general : Exposure hazard (1st
   revision)

9. **IS 1644**: 1998 (Reaffirmed 1993)
   Code of practice for fire safety of buildings (general) :
   Requirements and personal hazard.

10. **IS 1646**: 1982 (Reaffirmed 1990)
    Code of practice for fire safety of buildings (general) : Electrical installation (1st
    revision)

11. **IS 3786**: 1983 (Reaffirmed 1991)
    Methods for computation of frequency and severity rates for industrial injuries
    and classification of industrial accidents. (1st revision)

12. **IS 3808**: 1979 (Reaffirmed 1990)
    Method of test for non combustibility of building materials (1st revision)

13. **IS 5311**: 1969 (Reaffirmed 1990)
    Code of safety for carbon tetra chloride.

14. **IS 6382**: 1984 (Reaffirmed 1990)
    Code of practice for design and installation of fixed carbon dioxide for fire
    extinguishing system (1st revision)
15. IS 7969: 1975 (Reaffirmed 1991)
Safety code for handling and storage of building materials
(Amendment 1)
### Section 11  List of Approved ‘Makes’

**Note:** The tenderer must indicate the makes he has used to cost his tender. An alternate make may be indicated as a substitute to be used if the offered make become unavailable. More than (2) two makes are Not to be indicated.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items</th>
<th>Approved Makes</th>
<th>Make Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In Tender</td>
<td>Alternate</td>
</tr>
<tr>
<td><strong>EQUIPMENT/UNIT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>VRV System/split units</td>
<td>Daikin/Toshiba/LG/Samsung/Mitsubishi</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Split unit Cassette Type / Hi wall Type/Ductable Type/ Floor Mounted</td>
<td>Carrier/Hitachi/Voltas/LG/Blue star</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Voltage Stabilizer</td>
<td>Bluebird/Sky Line/V-Guard</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Air Washer</td>
<td>Crystal/Zeco/Airflow</td>
<td></td>
</tr>
<tr>
<td><strong>FANS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Inline Fan</td>
<td>Caryaire/ Systemair/ Greenheck/ Tristar</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Exhaust Blower (Forward curved)</td>
<td>Nictora/Comefri/Kruger</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Axial Fans</td>
<td>Humidin/Airflow/Vaiostar / Damair</td>
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</tr>
<tr>
<td><strong>PIPING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Refrigerant Copper Pipe</td>
<td>Merchant/Malaysian/Hitachi/ Mettube/Totaline/Rajco Metals</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>PVC Drain Pipe</td>
<td>Polypack/Supreme/Akg/BEC</td>
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</tr>
<tr>
<td><strong>INSULATION</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Nitrile Rubber</td>
<td>Armaflex/Vidoflex/superflex/ K-flex</td>
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</tr>
<tr>
<td>2.</td>
<td>Crossed linked Polyethylene</td>
<td>Torcellene/Thermobreak</td>
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<tr>
<td><strong>ELECTRICAL</strong></td>
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<td></td>
</tr>
<tr>
<td>1.</td>
<td>Power Cable</td>
<td>KEI/Skytone/ Rallison/National</td>
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<tr>
<td>2.</td>
<td>Control Cable</td>
<td>KEI/Skytone/ Rallison/National</td>
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<tr>
<td>3.</td>
<td>XLPE / PVC Insulated Aluminum Conductor Armoured Power Cables</td>
<td>Skytone/Universal/Delton/NICCO/ RPG Asian</td>
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</tr>
<tr>
<td><strong>FACTORY MADE DUCT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Rectangular</td>
<td>Ductofab/ Zeco/Rolastar</td>
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</tr>
<tr>
<td>2.</td>
<td>Round</td>
<td>Atco/GP Spiro</td>
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</tr>
<tr>
<td>3.</td>
<td>G.I. Sheet Metal Duct</td>
<td>Jindal/National/Tata</td>
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</tr>
<tr>
<td>4.</td>
<td>VCD/Gravity louvers/ Exhaust &amp; fresh air louvers</td>
<td>Air Flow/Vaiostar/ Mapro/Tristar</td>
<td></td>
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</tbody>
</table>